

TRANSPORTATION RESEARCH SYNTHESIS

Subject Area: Traffic

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Transverse Rumble Strips



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This Transportation Research Synthesis provides brief summaries of recent research on a topic of current interest. Online links are active at the time of publishing, but may change.

INTRODUCTION

The Federal Highway Administration (FHWA) defines rumble strips “as raised or grooved patterns on the roadway shoulder that provide both an audible warning (rumbling sound) and a physical vibration to alert drivers that they are leaving the lane.” Cities and counties may use rumble strips as means of enhancing safety to help warn motorists to slow down in anticipation of a stop sign or to help warn motorists that they are leaving the roadway or crossing the centerline.

The FHWA also classifies rumbles strips into three types:

- Shoulder rumble strips (SRS): The most common type located on the road shoulder of expressways, interstates, parkways, and two-lane rural roadways
- Centerline rumble strips (CRS): Often used on two-lane rural roadways
- Transverse rumble strips (TRS): Installed on approaches to intersections, toll plazas, horizontal curves, and work zones.

The FHWA asked states to implement policies and programs for the appropriate use of milled SRSs. While several state studies show significant changes in the number of crashes after installation of SRSs, there is less information available about TRSs. This synthesis offers a summary of national and international research, national perspectives, Minnesota studies, and state and local practices and policies regarding TRSs.

NATIONAL AND INTERNATIONAL RESEARCH

In an early study on rumble strips, Iowa State University researchers concluded the following in 1982: “The results of this research strongly suggest that in many instances the installation of rumble strips will have no effect on the occurrence of accidents.”

In Texas, a series of recent research studies explored the impacts of transverse rumble strips:

- *Traffic Operational Impacts of Transverse, Centerline, and Edgeline Rumble Strips (2005)*
http://tti.tamu.edu/publications/catalog/record_detail.htm?id=25726

This 30-month project included an evaluation of TRSs and centerline rumble strips (CRSs). Researchers collected before-and-after data at 10 stop-controlled intersection sites and at five horizontal curve sites. For most sites, installation of TRSs resulted in no significant speed change between the warning sign speed trap and intersection speed trap. Of the sites that did show statistically significant reductions in speed



changes, only three sites showed reductions that were larger than one mile per hour. While the study concluded that transverse rumble strips offer a low-cost and easy-to-install option, they “did not seem to be successful at reducing approach speeds at the project sites.”

- *Speed Changes Due to Transverse Rumble Strips on Approaches to High-Speed Stop-Controlled Intersections (2006)*

Available through the Transportation Research Board

In this project, researchers measured speeds at three locations along the approach to rural stop-controlled intersections before and after installation of TRSs. The overall impact in speed change reductions was equal to or less than one mile per hour.

- *Evaluation of Erratic Maneuvers Associated with Installation of Rumble Strips (2006)*

<http://trb.metapress.com/content/e427140102k80w6h/>

This study found no evidence that installation of TRSs resulted in erratic maneuvers by drivers.

- *Research Recommendations for Uniform Rumble Strip Applications in Texas (2005)*

http://tti.tamu.edu/publications/catalog/record_detail.htm?id=25727

As a result of synthesis of rumble strip use and projects, researchers “recommended a limited use of TRSs until follow-up work determines the safety impacts of TRSs.” Researchers did develop a layout for the future and also recommended the use of CRSs and edgeline rumble strips on conventional highways in Texas.

In Ohio, researchers recommended use of only milled-in SRSs and CRSs, as part of *Human Factors Opportunities to Improve Ohio’s Transportation System (2005)*.

<http://www.dot.state.oh.us/research/2005/Traffic/134154-ES.pdf>

In North Carolina, one county installed several safety improvements, including TRSs, and noted a significant crash reduction rate. In Spot Safety Project Evaluation (2006), researchers conducted a

before-and-after analysis of the installation of TRSs on the intersection of SR 1605-Paul Payne Store Road and SR 1610-Millersville Road in Alexander County. Two fatal crashes occurred at this intersection before TRSs installation, and other treatments including stop signs, stop-ahead signs, and an overhead flash. Researchers estimate a crash reduction range of 60 to 80 percent. They also noted a minimal vibrating effect and suggested the need for maintenance improvements on the TRSs.

http://www.ncdot.org/doh/preconstruct/traffic/Safety/ses/projects/completed_files/docs/SS1299201.pdf

In Canada, the Canadian Council of Motor Transport Administrators took a closer look at rural road safety issues in the country. According to the *2006 Rural Road Safety in Canada: Traffic Collision Trends and Recommended Strategies*, “TRS are an extraordinary traffic control measure when all other usual treatments such as signing, lane markings, and improvements to the geometric layout cannot eliminate the highly probable element of unexpectedness in the driving environment.”

