Surface Characteristics

Any factors that effect:

- Smoothness
- Friction
- Tire-pavement and joint noise
- Splash and spray
- Surface drainage
- Wheel path wear
- Light reflection
- Rolling resistance
HIGHWAY NOISE

- World wide the public demands quieter environments on and around highway facilities
- Safety and smoothness can’t be compromised
- Has both rural and urban elements
- One of the most important issues to the concrete paving industry
SURFACE CHARACTERISTICS

- Impacts the breadth of the concrete construction industry
  - Materials
  - Mix
  - Construction
  - Equipment
  - Maintenance
ISU & FHWA & ACPA

Management Goals

- To implement the Quiet Pavements International Scan findings
- To leverage funds
- To leverage experiences
- To promote unified solutions
Technical Goals

- To understand the relationship between noise and texturing/grinding
- To develop the noise-texture-time relationship
- To develop construction techniques that are repeatable and cost effective
- To evaluate non-texturing options
  - Porous, stamped, exposed aggregate, etc.
Project Team

Iowa State University

- Paul Wiegand, Dale Harrington, Tom Cackler, Jim Cable

TDC Partners, Ltd.

- Ted Ferragut

The Transtec Group, Inc.

- Robert Rasmussen, Eric Mun, Robert Light
- George Chang, Bebe Resendez

Expert Consultants

- Steve Karamihas, Bob Bernhard, Ulf Sandberg, Judy Rochat
- Bob Prisby, Gary Fick
Project Team

ACPA / IGGA
- Jerry Voigt
- Larry Scofield
- John Roberts

FHWA
- Mark Swanlund
RESEARCH PLAN

- Part 1: Strategic Plan
- Part 2: Field Experiments
- Part 3: Continued Field Experiments and Innovative Surfaces

One goal is to determine texture/noise relationship, not eliminate texture types.
Part 1 STRATEGIC PLAN STATUS

- Initial plan completed in September, 2005

- Update to be completed in May, 2006
PART 2  FIELD DATA COLLECTION

- Partnership with FHWA, NCPTC, ACPA, and the Iowa Highway Research Board

- Three types of data
  - Type 1: New construction & Grinding (1-3)
  - Type 2: Existing, but relatively new (6 to 7)
  - Type 3: Existing, all ages (21-28)
## Site Selection*

<table>
<thead>
<tr>
<th>Type</th>
<th>States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 New</td>
<td>IA, (TBD)</td>
</tr>
<tr>
<td>Type 2 Existing</td>
<td>CO, ND, KS, IA, GA, WI</td>
</tr>
<tr>
<td>Type 3 Existing</td>
<td>CO, MN, IA, ND, KS, AL, GA, NC, VA, IN, OH, MI, MO, CA, AZ, TX, Quebec</td>
</tr>
</tbody>
</table>

* Sites identified to date, funds driven
Sections to Date

To Date: **Over 100** Textures Tested

- 37 Transverse Tining (incl. 1 skewed)
- 23 Longitudinal Tining (incl. 1 sinusoidal)
- 15 Diamond Ground
- 15 Drag (Burlap, Turf, Broom, and Carpet)
- 6 Grooved (2 longitudinal, 4 transverse)
- 3 Exposed aggregate
- 1 Shot peened
- 1 Milled
- 5 HMA

Over **230** unique test sections for a total of over 57,000 ft
# Measurements

<table>
<thead>
<tr>
<th>Noise</th>
<th>Macrotexture</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-Board Sound Intensity (OBSI)</td>
<td>RoboTex (LMI line laser)</td>
</tr>
<tr>
<td>Wayside</td>
<td>Circular Texture Meter (CTM)</td>
</tr>
<tr>
<td>In-Vehicle</td>
<td>Digital imaging</td>
</tr>
<tr>
<td></td>
<td>Sand patch</td>
</tr>
<tr>
<td>Smoothness</td>
<td>Microtexture / Friction</td>
</tr>
<tr>
<td>Inertial Profiler</td>
<td>Locked wheel skid trailer (smooth tire)</td>
</tr>
<tr>
<td></td>
<td>Dynamic Friction Tester (DFT)</td>
</tr>
</tbody>
</table>
Noise Protocols

