TERRA Transportation Engineering and Road Research Alliance
Partnering for Roadway Innovation
January 2010
www.TerraRoadAlliance.org

Shoulder and Centerline Rumble Strips

Rumble strips—grooved patterns usually applied in a longitudinal direction along a shoulder, edgeline, or centerline of a road—have proven to be an effective crash countermeasure. The noise and vibration produced by rumble strips alert drivers when they leave the traveled way or roadway lanes.

Rumble strips were first installed as a safety measure along rural highways, but their use has been extended to urban highways and to rural and urban two-lane roads. They are now in use in almost all states in the country. Many studies show a high benefit-to-cost ratio for shoulder rumble strips. In addition, changes in rumble strip design are helping mitigate concerns of motorcyclists and bicyclists about shoulder rumble strips.

According to *NCHRP Report 641*, single-vehicle off-roadway crashes account for 18 percent of all accidents, and these crashes typically cause severe injuries or fatalities. The report found a significant reduction in single-vehicle run-off-road (SVROR) crashes and fatal crashes when shoulder rumble strips were installed. In addition, centerline rumble strips have also been found to be effective in head-on opposite direction sideswipe crashes.

Types of Rumble Strips

There are four types of rumble strips. They differ primarily in placement and function.

- **Shoulder**—Installed on highway shoulders outside the travel lane. Sometimes installed along the edge of the roadway and referred to as edgeline rumble strips or rumble stripes.
- **Centerline**—Installed on or near the center line of the road.
- **Midlane**—Designed for installation in the center of the travel lane to thwart SVROR and crossover crashes. These have not been installed in any states.
- **Transverse**—Installed horizontal to the travel lane to warn motorists when they are approaching intersections, toll lanes or other unexpected conditions. (This fact sheet does not address transverse rumble strips.)

Effectiveness

SVROR crashes account for a third of all fatal crashes and twice as many SVROR crashes occur on rural roads, due to a combination of higher speeds and more driving miles. One in five crashes in the United States is related to drowsy or fatigued driving. It is these crashes that shoulder and rumble strips are most effective in preventing.

Early studies reported between 15 and 80 percent reduction in ROR crashes after rumble strips were installed. More recent research has revised those numbers. *NCHRP Report 641* notes that in 2005:

- Shoulder rumble strips on urban and rural freeways reduce SVROR crashes by 18 percent and fatal SVROR crashes by 13 percent.
- Shoulder rumble strips on rural two-lane roads are expected to reduce SVROR crashes by 15 percent and fatal SVROR crashes by 29 percent.
- Shoulder rumble strips on rural multilane divided highways are expected to reduce SVROR crashes by 22 percent and fatal SVROR crashes by 51 percent.

Strips vs. Stripes

"Rumble stripes" is the term used for rumble strips painted with retro-reflective pavement markings. According to *NCHRP Report 641*, the majority of studies have found that rumble stripes are more visible than standard pavement markings, especially during wet night-time conditions. The report also notes that rumble stripes are more durable than standard pavement markings, especially in areas with significant winter maintenance issues.

Midlane Rumble Strips

Midlane rumble strips are an experimental treatment that run down the center of each lane and alert drivers when a vehicle's wheels veer to the right or left from the travel lane. According to *NCHRP Report 500*, midlane rumble strips could help prevent head-on and run-off-road crashes, especially on roads with no shoulders or narrow paved shoulders. Midlane rumble strips are more compatible with bicycle use than shoulder rumble strips, but may be a safety hazard for motorcycles. Some designers and safety engineers also fear the strip in the center of the lane may become an additional driver distraction. To date, midlane rumble strips are a concept no transportation agency has been willing to install, even on a trial or experimental basis.

Implementation

According to *NCHRP Report 641*, shoulder rumble strips are used in 46 of 50 states within the United States. Several states have shoulder rumble strip policies posted online, including Minnesota, Iowa, and North Dakota.

A 2005 survey of states by the NCHRP found that:

- **Shoulder** rumble strips being installed on a wide variety of road types including urban freeways, on and off ramps, rural freeways, multilane undivided highways (rural and urban), rural two-lane roads.
- The majority of **shoulder** rumble strip installations are on rural roads rather than urban roads.
- Milled rumble strips are the type preferred by most agencies
- Fewer transportation agencies use **centerline** rumble strips, and only a few that do have written policies about them.
- The majority of **centerline** rumble strips are installed on rural, two-lane divided roads. There are very few installations on other road types.

Research Opportunities

Some concerns about rumble strips present opportunities for further research.

- **Noise**—The unusual noise tires make as they roll over shoulder rumble strips can disturb some neighbors. Road agencies have experimented with several alternatives, such as banning their use in residential areas, constructing sound barriers, and moving the strips farther from the travel lane to reduce the chance of crossing them.
- **Bicyclists**—A main concern for bicyclists is the ability to control the bicycle when traversing a rumble strip. Another issue is that the presence of rumble strips encourages bicycles to ride in the travel lane, closer to cars. Agencies have experimented with skip patterns and narrower strips to address these concerns.
- **Maintenance**—There were initial concerns that heavy traffic and the freeze-thaw cycle of water collecting in the grooves of rumble strips would damage shoulder pavements. But tests have found that traffic tends to knock debris, ice, and water out of the grooves. In some places, snowplow drivers depend on the strips for orientation during low-visibility situations.
- **New applications**—Research is needed to better quantify the safety effectiveness of centerline and shoulder rumble strips on a wider variety of road types.

For Further Reading

- *Guidance for the Design and Application of Shoulder and Centerline Rumble Strips* (NCHRP Report 641, 2009)
- Rumble Strips and Stripes (FHWA Web site)
- *Effects of Center-line Rumble Strips on Non-Conventional Vehicles* (Mn/DOT, 2008)
- *Accident Modification Factors for Traffic Engineering and ITS Improvements* (NCHRP Report 617, 2008)
- *Placement and Design of Milled Rumble Strips on Centerline and Shoulder—A Driving Simulator Study* (VTI Report 523A, 2005)
- *Centerline Rumble Strips—A Synthesis of Highway Practice NCHRP Synthesis of Highway Practice 339* (Transportation Research Board, 2005)
- *A Guide for Addressing Run-Off-Road Collisions* (NCHRP Report 500, Vol. 6, 2003)
- *HSIS Summary Report: Safety Evaluation of Rolled-in Continuous Shoulder Rumble Strips Installed on Freeways* (FHWA, 1999)

Links to these resources and more are on the TERRA Web site at www.TerraRoadAlliance.og.

Partners

- Minnesota Department of Transportation (Mn/DOT)
- Minnesota Local Road Research Board (LRRB)
- Federal Highway Administration (FHWA)
- Transportation Research Board (TRB)
- University of Minnesota
- American Traffic Safety Services Association–Northland Chapter
- Industry representatives, including contractors and material providers

About TERRA

The Transportation Engineering and Road Research Alliance, or TERRA, brings together government, industry, and academia in a dynamic partnership to advance innovations in road engineering and construction, including issues related to cold climates. More about TERRA is online at www.TerraRoadAlliance.org.

For more about TERRA, please contact:

- Laurie McGinnis, Acting Director, Center for Transportation Studies, University of Minnesota, 612-625-3019, mcgin001@ umn.edu
- Maureen Jensen, Manager, Road Research Section, Office of Materials, Minnesota Department of Transportation, 651-366-5507, maureen.jensen@state.mn.us

For More Information

For more information about the research in this fact sheet, please contact:

- Roger C. Olson, P.E., Research Operations Engineer, Minnesota Department of Transportation, 651-366-5517, roger.olson@state.mn.us

20100203