



TECHNICAL SUMMARY

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LRRB PROJECT COST:

\$65,494



MnDOT's current sharp-edged, rectangular rumble strip design (left) and California's quieter, wave-shaped design (right).



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Wave-Shaped Rumble Strips Reduce Nuisance Noise

What Was the Need?

Rumble strips are well-established and effective tools for reducing the number of lane departure crashes by producing vibration and a loud noise in the vehicle to alert the driver. However, MnDOT has received a significant number of complaints from landowners near centerline rumble strips about the noise they produce, which has been detected more than 3,000 feet away in some rural settings.

Currently MnDOT uses a sharp-edged, rectangular rumble strip design that is milled into the pavement. In recent years, a few states have tested quieter sinusoidal rumble strip designs, which have a sine wave pattern.

Minnesota cities and counties needed to test these new rumble strip designs to determine the volume and tone of the sound they emit inside and outside of a vehicle, and the likely detectability of that sound in a typical rural Minnesota environment.

What Was Our Goal?

The goal of this project was to identify rumble strip designs that produce the least external noise while maximizing the sound produced inside the vehicle crossing the strip.

What Did We Do?

Researchers tested three rumble strip designs:

- The Minnesota design, with square-edged rumbles 3/8 inch to 1/2 inch deep, 16 inches wide and 12 inches from the center of one rumble to the center of the next.
- The California design, with sinusoidal rumbles 1/32 inch to 5/8 inch deep, 8 inches wide and 14 inches from center to center.
- The Pennsylvania design, with sinusoidal rumbles 1/8 inch to 1/2 inch deep, 8 inches wide and 24 inches from center to center.

Researchers drove three vehicles (a passenger car, pickup truck and semitrailer) at three different speeds (30, 45 and 60 mph) over the California and Pennsylvania designs. Sound level meters were installed inside the vehicle, 50 feet from the rumble strip and 100 feet from the rumble strip. Testing procedures were the same for the Minnesota design, but only the passenger car and pickup were available for testing.

Investigators calculated overall sound levels for each test and decay curves to estimate how audible the rumble strips would be at distances up to 3,000 feet. They also analyzed sound frequencies to understand the tonal quality of the sound produced, which can impact how detectable it is to neighboring landowners.

What Did We Learn?

California's rumble strip design had the best exterior-to-interior sound ratio: It produced as much noise inside the vehicle as the Minnesota design, but less sound outside of the

In response to landowner complaints about noise from rumble strips, researchers analyzed the volume and tone of the sounds produced by different rumble strip designs. California's wave-shaped design produced less external noise than MnDOT's current design, but created the same amount of sound inside vehicles to alert drivers.

“The tonal quality of the sound made by Minnesota’s current design is like a perfect dog whistle for people. The California design’s sound has two frequency peaks and they’re not as high, so the sound range is less abrupt.”

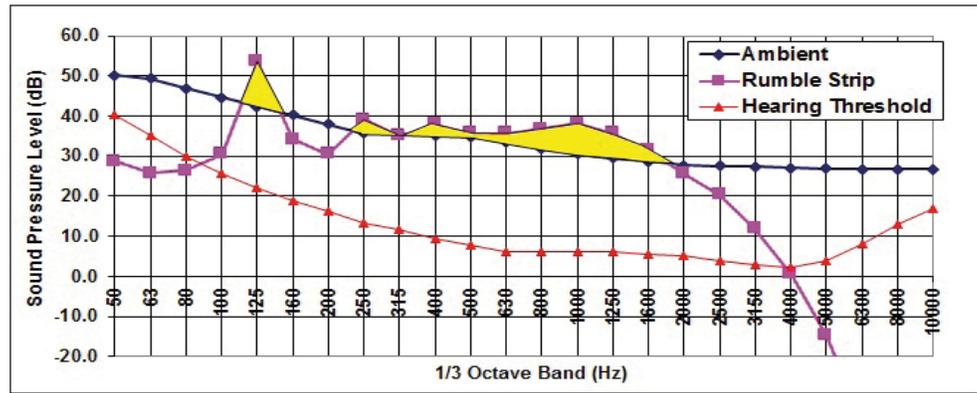
—Mark Vizecky,
MnDOT State Aid
Program Engineer

“The ultimate goal is to provide the maximum safety by capturing the driver’s attention through tactile and sound levels while minimizing the associated external noise generated by the rumble strips.”

—Ed Terhaar,
Principal Traffic Engineer,
Wenck Associates, Inc.

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This chart shows the anticipated sound spectrum from a car crossing a MnDOT rumble strip at 60 mph at a distance of 3,000 feet. The yellow sections show frequencies where the rumble strip noise is louder than the ambient noise, with a particularly piercing peak at 125 hertz.

vehicle. Pennsylvania’s design produced lower exterior and interior sound levels, and may not produce adequate feedback to alert inattentive drivers.

California’s design also had a better tonal quality than MnDOT’s current design. Minnesota’s design produces a single, strong tonal peak at 125 hertz, which stands out against ambient noise because few sounds in the natural environment produce similar tones. California’s design produces two smaller peaks at 100 hertz and 200 hertz, so the sound is less abrupt.

The noise of a rumble strip is considered detectable if it produces a sound level at a listener’s location greater than the ambient noise at any frequency. In passenger vehicles driving at 60 mph, the California design has been modeled as just detectable at 3,000 feet, while the Minnesota design would be detectable at well beyond 3,000 feet.

This research showed, however, that California’s design only produces its full sound when a tire is fully on the rumble strip. Minnesota’s design provided feedback to the driver immediately after the tire made contact with the rumble strip.

What’s Next?

A follow-up project is currently underway to test wider versions of sinusoidal rumble strips based on the California design. Since the California design that was installed was narrower than some commercial vehicle tires, the Local Road Research Board needs to determine the minimum width that will provide adequate feedback to all drivers. That project will also evaluate the impact of the designs on other types of vehicles, including motorcycles and bicycles.

When that project is completed, the new rumble strip design should be available for implementation. Any new design will not be a wholesale replacement of MnDOT’s current design since the sinusoidal designs are more expensive to install and some local roads may not have enough width to install them. However, the new design is likely to be appropriate for noise-sensitive areas.

Future research may include evaluating the new design’s performance to see if it is as effective at reducing lane-departure crashes as MnDOT’s current design, and determining if the new design might be appropriate for installation in certain urban environments.

This Technical Summary pertains to the LRRB-produced Report 2015-07, “Rumble Strip Noise Evaluation,” published February 2015. The full report can be accessed at <http://www.lrrb.org/PDF/201507.pdf>.