On-Board Sound Intensity (OBSI)

- SI differs from “noise trailer” which measures less sophisticated technique
- Paired microphones in SI allow for directionalized measurement
- Shielding from external noise sources not required
RoboTex Texture Device
European Pavements at 97 km/h

Source: Paul Donavan and Caltrans
Preliminary Catalog Results

Average OBSI Level (dBA)

Diamond Grinding
Drag
Longitudinal Tining
Transverse Tining
Longitudinal Grooving
Transverse Grooving
Cold Milling

Nominal Texture
CAUTION !!!

• All of these sites are different ages, different traffic, different environment, etc., etc., etc.
• All of these sites are shown in terms of NOMINAL texture.
• Rarely is the ACTUAL texture dimension the same as NOMINAL.
• **Rarely** is the ACTUAL texture dimension the same as NOMINAL.
• There is a HUGE overlap in noise for these textures. You will find transverse, longitudinal, and grinding on both the loudest and the quietest.
Iowa DOT
Type 1 Testing
US Highway 30
Near Marshalltown, IA
Type 1 Iowa DOT

<table>
<thead>
<tr>
<th>Data Collection</th>
<th>Collection Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>• Pre-Broom / Pre-Traffic</td>
</tr>
<tr>
<td>• Tire/Pavement (OBSI)</td>
<td>• Post-Broom / Pre-Traffic</td>
</tr>
<tr>
<td>• In-Vehicle</td>
<td>• Post-Broom / Opening</td>
</tr>
<tr>
<td>• Wayside (Roadside)</td>
<td>• Spring 2006 (3-6 mos.)</td>
</tr>
<tr>
<td>Texture</td>
<td>• Fall 2006 (1 year)</td>
</tr>
<tr>
<td>Smoothness</td>
<td></td>
</tr>
<tr>
<td>Friction</td>
<td></td>
</tr>
</tbody>
</table>
## Type 1 Iowa DOT

<table>
<thead>
<tr>
<th>Texture</th>
<th>Spacing (in.)</th>
<th>Depth (in.)</th>
<th>Pre-texturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal Tining</td>
<td>1</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>⅜</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>⅜</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>⅜</td>
<td>⅛</td>
<td>none</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>⅜</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>⅜</td>
<td>⅛</td>
<td>Artificial Turf</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>⅜</td>
<td>⅛</td>
<td>Artificial Turf</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>⅜</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Longitudinal Tining</td>
<td>½</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Burlap Drag</td>
<td>n/a</td>
<td>(Heavy Weight)</td>
<td>none</td>
</tr>
<tr>
<td>Burlap Drag</td>
<td>n/a</td>
<td>(Standard Weight)</td>
<td>none</td>
</tr>
<tr>
<td>Artificial Turf Drag</td>
<td>n/a</td>
<td>(Standard Weight)</td>
<td>none</td>
</tr>
<tr>
<td>Artificial Turf Drag</td>
<td>n/a</td>
<td>(Heavy Weight)</td>
<td>none</td>
</tr>
<tr>
<td>Transverse Tining</td>
<td>½</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Transverse Tining</td>
<td>½</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Transverse Tining</td>
<td>⅛</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
<tr>
<td>Transverse Tining</td>
<td>Random**</td>
<td>⅛</td>
<td>Burlap Drag</td>
</tr>
</tbody>
</table>
Type 1 Iowa DOT
Type 1 Iowa DOT
Type 1 Iowa DOT
1/8" Deep Longitudinal 3/4" Spacing + Burlap (Long Section)

102.3 dBA
1/8" Deep Longitudinal 3/4" Spacing + Burlap (Long Section)

Maximun Texture Depth

8

102.3 dBA

Longitudinal Texture Profile

Transverse Texture Profile

Maximum Texture Depth
1/8" Deep Longitudinal 3/4" Spacing + Burlap (Long Section) 102.3 dBA

[Graph showing distance vs. maximum texture height (mm) for OBSI Level, transverse texture, longitudinal texture, and nominal depth.]
Heavy Burlap Drag

100.7 dBA
Heavy Burlap Drag

100.7 dBA
Heavy Burlap Drag

Distance (ft.)

