Concrete Pavement Surface Characteristics Program: An Update

Paul Wiegand  
National Concrete Pavement Technology Center  
Iowa State University  
2711 South Loop Drive Suite 4700  
Ames, IA 50011  
pwiegand@iastate.edu

Robert Otto Rasmussen  
Transtec Group, Inc.  
6111 Balcones Drive  
Austin, TX 78731  
robotto@thetranstecgroup.com

Dale Harrington  
Snyder and Associates  
2727 SW Snyder Blvd.  
P.O. Box 1159  
Ankeny, IA 50023  
dharrington@snyder-associates.com

Ted Ferragut  
TDC Partners, Ltd.  
417 South Saint Asaph Street  
Alexandria, VA 22314-3747  
tferragut@tdcpartners.com

ABSTRACT

The acoustical characteristic of pavement surfaces continues to be an important factor for pavement owners. The National Concrete Pavement Technology Center has been leading a major study to understand how to optimize surface characteristics of concrete pavements. The findings from this research will be reviewed as well as the interim guidance being given to the participants in the study.

This presentation is part of the Sustainable Concrete Pavement Technologies session.

Key words: acoustical characteristic—better practices—concrete pavements
Concrete Pavement Surface Characteristics Program
An update

Paul Wiegand, PE (IA)
National Concrete Pavement Technology Center
Robert Otto Rasmussen, PhD, INCE, PE (TX)
The Transtec Group, Inc.
Dale Harrington, PE (IA)
Snyder and Associates
Ted Ferragut, PE (VA)
TDC Partners, Ltd.

AUGUST 2009
Concrete Pavement Surface Characteristics Program

- 6 Years (2005-2010)
- 3 Parts
- 11 Partners

[Logos and affiliations]
CPSCP Working Plan

3 Major Areas of Research and Analysis

1. Measurement & Analysis Techniques – Improvements, Adjustments, Corrections
   - OBSI
   - Texture & Friction
   - Wayside Noise

2. Guidance for Texture Type Selection – Understanding Averages and Variability
   - Link Texture to Noise
   - Fill Gaps
   - Functional Durability
   - Non-Traditional Functional Performance Indicators
   - Innovative Textures and Techniques

3. Construction Techniques & Control (Average and Variability)
   - Construction Equipment and Techniques
   - Control of Texturing Operation
   - Better Practices and Model Specifications
Test Methods

- **Noise**
  - On-Board Sound Intensity (OBSI)
  - Wayside (Roadside)
  - In-Vehicle

- **Smoothness**
  - Inertial Profiler

- **Macrotexture**
  - RoboTex (LMI RoLine)
  - Circular Texture Meter (CTM)
  - Sand patch

- **Microtexture / Friction**
  - Locked wheel skid trailer (smooth tire)
  - Dynamic Friction Tester (DFT)
Texture Testing: RoboTex 2.0

- Built around LMI-Selcom RoLine Sensor
- Laser height sensor, inertial referencing
- GPS, DMI encoder, video log
Noise Testing: OBSI

AASHTO TP 76
DFT / CTM vs. the Skid Trailer

Dynamic Friction Tester  Circular Texture Meter

Skid Trailer
Noise Testing: In Vehicle

- Standardized by SAE J1477 and ISO 5128
- Same vehicle used for OBSI and In-Vehicle noise testing
CP Tech Center Test Sections

- In 3½ years, Over **1000** Unique Textures Tested
  - Transverse Tining (incl. skewed and cross-tined)
  - Longitudinal Tining (incl. sinusoidal)
  - Diamond Ground
  - Grooved (longitudinal, transverse)
  - Drag (Burlap, Turf, Broom, Canvas)
  - Shot Peened
  - Exposed Aggregate
  - Porous (Pervious) Concrete
  - Milled
  - HMA and Surface Treatments

- **150 miles of test surface in 20 States and 6 Countries**
What we’ve learned

There is a lot of:

**VARIABILITY**

*Variability* from project to project, and *Variability* within a given project.
Acoustical Durability

A-Wtd. OAS Level, SRTT, 60 mph (dB re 1μW/m²)

1/3-Octave Center Frequency (Hz)

