Traffic

Twice

as

Loud

A Look Back at the Next Generation Concrete Surface (NGCS): 2007-2021

December 14, 2021
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Presentation Outline

- What Is a Quiet Concrete Pavement
- History of NGCS Development
- Use of NGCS
- Noise Performance of NGCS
- Frictional Performance of NGCS

What Is a Quiet Pavement?

NCHRP 10-67—Texturing Concrete Pavements (NCHRP Report 634) (ARA-2009)

<table>
<thead>
<tr>
<th>Noise Level (OBSI – dBA)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt;102</td>
</tr>
<tr>
<td>Fairly Low</td>
<td>102 To 104</td>
</tr>
<tr>
<td>Moderate</td>
<td>104 to 106</td>
</tr>
<tr>
<td>Fairly High</td>
<td>106 to 108</td>
</tr>
<tr>
<td>High</td>
<td>&gt;110</td>
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</tbody>
</table>

Concrete Texture Types and Typical Levels

<table>
<thead>
<tr>
<th>Texture Type</th>
<th>Typical Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse Tiling</td>
<td>160 – 110 dBA</td>
</tr>
<tr>
<td>Longitudinal Tiling</td>
<td>180 to 185 dBA</td>
</tr>
<tr>
<td>Conventional Diamond Grinding</td>
<td>190-195 dBA</td>
</tr>
<tr>
<td>Next Generation Concrete Surface</td>
<td>90-130 dBA</td>
</tr>
</tbody>
</table>
What is NGCS?

- The Next Generation Concrete Surface (NGCS) is the most recent new concrete texture introduced in the past 20 to 30 years.
- It was conceived as more of a manufactured texture whose properties are consistent and predictable because of the flush grind pass.
- Represents the quietest non-porous concrete texture developed to date. At the time of construction, the NGCS is typically 99 dBA in noise level and has a typical range up to 103 dBA over time.

Purdue Research--Tire Pavement Test Apparatus (TPTA)

Surface Texture
- Innovative New Concrete Surface Textures
- Diamond Ground Textures: Effect of Blade and Spacer Width, Grind Depth, and Custom Blades
- Effect of Longitudinal Grooving: width and depth
- Effect of Tire Type
- Friction
- Rolling Resistance

Transverse Joint Effects on Pavement Noise
- Opening Width
- Sealed or unsealed
- Faulting: Fault Level, step-up or step-down fault

Note That Prior to 2005:
- No Standard Noise Test Tire
- No Standard OBSI Test Method

The Noise Heard Around the Industry!

- PCA Funds Noise Research Through ACPA (2005)
- ACPA Contracts with Purdue University
TPTA Test Grind Surface Result: NGCS is 3 dBA Quieter than CDG

Impact of Joint Width Opening on Overall Pavement Noise

Foam Inserts in Longitudinal Grooves
Roller Used for Imprinting New Construction Concrete Textures

Geometric Patterns Tested At Purdue
- Uniform Waffle
- Random Waffle
- Simulated ARFC
- Circle
- Diamond
- Spheres

TPTA Proof of Concept Testing at MnROAD
- Cell 37
- Mn ROADS Test Center (Courtesy MnDOT)
- Diamond Surfaces, Inc. Grinding Unit with 2 ft Head
- Constructed 18" Strip of NGCS, CDG, and Left Transverse Tining

Proof of Concept Testing Comparing Different Textures
- TS3 CDG
- TS2 NGCS
- TS4 Transverse Tined
- TS1 NGCS
MnROAD Low Volume Road Test Strip Layout

MnROAD Test Strip Noise Results (OBSI- dBA)

Pavement Section

MnROAD 1/3 Octave Spectrum Results

MnDOT ASTM E-274 Friction Testing
Evaluating Joint Slap Noise Effect at MnROAD Test Strips

First Highway Installation I-355 in Chicago - 2007

UMTRI SUV ABS Braking Testing

What Does NGCS Looks Like
NGCS is a Diamond Grinding Procedure

NGCS Construction (2 Pass)

CDG

Positive Texture Removal

Grooved

Single Pass NGCS

Two Pass NGCS Flush Grind Head

Two Pass NGCS Grooving Head
NGCS Compared to CDG

1961 Patent on First Diamond Grinder -- Concrete Bump Cutter

Back to the Future Again

1960's California Texture

Future NGCS LITE2

Current NGCS

Style 15 Christiansen Diamond Grooving Pattern
**What is Important on NGCS Specs**

- **Material Removal**: ¼ inch or less with NGCS head, significantly more removal should require a CDG pass first—more efficient
- **Equipment**: 
  - 4 ft head
  - 35,000 lbs or more
  - Effective Wheelbase 12 or greater
  - Positive means for vacuuming the slurry pick up
- **Grooving Blades**: 0.095 + 0.005”
- **Spacers**: 0.035 + 0.005”

**NGCS Texture**

- Land Areas ⅜” to ½” Wide
- Macro Texture Developed by Groove Depth

**Conventional Diamond Grinding**

- Land Areas Approximately ⅛” Wide
- Macro Texture Developed by Land Height

**So Where Are We Today?**
On average, the experimental NGCS sections were quieter than the CDG sections by approximately 2 dBA.

Both NGCS and CDG textures improved smoothness substantially. The average IRI values improved from 142 in./mi before retexturing to 64 in./mi after CDG and 49 in./mi after NGCS.

"As of spring 2015, the difference in measured tire-pavement noise between the control surfaces and the most successful (lowest noise) quiet asphalt technology was no longer detectable with normal human hearing (3 dBA)."

"The lowest noise concrete surface (NGCS) continues to have a noticeable (approximately 4dB) advantage over the standard concrete finish."

The Virginia Quiet Pavement Implementation Program Under Section 33.2-276 of the Code of Virginia - Final Report - June 2015—House Document No. 13"
Virginia Quiet Pavement Research Results (Smoothness)

Arizona I-10 Pavement Noise Results (OBSI-dBA)

AZ I-10 Noise Spectrums

Comparison of MnROAD Test Section Noise Results (OBSI-dBA)
Friction Testing

Test Speed is 40 MPH

SN40R

SN40S

Smooth

IGGA Friction Data

MnROAD Friction Results

Next Generation Concrete Surface

Conventional Diamond Grinding
Hydroplaning

Mean Texture Depth

- **NGCS**: 1.9
- **Grooved Astro Turf**: 1.5
- **Exposed Aggregate**: 1.2
- **CDG Astro Turf**: 1.0
- **Long Drag**: 0.9
- **Long Tined**: 0.7
- **Burlap Drag**: 0.3

Pavement Section

Mean Texture Depth (mm)

- 2.0
- 2.1
- 2.2

Maximum Water Depth (mm)

- 2.0
- 2.1
- 2.2

Water Depth For

- 2.0
- 2.1
- 2.2

Pavement Section

Anisotropic Friction

- 5
- 15
- 30
- 45

Pavement Section
The Results Are In: The Next Generation Concrete Surface is a Sustainable Pavement Choice

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GM 2002
ADOT 2003
ACPA 2005

The Department of Public Works’ accident experience reveals that grooving has yielded a
1) 20 percent reduction in total accidents
2) 50 percent reduction in total accidents
3) 70 percent reduction in wet pavement accidents
The NGCS is more of a manufactured surface designed as one more tool in the tool kit. It has been used in 15 States and has been in service for 14 years at its earliest installations. NGCS provides three features: Quiet Pavement, Smooth Pavement, and Hydroplaning Resistance. Texas is the world leader in the implementation of NGCS. South Korea has used NGCS the second most and they use it in tunnels.