Innovative Textures

R26 Workshop
September 3, 2014
Minneapolis, MN

Terry Kraemer
Presentation Outline

- A Few Noise Basics
- What Did the Purdue Research Change
  - Existing Pavement Noise Reduction
  - New Pavement Noise Reduction
  - Joint Slap Prediction
- NGCS LITE—Renewable Texture
- Friction and Hydroplaning
- California and Virginia Quiet Pavement Programs
Transverse Tining Most Widely Used Texture—FHWA Tech Advisory

Volume (Too Loud)

Frequency (Off Station)
William Tell Overture (@50mph in a Honda Civic)
Growing Old Or “Acoustic Durability”

Changing Performance Over Time

Graph showing the noise level (dBA) over pavement age (Yrs) for Asphalt and Concrete.
TNM RESULTS (Noise Mitigation)

**FHWA vs. Specific PCC Pavement for Heavy Trucks**

- FHWA Avg Pavement
- FHWA PCC
- Astro Turf PCC
- Long Tine PCC
- Rand Trans PCC
- Text Grind PCC

**FHWA vs. Specific PCC Pavement for Light Vehicles**

- FHWA Avg Pavement
- FHWA PCC
- Astro Turf PCC
- Long Tine PCC
- Rand Trans PCC
- Text Grind PCC

Emission Level at 50 ft in dBA vs. Vehicle Speed, mph
What Did the Purdue Noise Research Evaluate

- Diamond Grinding of Existing Roadways
- Evaluation of Joint Slap Effect
- Evaluation of Geometric Patterns for New Construction
- Evaluation of Friction and Rolling Resistance
- Annoyance
Purdue Research-- Tire Pavement Test Apparatus (TPTA)
Purdue Defines New Grinding Texture

- Texture Consists of Flush Grinding Plus Longitudinal Grooves
- Evaluates Both Single Pass and Two Pass Construction Techniques
- Evaluates Groove Width and Depth Effects
- Grinding Performed on 6 ft Long Samples Using a Portable Grinding Device
- Proof of Concept Necessary on Real Pavement Using Real Grinding Equipment
Industry Consideration

Terry Kraemer
Proof of Concept Testing Conducted at MnROAD Low Volume Road Facility
Special Grinder Used for Proof of Concept
Proof of Concept Test Strips
Proof of Concept Work Validated Purdue Research

- Proof of Concept Conducted at MnROAD Low Volume Road Facility in 2007
- First New Construction and First Highway Installation on Chicago Tollway I-355 in 2007
- First Existing Highway and First Two Lane Installation I-94 In Minneapolis in 2007
NGCS Construction

Positive Texture Removal

Grooved
NGCS Surface

MicroTexture

Grooves for Macro Texture

MicroTexture
Concrete Texture Types and Typical Levels

- **Transverse Tine**
  - 103-110dBA
  - Twice as Loud

- **Conventional Diamond Grinding**
  - 101-106 dBA

- **Longitudinal Tine**
  - 101-106 dBA

- **Next Generation Concrete Surface**
  - 99-102 dBA

- **Traffic**
  - Twice as Loud
NGCS is a Diamond Grinding Procedure
Current Deployment of NGCS Surfaces

- California has more NGCS construction than all other states combined
- Texas has bid the largest NGCS project to date
Development of a Renewable Texture

- First Attempted in 2008 on MnROAD Cell 9 on I-94--- Not Successful
- Successfully Demonstrated on MnROAD Low Volume Road Cell 37 in 2010
- First Highway Installation on I-35 in Duluth, MN
- Second Highway Installation on I-80 In California
- First City Street Installation at Neenah, Wisconsin
Renewable Texture Concept

Current NGCS

1960’s California Texture

NGCS LITE
States with NGCS LITE/OTCS

- California
- Minnesota
- Wisconsin
Noise Results (OBSI)
Arizona NGCS Test Section