The Transportation Association of Canada published *Best Practice Guidelines for the Design and Application of Transverse Rumble Strips*, which provides an overall summary of key research findings. Previous research shows that “the effectiveness of TRS on speed reduction ranges from minimal to no effect.” It also discourages the widespread use of TRS and adds: “Locations where there is an over representation and where conventional warning methods, such as signs and signals, are inadequate could be considered for TRS installation.” The publication includes warrants as part of its guidelines.

NATIONAL PERSPECTIVES

The FHWA Manual on Uniform Traffic Control Devices (MUTCD) includes Section 6F.84 Rumble Strips, which provides the following technical guidance on the use of transverse rumble strips.

“Support: Transverse rumble strips consist of intermittent narrow, transverse areas of rough-textured or slightly raised or depressed road surface that extend across the travel lanes to alert drivers to unusual vehicular traffic conditions. Through noise and vibration, they attract the driver’s attention to such features as unexpected changes in alignment and to conditions requiring a stop. Longitudinal rumble strips consist of a series of rough-textured or slightly raised or depressed road surfaces

located along the shoulder to alert road users that they are leaving the travel lanes.

“Standard: If it is desirable to use a color other than the color of the pavement for a longitudinal rumble strip, the color of the rumble strip shall be the same color as the longitudinal line the rumble strip supplements. If the color of a transverse rumble strip used within a travel lane is not the color of the pavement, the color of the rumble strip shall be white.

“Option: Intervals between transverse rumble strips may be reduced as the distance to the approached conditions is diminished in order to convey an impression that a closure speed is too fast and/or that an action is imminent. A sign warning drivers of the onset of rumble strips may be placed in advance of any rumble strip installation.

“Guidance: Transverse rumble strips should be placed transverse to motor vehicle traffic movement. They should not adversely affect overall pavement skid resistance under wet or dry conditions. In urban areas, even though a closer spacing might be warranted, care should be taken not to promote panic braking or erratic steering maneuvers by drivers. Rumble strips should not be placed on sharp horizontal or vertical curves. Transverse rumble strips should not be placed on roadways used by bicyclists unless a minimum clear path of 1.2 m (four feet) is provided at each edge of the roadway or on each paved shoulder as described in AASHTO’s *Guide to the Development of Bicycle Facilities* (see Section 1A.11). Longitudinal rumble strips should not be placed on the shoulder of a roadway that is used by bicyclists unless a minimum clear path of 1.2 m (four feet) is also provided on the shoulder.”



Sections 6G.3 and 6H.11 also mention rumble strips as possible applications for complex conditions. The FHWA MUTCD is available at <http://mutcd.fhwa.dot.gov/>.

The NCHRP Report 440, *Accident Mitigation Guide for Congested Rural Two-Lane Highways*, sites some key issues with rumble strips: “Specific concerns

that affect the design for rumble strips and the locations where rumble strip installation is appropriate include noise created by rumble strip installation, motorist use of opposing lanes to avoid rumble strips, maintenance problems, motorist concerns, bicyclist concerns, and motorcyclist concerns.”

The NCHRP Report 500, *Guidance for Implementation of the AASHTO*

Strategic Highway Safety Plan, also discusses rumble strips: “Rumble strips should be used sparingly....Rumble strips are generally perceived to be effective in reducing intersection crashes when used appropriately, but there is no consensus on their effectiveness.” It also mentions potential difficulties of rumble strips including noise, problems for motorcyclists and bicyclists, challenges for snowplow operators, and inappropriate driver responses.

The NCHRP Report 476, *Guidelines for Design and Operation of Nighttime Traffic Control for Highways*, includes a statement about the effectiveness of rumble strips: “Although rumble strips do not necessarily produce a reduction in the speed of traffic, they can be effective in alerting inattentive drivers who fail to notice visual information.” The report also provides guidelines on installation, rumble strip patterns, and restrictions on use.

MINNESOTA RESEARCH

The Minnesota Local Road Research Board has sponsored a number of studies on transverse rumble strips, which are referred to in the reports as in-lane rumble strips:

Synthesis on the Effectiveness of Rumble Strips (2002)

This report analyzed the use and benefits of different types of rumble strips in Minnesota. Of the 68 counties that responded, 56 had installed in-lane rumble strips. According to the study, “while the use of the rumble strip continues to be popular, little documentation of before-and-after accident rates/crashes has been published.” It recommended a follow-up study to determine the effectiveness of in-lane rumble strips in helping inattentive and/or impaired drivers.

Stopping Behavior at Real-World Stop-Controlled Intersections With and Without In-Lane Rumble Strips (2006)

In this study, researchers gathered speed data from more than 400 vehicles on approaches to 10 intersections with in-lane rumble strips to determine the real-world stopping behavior of drivers. The research revealed that drivers slowed down earlier on approaches with rumble strips, on average two to five miles per hour. According to the study, “in-lane rumble strips facilitate safer stopping behavior at various intersection types, though their effect is most pronounced at intersections where cross-traffic is obscured.”