Maximum Texture Height (mm)

100.7 dBA

OBSI Level, 0.5sec Moving Avg. (dBA)

Transverse Texture

Longitudinal Texture

OBSI Level

Graph showing the relationship between distance and maximum texture height, with OBSI level and moving average shown.
1/16" Deep Transverse 1/2" Spacing + Burlap

101.4 dBA
1/16" Deep Transverse 1/2" Spacing + Burlap

101.4 dBA
1/16" Deep Transverse 1/2" Spacing + Burlap

Distance (ft.)

Maximum Texture Height (mm)

OBSI Level, 0.5sec Moving Avg. (dBA)

OBSI Level  Transverse Texture  Longitudinal Texture  Nominal Depth
Diamond Grinding

102.9 dBA
Diamond Grinding

102.9 dBA
Diamond Grinding

Distance (ft.)

Maximum Texture Height (mm)

OBSI Level, 0.5sec Moving Avg. (dBA)

OBSI Level

Transverse Texture

Longitudinal Texture
1/8" Deep Longitudinal 1/2" Spacing + Burlap

103.8 dBA
1/8" Deep Longitudinal 1/2" Spacing + Burlap

103.8 dBA
1/8" Deep Transverse Random Spacing + Burlap

108.4 dBA
1/8" Deep Transverse Random Spacing + Burlap

108.4 dBA
1/8" Deep Transverse Random Spacing + Burlap

108.4 dBA

110 dBA
1/8" Deep Transverse Random Spacing + Burlap

108.4 dBA

102 dBA
Remember
One job
One mix
One operator
One piece of equipment
Next Steps

- Categorize / rank ~200 unique nominal texture configurations
- Interrelate texture-noise-friction-smoothness
- Identify and reduce variability in texture and noise
- Analyze in-vehicle and wayside noise
- Conduct splash & spray experiment
- Develop texture specification
- Build trial sections to a “new” specification
PART 3 INNOVATIVE SURFACE CHARACTERISTICS

- Pooled fund
  - California; Iowa; New York; Texas; Washington; Minnesota
  - FHWA
  - NCPTC
  - ACPA/IGGA
PART 3 INNOVATIVE SURFACE CHARACTERISTICS (cont.)

- Continue testing of Type 1 and Type 2 sites
- Influence construction of sites utilizing early results
- Evaluate innovative surfaces
  - Porous
  - Exposed Aggregate
  - Two-lift construction
  - Stamped/brushed
FUTURE INITIATIVES

- Determine best practices for consistent texturing
- Develop specifications/controls for use by highway agencies
- Determine methods to monitor plastic concrete texturing for compliance with specifications
FUTURE INITIATIVES

- Work with equipment manufacturers to develop equipment that will consistently meet the specified texture requirement and thus the “design noise”

- Long Range Plan management and updates
FUTURE INITIATIVES

- Connect other interested industry experts/stakeholders
  - Purdue
  - Concrete Pavement Technology Program (CPTP)

- Improve communications with vehicle and tire industries
ASSOCIATED STUDIES

- Porous Concrete
- Splash and Spray
- Traffic Noise Model
Timeline

- Data Collection: Thru July 2006
- Expert Task Group: June 2006
- Specifications: Fall 2006
- Formal Report: Fall 2006
- Data Analysis: Continuous
National Concrete Pavement Technology Center

For more information, please contact:

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