Installation Guidance for Centerline and Edgeline Rumble Strips in Narrow Pavements

tech transfer summary

Centerline and edgeline or shoulder rumble strips are effective low-cost countermeasures for reducing cross-centerline and run-off-road crashes.

Background

Centerline rumble strips (CLRS) and edgeline rumble strips (ELRS) or shoulder rumble strips (SRS) have proven to be effective low-cost countermeasures for preventing head-on, opposite-direction sideswipe, and run-off-road crashes.

Many agencies have minimum pavement width dimensions that must be met for rumble strips to be installed along a roadway segment. These minimum widths help limit the number of times the rumble strips are struck inadvertently. Moreover, minimum shoulder widths are generally established on roadways with regular pedestrian and bicycle traffic to ensure that sufficient space is available for non-motorized users.

Problem Statement

While rumble strips can usually be accommodated without issue on wide pavements, proper placement is less straightforward on highways with paved widths less than 24 ft. Meanwhile, limited guidance is available regarding the minimum pavement width necessary to install both CLRS and SRS/ELRS in combination, or which to install when the installation of both types on one segment is not feasible.

Shoulder rumble strips on a two-lane roadway in rural Iowa

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RESEARCH PROJECT TITLE

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SPONSORS

Iowa Highway Research Board
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MORE INFORMATION

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The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC). Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

MTC's research focus area is State of Good Repair, a key program under the 2012 federal transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MTC research focuses on data-driven performance measures of transportation infrastructure, traffic safety, and project construction.

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Objective

The purpose of this research was to provide guidance to help county road agencies and the Iowa Department of Transportation (DOT) determine when to install rumble strips on narrow pavements based on various site-specific factors, such as traffic volume, roadway alignment, and shoulder type.

Research Description

This research included three component studies:

- The researchers conducted an analysis of historical crash data for roadway segments with various rumble strip configurations on the Iowa primary highway system to assess the risk of cross-centerline and run-off-road crashes. To maximize the applicability of this research to the paved secondary roadway network, only the two-lane undivided portion of the primary roadway network was considered.

  Configurations included ELRS/SRS only, CLRS only, and both ELRS/SRS and CLRS. The research team compared crash rates for these segments to similar control segments without rumble strips while controlling for the effects of other pertinent factors, such as lane and shoulder widths.

  To estimate the cost-effectiveness of rumble strip installation for these configurations, the researchers conducted a benefit/cost (B/C) analysis to compare the crash cost savings to the installation costs associated with CLRS, ELRS/SRS, and the combination of both.

- The researchers conducted field studies of road user behavior to determine how the presence of CLRS and SRS/ELRS affected the lateral position of vehicles along two-lane highways on the primary (i.e., state-maintained) and paved secondary (i.e., county-maintained) systems in Iowa. Road segments with different cross-sectional characteristics (e.g., lane width or shoulder width) and varying combinations of rumble strip installations (i.e., CLRS only, SRS/ELRS only, or CLRS and SRS/ELRS) were observed. Control segments without rumble strip installations were also observed.

  In all, 53 locations within 14 Iowa counties were examined. A data collection team manually collected roadway geometry information and rumble strip dimensions at each site. Motorist interactions with SRS and/or CLRS were collected using a data collection trailer, which consisted of a video camera and Wavetronix radar sensor.

- The researchers conducted a road user survey at 10 Iowa DOT driver's license stations across the state to gauge public opinion on rumble strips. The survey solicited feedback on the operational and safety effects of rumble strips, as well as on the secondary impacts such as noise, effects on passing maneuvers, and bicyclist safety.

  The surveys were conducted in counties known to have rumble strip installations to increase the probability that survey participants had interacted with rumble strips while driving on the paved secondary highway system.

Key Findings

- The rates of centerline-related crashes per mile per year are a function of traffic volume and lane and shoulder widths. Crash rates are higher for road segments with lane widths from 10 to 11.5 ft than for segments with lane widths of 12 ft or more. For all lane widths, segments with paved shoulders less than 2 ft wide or non-paved shoulders less than 4 ft wide experience higher crash rates than segments with wider shoulders. Road segments with narrow lanes and shoulders experience higher centerline-related crash rates when traffic volumes are as low as 1,200 vehicles per day (vpd), while segments with wider lanes and shoulders experience similar crash rates when traffic volumes are 1,900 vpd.

Data collection trailer components, including a 360° camera, Wavetronix sensor, and solar panel

- Road segments with narrow lanes and shoulders experience higher rates of edgeline-related crashes when traffic volumes are as low as 600 vpd. In contrast, segments with 12 ft lanes and wider shoulders only experience a similar edgeline-related crash rate when traffic volumes reach 2,100 vpd.

- The analysis of historical crash data showed that both CLRS and SRS/ELRS tend to reduce crashes. The reduction is greatest for CLRS, although both SRS and ELRS were found to reduce crashes.

- The crash data analysis revealed a synergistic effect, wherein the combination of CLRS with SRS/ELRS led to a greater reduction in lane departure crashes than either installation alone.

- The field study results showed that rumble strips are generally associated with fewer instances of drivers deviating from their travel lanes. This finding suggests that rumble strip installations effectively provide drivers with feedback and help them stay in their lanes and avoid potential cross-centerline or run-off-road crashes.

- Statistical analysis of the field data showed that rumble strips and other roadway characteristics affect centerline and edgeline encroachment rates. In particular, roads with lower posted speed limits, narrow lanes, paved shoulders, and horizontal curves are associated with an increased likelihood of edgeline encroachments. Large vehicles are also more likely to encroach on the centerline or edgeline.

Still frame from a traffic camera showing vehicle encroaching on the centerline

- The results of the road user survey indicate that Iowa motorists are generally supportive of rumble strip installations. Rumble strips were perceived to have minimal adverse impacts on roadway operations, including passing and traffic speeds, although some respondents indicated concerns regarding noise and bicycle safety. Most respondents found that rumble strips have an impact when needed, i.e., when a vehicle unintentionally departs the roadway.

Implementation Readiness and Benefits

The B/C ratios estimated for various lane widths, shoulder widths, and traffic volumes suggest that rumble strips are a cost-effective crash countermeasure nearly everywhere on the two-lane rural highway network.

Recommendations and guidance based on the results of this research can help agencies determine scenarios in which the implementation of rumble strips is warranted as follows:

- The results of this research suggest that rumble strips are viable for installation over the vast majority of the two-lane undivided roadway network, with the exception of areas with relatively high levels of development. Noise issues and bicycle safety should be considered when deciding where to install rumble strips.

- Centerline rumble strips can most benefit road segments with either narrow lanes and shoulders and traffic volumes of 1,200 vpd and above or wider lanes and shoulders and traffic volumes of 1,900 vpd. Edgeline/shoulder rumble strips can most benefit road segments with either narrow lanes and shoulders and as little as 600 vpd or wider lanes and shoulders above 2,100 vpd.

- The crash prediction models (i.e., safety performance functions or SPFs) developed as a part of this research can be used to identify those segments that represent the most promising candidate locations for subsequent rumble strip installations. The series of SPFs that the team developed can be used to estimate the expected number of cross-centerline and run-off-road crashes for a segment with specific characteristics. These SPFs provide a means for conducting network screening to identify locations where CLRS and/or SRS/ELRS may provide the greatest benefit.

- Candidate rumble strip locations should be prioritized based on characteristics such as lane width, shoulder width, and annual average daily traffic.