IGGA
International Grooving & Grinding Association
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the next generation concrete surface (ngcs)

The Quiet Pavement Solution

NGCS is the Smooth, Safe, Quiet and Sustainable Concrete Surface

THE NEXT GENERATION CONCRETE SURFACE (NGCS) is the quietest non-porous concrete pavement surface available. NGCS is a hybrid texture that resembles a combination of diamond grinding and longitudinal grooving. It consists of a uniform land profile design with essentially an all-negative texture. Despite its flatter, smoother riding surface compared to traditional portland cement concrete pavement (PCCP), the NGCS still possesses and maintains reliable microtexture (friction) when constructed with quality aggregates. The longitudinal grooves provide substantial macrotexure and increase resistance to hydroplaning by providing escape channels that allow water to move out of the tire contact patch area.

NGCS is typically constructed as a two-pass operation using diamond-tipped saw blades mounted on conventional diamond grinding (CDG) and grooving equipment. It can be used for both new construction and rehabilitation of existing surfaces. Typical NGCS specifications involve a first step of flush grinding concrete with blades mounted on a minimum 4-foot grinding head, stacked with 0.125-inch-wide blades separated by 0.035 +/-0.005-inch-wide spacers, resulting in 92 to 100 blades per foot. The second step of the operation provides the longitudinal grooves. Longitudinal grooving blades are specified to be 0.095 +/- 0.05 inches wide and produce grooves 1/8-inch to 3/16-inch in depth, with the grooves spaced on 1/2-inch to 5/8-inch centers. The grinding process can be accomplished in single lane operations and short lane closures when necessary. It can be quickly and efficiently constructed without impacting other roadway features such as guardrails, barriers or curbs.

Microtexture

Grooves for Macrotexture

» BENEFITS

- **Smoother Ride:** IRI measurements indicate that NGCS provides a smoother, more uniform ride.
- **Increased Safety:** Diamond grooving provides improved traction and allows the road to maintain its texture longer, creating a safer road over the long-term.
- **Decreased Noise:** A smoother surface with a less protruding texture results in a lower overall noise level.

» IT'S A QUALITY-OF-LIFE ISSUE

Environments with excessive noise aren't merely annoying; they're considered a health hazard, with documented effects on individuals that include sleep disruption, impaired function and reduced productivity. Pavement noise as a quality-of-life issue is even being addressed within neighborhood groups, as they become more and more aware of noise generation issues.

Traditionally, noise has been controlled using expensive walls or berms. However, there is growing interest in controlling noise at the source, namely, the pavement surface.

It should be noted that for typical highway applications, the noise contribution of cars and large trucks is quite different. Passenger cars generate about 70 to 90 percent of their total noise through the tire-pavement interaction. This implies that modification of the roadway surface (through techniques such as the NGCS surface) can meaningfully impact the overall tire-pavement noise when passenger cars are the main source of noise. Truck noise generation is less affected by pavement type and when trucks become the dominant noise source, pavement solutions of any type become less effective.

» THE BEAT GOES ON

NGCS was developed by Purdue University between 2006 and 2008 and funded by the concrete industry. Researchers evaluated numerous diamond ground and cast-in-place textures on their Tire Pavement Test Apparatus. The "epiphany" moment during the research was the realization that upward protruding textures are responsible for most tire-pavement noise and that by minimizing these textures, a quieter concrete surface can be produced. A texture with essentially no positive texture was created by diamond grinding a surface to be smooth (aka flush grinding) and then imparting additional texture via grooving—a subtractive process. This procedure controlled the land profile, making a completely "manufactured surface," and created a negative or downward texture. Noise testing for this surface showed that the uniform land profile reduced the overall noise level. Subsequently, the researchers identified the optimal grinding/grooving configurations and created what we know today as NGCS.

Tests performed on the Tire Pavement Test Apparatus were followed up with ones validating that the same results would be obtained when the NGCS surface was constructed on a real highway using actual diamond grinding equipment. The first proof-of-concept testing was conducted in 2007 using a test strip at the Minnesota DOT MnROAD low-volume pavement research facility. Results verified both the Purdue research and the fact that conventional diamond grinding equipment could successfully construct the texture. That same year, the first highway installation of NGCS occurred on Chicago's I-355 Tollway. The first conventional project to bid NGCS occurred near Omro, Wisconsin on SR-21 in 2008.