The Effects of In-Lane Rumble Strips on the Stopping Behavior of Sleep-Deprived Drivers (2005)

This research project involved evaluating the use of the impact of in-lane rumble strips on stopping behavior at simulated rural-controlled conditions. Results indicated that the 20 study participants started to slow down at the same time and finished braking at the same time, but did brake earlier when slowing down with rumble strips.

Reducing Crashes at Controlled Rural Intersections (2003)

This research project identified gap selection as the primary factor contributing to angle crashes at

controlled rural intersections. It also concluded: “Rumble strips do not appear to be effective at reducing the frequency of Ran the STOP crashes (intersections with or without rumble strips had the same frequency of crashes).”

The Effects of In-Lane Rumble Strips on the Stopping Behavior of Attentive Drivers (2001)

Researchers used a simulator to study braking patterns among sleep-deprived drivers who encounter transverse rumble strips before approaching a stop sign. While results reveal little difference in mean approach speeds, drivers did brake to a greater extent earlier in approaches with rumble strips.

These research reports are available online at www.lrrb.org

MINNESOTA DEPARTMENT OF TRANSPORTATION (Mn/DOT) REFERENCES

Mn/DOT includes references to rumble strips in several of its documents:

- Technical Memorandum No. 06-07-DS-01: Rumble Strips on Shoulders of Rural Trunk Highways establishes a policy for placement of rumble strips on shoulders of rural, state-owned highways, and Technical Memorandum No. 07-09-T-03: Edgeline Rumble Strips Guidance for Rural Trunk Highways establishes an interim guideline for placement of edgeline rumble strips on rural state trunk highways. There is no Technical Memorandum that addresses TRSs. Mn/DOT Technical memorandums are available at <http://www.dot.state.mn.us/tecsup/tmemo/>.

- *The Minnesota Manual on Uniform Traffic Control Devices* contains the same language as the FHWA MUTCD (see National Perspectives). The manual is online at

<http://www.dot.state.mn.us/trafficeng/otepubl/mutcd/>.

- *The Traffic Engineering Manual*

(<http://www.dot.state.mn.us/trafficeng/otepubl/tem/index.html>) includes the following reference:

“Rumble strips may be used when unusual alertness is required of drivers, and standard traffic control devices such as signs and/or flashers have apparently not proven to give adequate warning. Several strips are placed laterally across the pavement to cause a rumble or bumpy motion that, when traversed by a vehicle, will alert the driver. Typical locations for use of rumble strips are approaches to toll gates and to stop signs hidden by horizontal or vertical curves. Proximity of the rumble strip to the hazard is

important. If the rumble strip is located too close to the hazard, sufficient driver reaction time is not given; and if they are located too far away, the driver may not relate the rumble trip to the hazard.”

STATE AND LOCAL PRACTICES AND POLICIES

The FHWA rumble strip web site:

http://safety.fhwa.dot.gov/roadway_dept/rumble/index.htm

provides links to state specifications for rumble strips. Some examples of state approaches to policies and practices include the following:

- California

Main Streets: Flexibility in Design and Operations, Caltrans, January 2005

Suggests the selective use of TRSs on approaches to a main street “where a speed reduction is desired and where speed limit or warning signs are installed.”

- Maryland

Uses temporary transverse rumble strips in work zones. MUTCD includes guidelines that call for a traffic

engineering study to ensure that rumble strip placement is necessary and will be effective, use of temporary transverse rumble strips in advance of other traffic control methods, placement before the work zone location, and use with care at locations with high bicycle and motorcycle traffic volume.

<http://www.sha.state.md.us/businesswithsha/bizStds/Specs/desManualStdPub/publicationsonline/oots/mmutcd/mmutcd.asp>

- Oklahoma

Uses FHWA MUTCD language on TRSs (See National Perspective).

- Oregon

Is investigating the usefulness and impact of TRSs and other devices, according to *The Oregon Transportation Safety Action Plan (2006 Amendment)*.

Summary

The 2002 Synthesis on the Effectiveness of Rumble Strips mentions that past studies of the effectiveness of transverse rumble strips have been inconclusive. What does more recent research reveal?

Texas has conducted a series of studies on rumble strips, including transverse rumble strips. The research showed an overall impact in speed change reductions of equal or less than one mile per hour. The 2006 Minnesota study shows higher speed reductions of two to five miles per hour. None of these studies show a link between the installation of TRSs and crash reduction. Researchers in Texas recommended limited use of TRSs until additional follow-up work to determine safety impacts is available. The Canadian transportation report refers to TRSs as an “extraordinary traffic control measure” to use when other methods are not successful.

North Carolina experienced dramatic results in the installation of TRSs at an intersection with a record of two fatal crashes. However, other treatments also were used. The report also emphasized the need for regular maintenance of TRSs. Maintenance is an ongoing cost of rumble strip installation, as are other non-financial factors, such as noise, and concerns for motorcyclists and bicyclists. Other research points to challenges in using transverse rumble strips in winter environments.