Tire-Pavement Noise Evaluation Using On-Board Sound Intensity (OBSI) Measurements

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Noise Fundamentals

- Noise is unwanted sound
- Sound is measured in decibels (dB)
- A-weighted decibels (dBA) correspond to human hearing

Image source: City of Vancouver, Canada
Noise Fundamentals

- Logarithmic scale:
  - 2x sound energy = 3 dB increase
  - 10x sound energy = 10 dB increase

  but . . .

  - 1-3 dB change barely perceptible
  - 6-10 dB change perceived as doubling or halving
Noise Fundamentals

- 23 CFR 772 provides Federal Procedures for Abatement of Highway Traffic Noise
- Each State DOT must develop policy consistent with 23 CFR 772
- Who has this responsibility in your state?
Quieter pavements: another tool in the toolbox

- Noise barriers not always the best/only solution
- Quieter pavements provide another tool
FHWA’s Little Book of Quieter Pavements

http://www.fhwa.dot.gov/publications/focus/08jun/03.cfm
What is Traffic Noise?

Source: FHWA Little Book of Quieter Pavements
What are the sources of tire-pavement noise?

- Tread impact
- Air pumping
- Stick-slip
- Stick-snap

Source: FHWA Little Book of Quieter Pavements
What amplifies tire-pavement noise?

- Horn effect
- Helmholtz resonance
- Sidewall vibrations
- Pipe resonance
- Cavity resonance

Source: FHWA Little Book of Quieter Pavements
What pavement characteristics affect tire-pavement noise?

- Texture (this is the big one)
- High Porosity
- Low Stiffness (less important)
How can tire-pavement noise be measured?

- Wayside Measurements
  - Controlled Passby (CPB)
  - Statistical Isolated Passby (SIP)
  - Continuous Flow Traffic Time-Integrated Model (CTIM)
How can tire-pavement noise be measured?

- **Source Measurements**
  
  - **Close Proximity (CPX)**
    - Sound *pressure* level
    - ISO standard (11819-2)
  
  - **On-Board Sound Intensity (OBSI)**
    - Sound *intensity* level
    - AASHTO standard (TP 76-09)
On-Board Sound Intensity (OBSI) Test Rig
Relationship of OBSI level to wayside noise level

Source: Donavan and Lodico, 2008
Representative OBSI Test Results

Source: Lodico and Donavan, 2009
Normalized Distributions of OBSI Noise Levels for Conventional Concrete Pavement Types

Source: National Concrete Pavement Technology Center Tech Brief, September, 2010
Quiet Pavement Pilot Program (QPPP) vs. Quiet Pavement Research (QPR)

- The data gathered are the same.
- Arizona (ADOT) only state with an approved QPPP.
- With an approved QPPP, the State may make adjustments for (1) pavement type in the prediction of traffic noise levels; and (2) the use of specific pavement types or surface textures as noise abatement measures.
- State DOT(s) implementing a QPPP must commit to monitor noise levels and take appropriate actions if the noise reduction benefits do not last in perpetuity.
- Several states conducting QPR: CA, TX, MN, CO, VA, WA, FL.
- State DOT(s) conducting QPR do not need to make any commitment regarding the noise reduction benefits of the pavement, since no change in program policy can occur until the research is complete.

http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/qpppmem.cfm
“The goal of this bulletin and the overall QPR Program is . . . to build quieter pavements that will maintain noise reduction benefits over time without compromising on safety, ride quality, and sustainability of pavement surfaces.”

http://www.dot.ca.gov/hq/esc/Translab/ope/QuiterPavements.html
Summary

- Tire-pavement noise is the most significant contributor to overall highway traffic noise
- Noise barriers helpful, but have limitations
- Quieter pavements address tire-pavement noise at the source
- Both asphalt and concrete pavements can be louder or quieter
- OBSI provides an efficient, standardized approach for comparing noise characteristics of different pavements and also evaluating benefits over time
- FHWA provides two approaches for quieter pavement programs: QPPP and QPR
- Effective program requires cooperation between environmental and pavement management personnel