The surface's first large-scale application—and its first use on an urban interstate concrete pavement--occurred in Duluth, Minnesota in the summer of 2010. NGCS work was performed on two segments of the I-35 Duluth megaproject, for both northbound and southbound lanes. Both segments were located within an ongoing concrete pavement preservation (CPP) project. Repaired sections were equal to 3.7 miles of a four-lane freeway with over 100,000 square yards of NGCS installed. Residents of the city were very pleased with the results, as indicated by the fact that the local newspaper, the Duluth News Tribune, published an article acknowledging its success on the front page.

NGCS pavement installed in Duluth, Minnesota

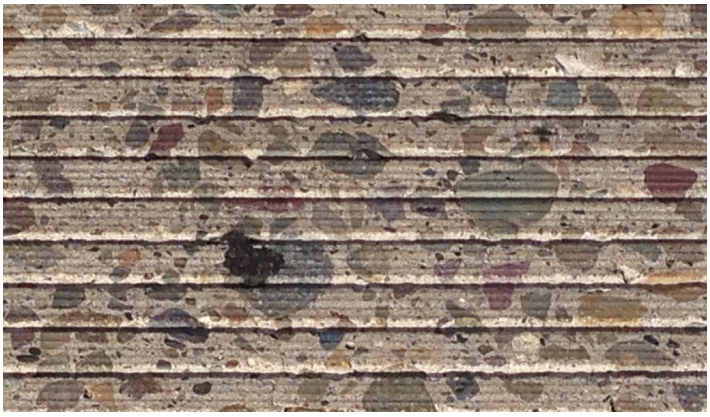
According to the Sept. 21, 2010 article, "The surface treatment reduces noise substantially – by six decibels on the northernmost section of the I-35 megaproject, according to John Bray, MnDOT regional spokesman. Six decibels translate to an 80 percent reduction in the overall vehicle tire noise. 'It was shocking,' Bray said of the difference in noise levels. 'I think it could be the key to reducing noise levels in big cities across the country.'"

» NGCS SEES WIDER ADOPTION

Since its inaugural year, 15 states and three international transportation authorities have installed NGCS, reaping the benefits of concrete's durability and low maintenance while reducing trade-offs associated with concrete's tire/pavement noise.

Caltrans has constructed NGCS surfaces at 7 different locations in **California** and until 2016, California was the largest user of NGCS technology among the states. The state's early NGCS installations were mostly performed on existing concrete pavement, with an average age of 30 years, and were used to address areas with particular noise sensitivity.

UC Davis, who conducted Caltrans' quiet pavement program, evaluated NGCS over a four-year period and summarized its findings in a report titled, "Evaluation of Grind and Groove (Next Generation Concrete Surface) Pilot Projects in California." NGCS was found to be quieter than CDG by approximately 2 dBA. Lane average OBSI values ranged from 99.5 dBA to 101.7 dBA, with an average of 100.8 dBA, compared with a range of 100.6 dBA to 104.7 dBA and an average of 102.8 dBA measured on the CDG. IRI measurements showed that both NGCS and CDG improved smoothness significantly. The average IRI was reduced from 142 inches per mile to 64 inches per mile after CDG and to 49 inches per mile after NGCS.



NGCS installed on I 5 in San Diego, California

The **Virginia** DOT has also conducted extensive evaluations of quiet pavement technologies, including both CDG and NGCS surfaces. Test results showed NGCS to be approximately 5 dBA quieter than the transverse tined concrete used in Virginia. It was also within ½ dBA of all quiet asphalt textures except one. The Virginia Tech Transportation Institute also reported "NGCS is reliable in terms of noise variability between different locations."

