2016-23TS
Published September 2016

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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

IMPLEMENTATION SUMMARY

Technical Liaison:
Ken Johnson, MnDOT
Ken.Johnson@state.mn.us

Project Coordinator:
Bruce Holdhusen, MnDOT
Bruce.Holdhusen@state.mn.us

Principal Investigator:
Ed Terhaar, Wenck Associates, Inc.

PROJECT COST:
$95,806

In tests among motorcyclists, single-rumble designs were found to be more navigable.

Putting Research into Practice: Sinusoidal Centerline Rumble Strips Perform Better Than MnDOT's Current Design

What Was the Need?

Rumble strips produce vibrations and noise to alert drivers when their vehicles drift outside their lanes. As a result, rumble strips are effective tools for reducing lane-departure crashes, which frequently cause serious injuries or fatalities. However, MnDOT has received complaints from landowners about the noise that rumble strips produce.

A previous MnDOT research project evaluating the noise produced by several rumble strip designs found that sinusoidal (sine-wave-shaped) rumble strips reduced noise outside a vehicle. In that project, the design with the best sound profile produced its full sound only when a tire was fully on the rumble strip. However, the strip tested was narrower than some commercial vehicle tires.

MnDOT needed to investigate the properties of wider sinusoidal rumble strip designs, as well as the designs' impacts on bicycles and motorcycles.

In field tests of sinusoidal centerline rumble strips, all four designs tested produced less exterior noise than the current design, but enough interior noise to alert drivers if they drift outside their lanes. The design that produced the most noise inside a pickup truck was recommended for implementation.

What Was Our Goal?

The goal of this project was to evaluate several sinusoidal centerline rumble strip designs.

What Did We Implement?

This project expands upon project 2015-07, "Rumble Strip Noise Evaluation," which previously investigated the noise produced by three roadside rumble strips.

How Did We Do It?

Investigators installed seven preliminary milled rumble strip designs at the MnROAD pavement test track. The project's Technical Advisory Panel reviewed these installations, conducted tests of their impacts on motorcycles and bicycles, and decided to test four designs in the field:

- Design 1: one 14-inch-wide rumble strip, with rumbles 1/16 inch to 3/8 inch deep.
- Design 2: two 8-inch-wide rumble strips separated by a 4-inch ridge, with rumbles 1/16 inch to 1/2 inch deep.
- Design 3: one 14-inch-wide rumble strip, with rumbles 1/16 inch to 1/2 inch deep.
- Design 4: two 8-inch-wide rumble strips separated by a 4-inch ridge, with rumbles 1/16 inch to 3/8 inch deep.

All four designs were sinusoidal with a 14-inch wavelength.

These designs were installed on Trunk Highway 18 in Mille Lacs and Aitkin counties. Investigators drove over the rumble strips with three vehicles (a passenger car, pickup truck and dump truck) and measured sound levels at three locations (within the vehicle, at 50 feet from the rumble strip and at 75 feet from the rumble strip). Investigators analyzed both overall sound levels and sound frequencies, which affect the tonal quality of

continued

"The sound quality for all four designs was similar, so our recommendation really came down to driver feedback, particularly in pickup trucks."

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

"One additional advantage of the sinusoidal rumble is that pavement markings installed on the rumbles stay below the pavement surface, which should protect them against plow damage and extend their life."

—Ken Johnson,
State Work Zone,
Pavement Marking and
Traffic Devices Engineer,
MnDOT Office of Traffic,
Safety and Technology

Produced by CTC & Associates for:
Minnesota Department
of Transportation
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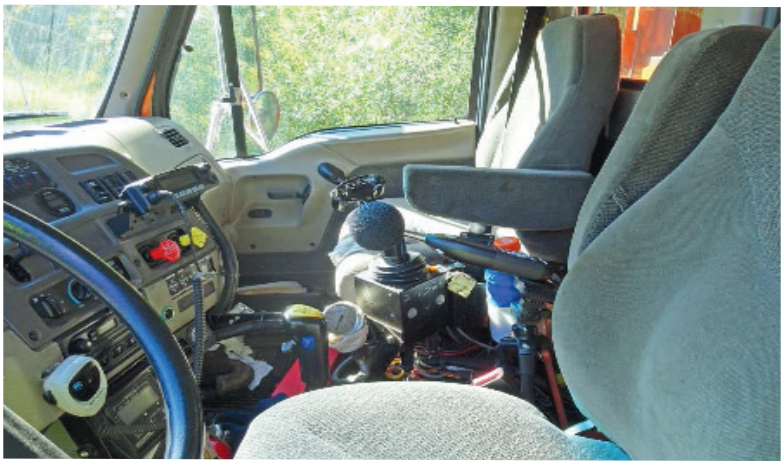

While all four designs field-tested by this project performed adequately, the recommended design produced the most noise inside the cab of a truck.

the sound produced and the level of disruption the sound is likely to cause with neighboring landowners.

What Was the Impact?

All four designs produced less exterior sound and a better tonal quality than Minnesota's current, square-edged rumble strip design. MnDOT's current design produces a strong tonal peak at 125 hertz, which stands out above ambient noise because few natural sounds produce similar tones. The test designs produced smaller and less harsh and intrusive peaks at 80 hertz and 160 hertz.

For cars, all four designs produced sound increases greater than 10 A-weighted decibels within the vehicle, which is considered adequate to attract driver attention. A-weighted decibels are a measure of sound similar to decibels, but adjusted to give less weight to low-frequency sounds that human ears are less sensitive to.

While all four designs produced similar and satisfactory results, investigators recommended Design 3 as best at providing feedback to drivers while minimizing external noise. In particular, Design 3's deeper rumbles produced better driver feedback for pickup truck drivers.

Motorcycle riders, however, found designs with a single rumble to be more navigable than those with a ridge between two rumbles. Due to scheduling issues, too few bicycle riders were tested to produce conclusive results.

What's Next?

An interim sinusoidal rumble design that is slightly shallower than the final recommendation has already been approved and is available for districts to use.

Using the results of this project and of additional testing to be conducted at MnROAD, a group of state and district traffic engineers, materials engineers, environmental noise experts and State Aid representatives will make a final recommendation. This will address both the design itself and the question of whether the design should be deployed only in noise-sensitive areas, on all centerlines, or on all centerlines and edge lines. The group will also decide whether a single- or split-rumble design should be used: While motorcyclists prefer a single-rumble design, materials engineers prefer a double-rumble design with a ridge that can keep the rumble away from joints between pavements and shoulders and improve durability.

MnDOT has drafted a revised Technical Memorandum to incorporate the recommended rumble strip design. If the draft is approved, the revised memorandum should be published later this year.

This Implementation Summary pertains to Report 2016-23, "Sinusoidal Rumble Strip Design Optimization Study," published June 2016. The full report can be accessed at mndot.gov/research/TS/2016/201623.pdf.