- CDOT Rifle 2006
- CDOT Rifle 2007
- CDOT Rifle 2007 (Center Lane)
Texturing Guidelines

- A “how to” guide for designing and constructing quieter concrete pavements
- Addresses all conventional concrete pavement texture types, including grinding
- Simple and practical guidance

Download from www.CPTechCenter.org
Better Practices

Surface Texture

- Avoid (flatten) texture at intervals > 1 inch
- Avoid smooth (floated or worn) surfaces
  - Some fine texture (< 0.25 inch) required
- Texture should be negative
  - Point down (grooves), not up (fins)
- Texture should be oriented longitudinally
Better Practices

Surface Texture

Bad

Good
Better Practices

Concrete Properties

- Strong, durable, wear resistant mortar
- Use siliceous sands
- Hard, durable, polish resistant coarse aggregate for texture durability, especially if diamond ground
- Adequate and consistent mortar depth for tined surfaces to hold texture shape
Better Practices

Joints

- Narrow, single cut joints preferred over widened cuts
- Avoid faulted joints with adequate load transfer
- Keep joint sealant below pavement surface
- Prevent spalled joints through good design, materials selection, and construction
Better Practices

Operations impacting noise

- **Paving Equipment**
  - Minimize vibrations
  - Uniform paver motion
  - Uniform extraction
  - Equipment maintenance
Better Practices For Texturing

Paving Equipment
Better Practices

Operations impacting noise

- **Texture/Cure Equipment**
  - *Minimize vibrations*
    - *Especially critical for tined surfaces*
  - **Cleanliness**
    - Prevent build up on tines/drag media to get texture you want
  - **Consistent tracking**
    - *Minimize lateral wander*
  - **Heavy duty curing**
    - *Critical for texture durability*
  - **Equipment maintenance**
    - Prevent jerking/unwanted motions
Better Practices For Texturing

Texture-Cure Equipment
Monitor Texturing Operations

Accelerometers
Texture Machine and Paver
Texture and Vibration Feedback
LMI-Selcom RoLine Line Laser
Better Practices

Operations impacting noise

- **Grinding Equipment**
  - **Size**
    - Larger, heavier is better
  - **Holidays and overlap**
    - Keep out of wheel tracks
    - Use wider heads to minimize match lines
  - **Bogie wheels**
    - Ensure no imperfections
  - **Vibrations**
    - Minimize excess vibrations
Texture: Diamond Grinding
BETTER TEXTURING PRACTICES

MATERIALS
- Durable Fine Aggregate
- Concrete Temperature
- Setting Characteristics
- Mortar Volume
- Paste Volume
- Aggregate Gradation

CLIMATE
- Ambient Temperature
- Wind Velocity
- Humidity
- Solar Radiation

CONSTRUCTION
- Paving Uniformity
- Pre-texture Uniformity
- Travel Speed
- Tine/Drum Angle
- Tine/Drum Pressure
- Tire/Drag Spacing/Diameter/Sheep
- Tire Roll/Drum Support Positioning
- Tire/Drum Cleanliness
- Matched Track Speed
- Machine Stability/Vibration
- Delay due to Curing

OPTIMUM TEXTURING CONDITIONS
Better Practices

Summary

- Establish a higher level of control over texturing
- Recognize and manage the sources of variability
- Better practices will also improve smoothness, durability, and potentially reduce costs
Current Technical Documents?

- The Little Book of Quieter Pavements (FHWA)
- Strategic Plan for Concrete Pavement Surface Characteristics
- Concrete Solutions for Quieter Pavements on Existing Roads
Current Technical Documents?

- Concrete Pavement Surface Characteristics: Evaluation of Current Methods for Controlling Tire-Pavement Noise
- Evaluation of U.S./European Concrete Pavement Noise Reduction Methods
- Identifying Quieter Concrete Pavements Using On-Board Sound Intensity
What are the Technical Documents Planned in the Future?

- Advanced Texture Model Specifications (Dec., 2010)
- Selecting the Right Texture for the Right Situation (Draft in 2009)
- Tech Briefs
  - Diamond Grinding
  - Acoustic Durability
  - Joint Effects on Noise and Annoyance
  - Variability of Tire-Pavement Noise
  - The next generation of Texture Specifications