US Pavement Noise Research

47th GRB, February 2008
Background

• US Pavement research has focused on building the necessary tools and knowledge to allow pavements to be designed and constructed for reduced noise.

• With this knowledge, pavements can be part of the environmental toolbox and policy options of road authorities to provide environmental benefits.

• US road authorities are using quiet pavement for noise abatement today and research continues to improve technology and compliment other global pavement noise research.

• The results presented are the work of Dr. Robert Rasmussen and Dr. Paul Donavan under contract to the US Federal Highway Administration (FHWA) and various US State departments of Transportation (DOT).
Overview

• Motivation
• Research Tools
• Pavement Noise Results
• Implications to Real Traffic Noise
Motivation

• In the US, various state Departments of Transportation (DOT) desire to use pavement as noise mitigation tool.
  – Federal policy requires proven performance of mitigation tools for funding.
  – Current low noise pavement projects need to quantify and certify acoustic performance.

• Understanding of noise performance of pavements:
  – $\text{dB} = f(\text{texture, age, wear, design, construction, etc.})$

• Need measurement techniques and apparatus useful in field work.
Research Tools

• On-board Tire / Road Noise Measurement
• Roadside (traffic) Noise Measurement
• Road Texture Measurement
• Road Friction Measurement

• US Research Projects
  – NCHRP 1-44: On vehicle tire/road noise measurement
  – NCHRP 8-56: Truck noise source identification
  – NCHRP 10-76: Methodologies for assessing pavement and barriers for noise abatement
Noise Testing: OBSI

- On-Board Sound Intensity (OBSI)
- Standardization underway via AASHTO and SAE
Noise Testing: Wayside

- Controlled pass-by (CPB) measures noise “roadside” using test vehicle under controlled conditions
- Same vehicle used for OBSI and CPB noise testing
Texture Testing: RoboTex

- Robotic Texture (RoboTex) Measurement System
- Built on LMI-Selcom RoLine sensor
- 3-D texture profiling at 1 mm × 0.5 mm sample interval
- Height sensor resolution is 0.01 mm (accuracy ~ 0.05 mm)
- Same line laser sensor currently being used by some profiler vendors to help solve “footprint” issues
Friction Testing: Skid Trailer and DFT

- Measures wet friction
- Smooth tire allows on trailer to account for micro- and macrotexture effects on friction
- Standardized in ASTM E 274 (ASTM E 524 tire) and ASTM E 1911
OBSI Noise Catalog

- Diamond Grinding
- Drag
- Longitudinal Tining
- Transverse Tining
- Longitudinal Grooving
- Transverse Grooving
- Exposed Aggregate
- Shot Peened
- Other

Full Range of Concrete Pavements 100 to 111 dB
European Asphalt Pavements

European Pavements at 97 km/h

Sound Intensity Level, dBA

PA
PCC
DGA
DLPA
SMA
US Asphalt Pavements

Caltrans Data Base - California & Arizona

Sound Intensity Level, dBA
Construction Quality – “Joint Slap”
Measurement of “Joint Slap”
Hearing is Believing


With a number of comments received so far on the posts from the European testing being conducted by the National CP Tech Center, it seemed appropriate to fulfill another (quite logical) human sense... hearing.

From the results posted so far, 7 sound clips have been prepared to form a "listening experience" of some of the European pavements: 3 from Austria, 2 from Belgium, and 2 from the Netherlands.

Total OSCI levels and corresponding third-octave spectra from these sections are summarized together below (click on either image to expand):

![Sound clip](image)

Each sound clip was prepared by sampling approximately 5 seconds of OSCI data. The left channel (ear) is a measurement taken near the leading edge (front) of the test tire. The right ear will hear a measurement from the trailing edge (rear) of the tire. Some filtering has been performed to better reproduce the sound so one might hear at these locations (and still minimizing the effect of wind noise).

To listen to these sound clips, simply click on the following links. If they do not play, you might need to download them first, and play them separately.

File AT03.mp3 (Austria, 8 mm Exposed Aggregate, 7 yrs old)

File AT05.mp3 (Austria, 11 mm Exposed Aggregate, 6 yrs old)
Implications to Real Traffic Noise

• Pavements are an important part of the traffic noise system.
  – This includes vehicles, traffic management, land use planning, and enforcement.

• Pavement range of 15-18 dB.
  – Pavement information is necessary to make good policy decisions.
Thank You

• Questions?
Background Information
Background

Nomenclature

- PCC – Portland Cement Concrete
- DGA – Dense Graded Asphalt (non-porous)
- OGAC/RAC – Open Graded/Rubber Asphalt
- PA – Porous Asphalt
- DLPA – Double Layer Porous Asphalt
- SMA – Stone Mastic (Matrix) Asphalt
Noise vs. Friction

Average DFT/CTM-Estimated SN40S (ASTM E 274 Skid Trailer, Bald Tire)

- Diamond Grinding
- Drag
- Longitudinal Tining
- Transverse Tining
- Other
1/8" Deep Random Transverse Tining Texture vs. Noise

ZONE 2. 100 dBA (OBSI SRTT)
1/8" Deep Random Transverse Tining Texture vs. Noise

ZONE 3. 108 dBA (OBSI SRTT)
Near Field – OBSI

Total Level: 103.0 dBA

Average

SPB Location

Near Field – OBSI
Measurement Techniques

SPL (0.125s exp. avg), dBA vs Time (min)