Sound Intensity Level, dBA

Pavement Section

NGCS Lane 2
99.0

NGCS Lane 1
99.4

Typical 4-5 Yr Old ARFC
100.2

CDG
102.1

2002 ARFC Test Section
102.8

Longitudinal Tining
103.2

103.9
What Did the Purdue Noise Research Change

- Diamond Grinding of Existing Roadways
- Evaluation of Joint Slap Effect
- Evaluation of Geometric Patterns for New Construction
- Evaluation of Friction and Rolling Resistance
- Annoyance
Joint Slap Effects

- Joint Opening Width
- Sealant Level
- Faulting
Safety: Friction and Hydroplaning
MnDOT ASTM Locked Wheel Skid Testing of NGCS

Friction (SN40) as a Function of Surface Texture and Time

Texture Type:
- Ribbed Tire (SN40R)
- Smooth Tire (SN40S)

- Random
- Transverse
- Tined
- Next Generation Concrete Surface
- Conventional Diamond Grinding
- NGCS LITE

Shadow effect indicates testing at construction:
- 10/31/08
- 10/23/07
- 5/28/08
- 10/31/08

Friction (SN40):
- Random Transverse Tined
  - 10/31/08
  - 10/23/07
  - 5/28/08

- Next Generation Concrete Surface
  - 10/31/08
  - 10/23/07
  - 5/28/08

- Conventional Diamond Grinding
  - 10/31/08
  - 10/23/07
  - 5/28/08

- NGCS LITE
  - 10/31/08
Does Frictional Resistance Change as a Function of Direction of Skidding--Yes
Calibration of the Equipment

- Glycerin Container
- WD 40
- Environmental Trays
- Power Cable
- Serrated Edge Calibration Plate
- Mounting Plate
Operation of CT-342 for Determining Effect of Test Angle on Friction Value
Friction as a Function of Test Angle

Friction Index as a Function of Angle from Direction of Travel - Uncorrected for Cross Slope

- CDG Index
- Astro Turf Index
- Grooved Index
- NGCS Friction
- NGCS Lite Friction
- CDG Friction
- RTT Friction
- RTT Index
- Astro Turf Friction
Splash and Spray Durability

ARFC

Longitudinally Grooved PCCP

March 2006 after 143 Days w/o Rain
Texture and Why Do We Need It?

(Hydroplaning)
Mean Texture Depth

Pavement Section

<table>
<thead>
<tr>
<th>NGCS</th>
<th>Grooved Astro Turf</th>
<th>Exposed Aggregate</th>
<th>CDG</th>
<th>Astro Turf Drag</th>
<th>Long Tined</th>
<th>Burlap Drag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9</td>
<td>1.5</td>
<td>1.2</td>
<td>1.0</td>
<td>0.9</td>
<td>0.7</td>
<td>0.3</td>
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</table>

Mean Texture Depth (mm)
Water Depth For Hydroplaning

<table>
<thead>
<tr>
<th>Pavement Section</th>
<th>Maximum Water Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGCS</td>
<td>1.8</td>
</tr>
<tr>
<td>Grooved Astro Turf</td>
<td>1.9</td>
</tr>
<tr>
<td>Exposed Aggregate</td>
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</table>
“...a measurable and noticeable decrease of more than 5 dB(A) for the NGCS. The NGCS is therefore a significantly better technology for concrete projects designed to decrease noise. Another advantage is that the NGCS seems to be the most reliable in terms of noise variability between different locations. Given the potential for improved lateral stability and the better hydroplaning resistance benefits of the NGCS, it is reasonable to conclude that this technology represents an attractive option as a quiet surface for concrete pavement projects.”
The GnG surface texture was found to be quieter than the CDG, with lane average OBSI values on the GnG texture ranging 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 surface texture. The average OBSI level for all GnG sections was 100.8 dBA compared with an average of 102.8 for all CDG sections.”
Questions?
Rumble Strip Developments
Mumble Strips
Questions?