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RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS, RESEARCH & INNOVATION

TECHNICAL SUMMARY

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TASK COST:
$5,000

The ultimate grind was developed to improve the friction of the innovative grind by using wider, corrugated fins.

Creating Quieter Pavements Without Compromising Friction

What Was the Need?

To ensure that concrete pavements exhibit sufficient friction and skid resistance, these pavements are textured during construction; this commonly involves dragging an inverted turf or stiff-bristled broom across the surface, creating tines (grooves) in the concrete using a mechanical rake, or brushing away some of the mortar before it hardens to expose the texture of the aggregate. These textures wear away over time, requiring pavement rehabilitation.

To create a long-lasting texture, some agencies require grinding a pavement's surface immediately after paving and curing. The grinding texture is selected based on the resulting pavement's skid resistance, ride quality and level of tire-pavement noise. A common texture is the diamond grind, which uses closely spaced, diamond-coated saw blades to cut longitudinal grooves that yield less noise than lateral grooves.

Investigators studied an innovative concrete pavement grind texture that helps both to restore pavement friction and reduce tire-pavement noise. Quieter pavements can save the expense of sound barriers on highways, which can cost up to $3 million per mile.

Purdue University's Institute for Safe, Quiet, and Durable Highways conducted research to optimize diamond grinding and found that pavements could be made quieter by widening grooves and creating a smoother profile for fins, which are the peaks alongside grooves. Because this innovative grind results in less friction than the conventional diamond grind, Purdue also developed an alternative called the ultimate grind, which enhances the friction of the innovative grind by adding corrugations to even wider fins. Further research was needed to verify the friction and noise characteristics of these textures on full-scale tests in the field.

What Was Our Goal?

This study aimed to verify the constructability of Purdue's quiet configuration and to further optimize it with regard to noise, friction, ride quality and texture depth.

What Did We Do?

Field tests were performed at Minnesota's MnROAD pavement research facility. Researchers prepared 500-foot-long test cells with the following textures:

- The conventional grind, using 0.125-inch wide blades spaced 0.12 inches apart.
- The innovative grind, in which fins are made wider by spacing saw blades farther apart and made flush by shaving a thin layer off the top of the pavement.
- The ultimate grind, which modifies the innovative grind by making fins even wider and corrugating them with an additional pass by grinding machinery.

Researchers began by grinding and evaluating proof-of-concept test strips on cell 37 of MnROAD's low-volume road, a 2.5-mile loop with traffic restricted to MnROAD-operated vehicles. Researchers then conducted full-width grinding of each texture on cells 7, 8 and 9 of MnROAD's main line, which consists of a two-lane, 3.5-mile Interstate roadway that carries live traffic from I-94 for three weeks per month.

Before and after grinding, researchers measured all of these cells for:

- Noise levels, using onboard sound intensity testing (AASHTO TP 76-09), which takes

continued

"The innovative grind is the quietest diamond ground pavement in the United States. This can save Minnesota millions of dollars in noise wall construction."

—W. James Wilde,
Professor, Minnesota State University Mankato Department of Civil Engineering

"This project was a model of industry and government collaboration, with the International Grooving and Grinding Association providing free grinding that otherwise would have been very costly."

—Bernard Izevbekhai,
Concrete Research Operations Engineer, Mn/DOT Office of Materials

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The innovative and ultimate grinds were developed and evaluated in the laboratory using Purdue's Tire Pavement Test Apparatus, a 12-foot-diameter rotating drum to which pavements can be attached and moved relative to a tire or grinding head at 30 miles per hour.

measurements with microphones mounted near vehicle tires.

- Friction and skid resistance, using locked-wheel skid testing (ASTM E-274), in which a vehicle drags an immobilized tire across a wet pavement.
- Ride quality, with the lightweight profiler (ASTM E-950), a small utility vehicle with laser sensors for measuring pavement smoothness.
- Mean profile depth, using the circular track meter (ASTM E-2157).

What Did We Learn?

The innovative grind was found to be much quieter for both high- and low-volume traffic than the conventional grind and the un-ground tine: The noise difference of 6 dB(A) typically observed is tantamount to an 80 percent reduction in tire-pavement noise. On the main line, the ultimate grind was also quieter than the conventional grind and un-ground tine, although somewhat louder than the innovative grind.

The friction of the ultimate grind on the main line—though less than that of the conventional grind—was an improvement over that of the innovative grind. The ultimate grind also had greater mean texture depth, suggesting that it will maintain its friction longer. All diamond grind textures on the main line exhibited better ride quality than the existing transverse tine, with the innovative and ultimate grinds exhibiting equal or greater smoothness than the conventional grind.

What's Next?

Minnesota has been evaluating diamond grinding at MnROAD since 2007, and this project is part of pooled fund study TPF-5(134), PCC Surface Characteristics—Rehabilitation, which is exploring grinding techniques that reduce tire-pavement noise and increase ride quality without compromising friction. Researchers plan to monitor test cells over the next five years to evaluate the long-term performance of the different grinding methods. They will also take measurements correlating air temperature and tire-pavement noise, and conduct rolling resistance testing of innovative grind cells in comparison to various other MnROAD surfaces.

This Technical Summary pertains to the Interim Report 2011-05, "Innovative Diamond Grinding on MnROAD Cells 7, 8, 9, and 37," published December 2010. The full report can be accessed at http://www.lrrb.org/PDF/201105.pdf. *More information about the ongoing pooled fund study TPF-5(134) can be found at* http://pooledfund.org/projectdetails.asp?id=363&status=4.