Additional NGCS work has also been performed in **Minnesota**. The superior performance of the surface on the Duluth megaproject inspired its use on another unbonded overlay project on I-35, constructed in 2013 just south of Duluth (near Midway Road/ Thompson Hill). Duluth maintenance crews had observed that the existing NGCS surface was experiencing a low winter accident rate and held salt well, so they requested incorporation of NGCS into an approximately two-mile section of the roadway under construction, both north and southbound lanes, which were experiencing a higher-than-expected incidence of winter accidents. IRI measurements taken at the time of the overlay's completion were quite low—in the 30s and 40s—and after application of NGCS, IRI numbers were lowered still further, into the 20s.

A $13 million rehabilitation project was performed on I-394 in the summer of 2015. The project scope included removing the existing asphalt overlay, assessing and repairing the exposed concrete (with work including both full- and partial-depth repairs) and constructing NGCS. All repaired areas had joints resealed. A research team from the MnDOT Office of Materials and Road Research conducted OBSI measurements both before and after construction and found a 56 percent reduction in tire/pavement noise compared to the pre-existing asphalt wearing course. A 24 percent reduction was achieved compared to the pre-grind transverse tined surface. Measurements showed an overall reduction of 47 percent in the contiguous 14 segments into which the project was split for the convenience of the test. Smoothness testing also yielded positive results.

The Houston District of TxDOT—the largest DOT district in the state—has incorporated NGCS into several major **Texas** highways, including I-10, Harris County's U.S. 290, and the 610 Loop. The city is expected to construct several million square yards of NGCS in total.

Australia's Roads and Maritime Services (RMS) first installed trials of NGCS in New South Wales (NSW) in 2012. The surface was installed on existing jointed plain concrete pavement (JPCP) sections of the New England Highway. Additional trials of a modified NGCS were installed along a section of the Hunter Expressway. Road noise tests, as well as skid-resistance and ride-quality tests, conducted on the completed trial surfaces indicated that they were up to 3 dBA quieter

NGCS being installed in New South Wales

than densely graded asphalt (the material that had traditionally been used in the region to reduce road noise). NGCS was also shown to cost significantly less than an asphalt-wearing course. Based on the trial project, the RMS in 2013 approved NGCS for use in NSW.

A second trial was installed in the late 2010s on a stretch of Australia's Pacific Highway, known as Nambucca Heads to Urunga (NH2U). In this trial, various blade and spacing configurations were used on four different roadway sections. On-board sound intensity (OBSI) testing after project completion led the RMS to conclude that the surface produced comparable noise levels to the traditionally 'low noise' 10 mm stone mastic asphalt pavement.

In 2014, Korea Expressway Corp., aided by its Research Institute, completed a pilot project in **South Korea** using NGCS. Preliminary tests conducted by the Korea Highway Traffic Engineering Institute demonstrated a noise reduction of 1.5-7.5 dBA. A flatness of 55.76 inches per mile (0.88 meters per kilometer) was achieved and IRI was 41.18 inches per mile (0.65 meters per kilometer). Improvement of friction forces, tested according to the ASTM E 501 sliding friction test, was an average of 52.7 on the sliding resistance index (SN). The pilot project's results led to the company choosing NGCS for its long tunnels—which are plentiful, given the country's mountainous terrain.

NGCS is used in all new South Korean expressway tunnels that are 1.24 miles (2 kilometers) or more in length. As of 2020, nearly 2 million square yards (1.65 kilometers) had been installed. Use of the surface has expanded to national highways, local roads and bridges due to the surface's various advantages, such as safety, smooth driving and durability in severe weather conditions.

NGCS being installed in Korea's long tunnels, courtesy Hexacon

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ABOUT IGGA

The International Grooving & Grinding Association (IGGA) is a non-profit trade association founded in 1972 by a group of dedicated industry professionals committed to the development of the diamond grinding and grooving process for surfaces constructed with Portland cement concrete and asphalt. In 1995, the IGGA joined in affiliation with the American Concrete Pavement Association (ACPA) to form what is now referred to as the Concrete Pavement Preservation Partnership (IGGA/ACPA CP3). The IGGA/ACPA CP3 now serves as the lead industry representative and technical resource in the development and marketing of optimized pavement surfaces, concrete pavement restoration and pavement preservation around the world.