Improving the Friction and Quietness of Concrete Pavements

What Was the Need?
After concrete pavements are placed, the surfaces are textured to ensure that they have sufficient friction and skid resistance. The most common texture for North American pavements is the transverse tine, produced by dragging metal prongs laterally across the surface before it has fully cured. Because this texture can cause a significant amount of tire-pavement contact noise, in 1998 MnDOT began using a method that involves dragging an inverted strip of AstroTurf over the surface, resulting in a finer texture that produces significantly less tire-pavement noise.

Another method that has been shown to provide even greater benefits is diamond grinding. Developed to restore friction to older pavements worn smooth with age, diamond grinding involves cutting longitudinal grooves into the pavement surface using closely spaced, diamond-coated saw blades. In 2005, Purdue University’s Institute for Safe, Quiet and Durable Highways conducted research to optimize diamond grind blade configurations in the laboratory, developing several textures to make pavements even quieter while preserving friction. To evaluate the friction and noise characteristics of these textures in the field, in 2006 Transportation Pooled Fund study TPF-5(134) was initiated with Minnesota as the lead state.

What Was Our Goal?
The objective of this project was to provide a quiet grinding configuration with sufficient skid resistance and ride improvement.

What Did We Do?
Researchers evaluated the following diamond-ground textures (also known as next generation concrete surfaces) on 500-foot portland cement concrete test cells at Minnesota’s MnROAD pavement research facility:

- **Cell 8 (ground in 2007), the conventional grind:** Consists of grooves that are 0.125 inches deep and 0.125 inches wide, with 0.125-inch tire landing areas.
- **Cell 7 (ground in 2007), the innovative grind:** Consists of landing areas made wider—0.375 inches—and made flush by shaving a thin layer off the top of the pavement. Grooves were the same width and slightly less deep at 0.12 inches.
- **Cell 9 (ground in 2008), the ultimate grind:** Modifies the innovative grind by making landing areas even wider—0.502 inches—and corrugating them with an additional pass by grinding machinery. Grooves were more than twice as deep at 0.309 inches and somewhat wider at 0.129 inches.
- **Cell 71 (ground in 2011), the new ultimate grind:** Also uses the corrugated surface and wider and deeper grooves of the ultimate grind, but returns to the 0.375-inch landing area of the innovative grind.

The diamond grind textures studied in this project help to restore pavement friction and reduce tire-pavement noise. Creating quieter pavements is far more cost-effective than other methods for mitigating highway noise pollution, such as placing sound barriers along highways, which can cost up to $3 million per mile.
As a control, researchers also evaluated the transverse tine on MnROAD Cell 12. From the date of grinding until June 2012, researchers measured the following surface characteristics both before grinding and at regular intervals:

- Noise levels, using onboard sound intensity testing.
- Friction and skid resistance.
- Ride quality, with the lightweight profiler.
- Mean profile depth of texture.

Researchers also evaluated the use of ambient air temperatures to correct noise data and the use of various statistical analysis methods to evaluate data trends.

**What Did We Learn?**

For long-term performance (after 4 million equivalent single axle loads in the driving lane and 1 million in the passing lane):

- The ultimate grind (NGCS) had the least noise.
- NGCS is an overall improvement over the conventional grind, particularly in quietness, ride improvement and durability.
- Increased use of NGCS has reduced grinding cost.
- The conventional grind had the best ride quality.
- The innovative grind had the best friction for smooth tires, and the ultimate grind had the best friction for ribbed tires.
- The innovative grind had the best texture skid resistance for smooth tires followed by the ultimate grind.
- Although the ultimate grind involves more elaborate blade stacking and may occasionally be a two-stage grinding process, increased use has reduced grinding cost.

Researchers also found that noise measurements could be better compared over time by correcting data for air temperature and sound intensity.

**What’s Next?**

Researchers recommend monitoring test cells for surface characteristics, developing innovative grinding configurations and implementing temperature correction of noise measurements so that values can be compared over the long term. Other research products include Report 2013-16, and future research will continue to evaluate the rolling resistance of diamond-ground MnROAD test cells.

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*The innovative diamond grind reduces noise by as much as 6 decibels over the transverse tine, which amounts to an 80 percent reduction in tire-pavement noise.*

—Bernard Izevbekhai, Concrete Research Operations Engineer, MnDOT Office of Materials and Road Research

*Because pieces of the conventional diamond grind pavement texture break off over time, this pavement can eventually become noisier. Innovative grinds solve this problem by increasing tire landing areas between grooves, leading to less degradation in texture.*

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

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