Time to Groove to a New Grind?

Nation’s fourth-largest city found a way to address complaints about noise from transverse grooves in concrete pavement.

By Stephanie Johnston

Using concrete to pave rapidly growing post-World War II cities made sense at the time. Concrete doesn’t rut, thus requiring less maintenance than asphalt; and transverse tining was proven to grip tires, thus ensuring the driving public’s safety.

That worked well in low-traffic areas, but roads got louder as cities accommodated more cars by widening roads with more transverse-grooved concrete. In Houston, one of the nation’s largest cities, the issue hit critical mass in 2009. After the Katy Freeway was widened from six to 12 lanes, high-income residents along a five-mile stretch were particularly perturbed. Not uncommon in urban areas, change orders had rendered noise-modeling results moot and a sound-absorption wall actually amplified noise.

What to do?

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A solution that may work for similarly congested areas is to remove the transverse tines, grind the pavement flush, and then install longitudinal grooves, which research shows may be just as if not more effective than transverse tines in keeping tires on...
The road. There’s no question next-generation concrete surfaces (NGCS) are quieter and a more-comfortable ride, but the jury’s out on their durability. As Concrete Construction Editor-at-Large Bill Palmer points out, concrete is stronger and less permeable at the original surface than in the concrete matrix beneath, so does removing that surface cause the matrix to break down faster?

No matter: As with all decisions involving taxpayer desires and taxpayer dollars, it was the best solution to the competing demands confronting Texas DOT (TxDOT).

Residents Prove There’s a Problem
Mayors in communities most affected by the widening hired an engineering firm that replicated the original noise-modeling using the same contractor with the same instruments in the same test locations at the same time of year and the same software. Armed with confirmation the as-built road exceeded federal noise standards, they requested but didn’t receive help from their U.S. representative. Their state representative met with homeowners, some of whom were unable to sell due to noise levels, and then referred the issue to – where else – TxDOT.

Houston is in one of the nation’s five-largest counties. Roughly half the city’s 10,772 lane miles are concrete, so TxDOT Houston District pavement engineers know their asphalt as well as their concrete.

At a November 2017 open house I attended, they said they rejected an asphalt overlay over lifecycle costs. Longitudinal grooving was too loud and diamond grinding too smooth. Rubberized asphalt was suggested by residents but rejected due to installation and maintenance costs; because of its porous nature and air-void content it tends to compress and consolidate, losing its noise-dampening qualities over time and requiring maintenance every several years to restore them.

Many of Houston’s roads are transverse-grooved. Having heard of NGCS, the district called in International Grooving & Grinding Association (IGGA) Executive Director John Roberts to consult with pavement engineers and the mayors. After inspecting the freeway and reviewing the data, Roberts said he was “certain NGCS would significantly reduce the tire-pavement noise issue without the need for reoccurring maintenance while providing a safe, smooth driving surface.”

The district decided a pilot project on existing pavement would reveal if engineers could add a new tool to their concrete-rehabilitation toolbox.

Achieving Acceptable Cost-Sharing
The project was $12.5 million including traffic control, which was significant given the freeway’s high traffic volumes. Half the road was within village jurisdictions and half within the city’s jurisdiction, so TxDOT proposed Houston and four of the six affected villages contribute $2 million over five months at no interest.

The villages used capital improvement funds to raise their portion, but two other potential obstacles arose. TxDOT had to figure out how to proportionally allocate funds across its entire road network, a common consideration for any state transportation department. The second was a newer type of challenge: legalities surrounding a city contributing local funds to a federal road project. After two years, Houston’s city council and city attorney signed off on the matter. Valued at $2 billion, owners of homes backing the freeway had been arguing down their tax values based on the fact that noise was reducing property values. The village and city governments realized they faced continuing revenue reductions if property values continued to fall.

How the Process Worked
In late winter 2016, the project was awarded to Penhall Co., a concrete contractor with locations in 18 states, including Texas, and Canada. Using Diamond Products’ PC6000 grinder equipped with diamond-tipped saw blades supplied by Concut Diamond Products in Kent, Wash., the contractor installed NGCS on the entire length except the 4-inch-thick bridge decks.

Three applications were used to create NGCS on the project. Transverse grooves were removed via conventional grinding with 240 blades spaced 0.015 inch center-to-center. The pavement was then flush-cut using 370 blades stacked virtually next to each other, at
0.30 inch center-to-center, for a smooth, quiet finish. Finally, the same shaft was stacked with 60 blades spaced ¼ inch center-to-center for the longitudinal grooving operation.

The 680 hp diamond grinder is about the size of a shipping container. The 56,000-pound behemoth strips away asphalt and concrete to preprogrammed depths and speeds in a swath 50 inches wide. Sensors located on various components send operational data to a monitor in the cab, where the machine’s operator can take over the controls similar to overriding a car’s cruise control.

The project was completed by fall 2017. Houston is the largest user of NGCS, which the agency refers to as next generation diamond grooving (NGDG), worldwide. Approximately 3 million square yards are being placed in and around the city.

Decade-Old Solution to Decades-Long Problem
NGCS surface was developed at Purdue University in 2007 by the American Concrete Pavement Association, Portland Cement Association, and IGGA. It has been installed in 16 states.

The texture is usually produced in two passes using diamond-tipped saw blades mounted on conventional diamond grinding and grooving equipment. After transverse grooves are removed, pavement is flush-ground using 1/8-inch-wide blades with 0.035-inch spacers. Then, 1/8-inch-wide longitudinal grooves are saw-cut to a depth of 1/8 inches to 3/16 inches at ½-to-5/8-inch centers.

Without any upward texture, the surface has a consistent profile with a predominantly negative texture that produces much less noise. The longitudinal grooves provide friction.

Purdue University’s Herrick Laboratories of West Lafayette, Ind., conducted research using its Tire Pavement Test Apparatus (TPTA), a 12-foot-diameter drum. The machine takes six curved textures of pavement to form a circle around the vertical edge of the drum. Then two tires, mounted on opposite ends of a beam, are rolled over the test samples while sensors and microphones record the data. Test findings indicate it’s not the geometric configuration of the blades and spacers used in diamond grinding that causes noise, but the resulting fin profile. Producing a low-noise diamond grind requires creating uniform and consistent land profiles.

At any rate, TxDOT says NGCS costs $6 per square yard.

About the Author
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As editor in chief, Stephanie Johnston oversees Public Works’ print magazine, website, e-newsletters, and digital initiatives. Before joining the staff 10 years ago, she worked on publications owned by the American Bar Association, Associated Equipment Distributors, and agriculture-industry publisher Century Communications. In 2015, she became editor of Concrete Construction sister publication Concrete Surfaces. She has a master’s degree from Northwestern University’s Medill School of Journalism and lives in a Chicago suburb. E-mail sjohnston@hanleywood.com or follow her on Twitter at @StephanieatPW.

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