“Quiet” Pavements

Gary L. Fitts, P.E.
Sr. Field Engineer
Asphalt Institute
Topics

• Background, definitions
• Approaches to reduce highway noise
• Why do porous asphalt mixtures work, and what other benefits do they provide for the public?
Roadway noise isn’t a new issue

In 44 B.C., Julius Caesar declared: “Hence-forward, no wheeled vehicle whatsoever will be allowed within the precincts of the city, from sunrise until the hour before dusk….Those which shall have entered during the night, and are still within the city at dawn, must halt and stand empty until the appointed hour”.

Obtained from ACPA R&T Update, October 2006, Ref.1
Terminology

- **Noise**
  - 2a: *SOUND*; especially: one that lacks *agreeable* musical quality or is noticeably *unpleasant*

- **Sound**
  - c: *mechanical radiant energy that is transmitted by longitudinal pressure waves in a material medium (as air) and is the *objective* cause of hearing*

- **Decibel**
  - 2: *a unit for expressing the relative intensity of sounds on a scale from zero for the average least perceptible sound to about 130 for the average pain level*

  - Three different types of adjustment for frequency. “A” weighting is used to characterize sound relative to the sensitivity of the human ear.

From: [http://www.m-w.com/](http://www.m-w.com/)
The Decibel Scale

Sound Pressure, N/sq. m.

Decibel Level

Logarithmic Scale

- Hearing Threshold
- Conversation
- Discomfort
- Pain Threshold

We're driven. www.asphaltinstitute.org
Increasing the decibel level by 10 doubles the sound intensity.
The Decibel Scale

A reduction of 3 dB(A) is like doubling the distance from the noise.

67 dB(A)

50 ft
A reduction of 3 dB(A) is like doubling the distance from the noise.

$$67 \text{ dB(A)} - 3 \text{ dB(A)} = 64 \text{ dB(A)}$$
## FHWA Noise Policy

<table>
<thead>
<tr>
<th>Activity Category</th>
<th>Leq(h)</th>
<th>L\textsubscript{10}(h)</th>
<th>Description of Activity Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>57 (Exterior)</td>
<td>60 (Exterior)</td>
<td>Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.</td>
</tr>
<tr>
<td>B</td>
<td>67 (Exterior)</td>
<td>70 (Exterior)</td>
<td>Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.</td>
</tr>
<tr>
<td>C</td>
<td>72 (Exterior)</td>
<td>75</td>
<td>Developed lands, properties, or activities not included in Categories A or B above.</td>
</tr>
<tr>
<td>D</td>
<td>--</td>
<td>--</td>
<td>Undeveloped lands.</td>
</tr>
<tr>
<td>E</td>
<td>52 (Interior)</td>
<td>55 (Interior)</td>
<td>Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.</td>
</tr>
</tbody>
</table>
What the public expects

• Noise has become a functional consideration, along with ride quality and surface friction—especially in non-rural areas

• Cities are developing or strengthening noise ordinances in response to quality-of-life concerns caused by excessive noise
From the press...

• Livonia Residents Complain of Freeway Noise

• Drivers on Exeter, U.K.’s A30 Complain About Noise from Concrete Surface, Joining Residents for Asphalt Resurfacing
  – Western Morning News, Exeter, U.K., December 4, 1999
Major noise generators of vehicles are:
- engine,
- exhaust system,
- aerodynamic noise, and
- tire noise.

(Herman, TRR 1626; McNerney, et al., TRR 1626)

For > 50 mph, **pavement/tire noise dominates**. (Billera, et al., TRR 1601)
Sound Generation at Tire-Pavement Interface

- Driving direction
- Block 'snap out'
- Air is compressed (air pumping)
- Road surface
- Tread block slip
- Contact length
- Greatest slip velocities
What Can Be Done to Mitigate Pavement Noise?

• Distance
• Solid Obstructions
  – Walls
  – Earth Berms
  – Trees/Shrubs are aesthetically pleasing but don’t significantly affect measured sound
• Control at the Source with Pavement Surface
How Barriers Work

Sound waves are deflected and/or partially absorbed by the barrier.

“Each Additional 1 m Height = 1.5 dB(A) Additional Attenuation”

Source

Line of Sight Blockage = 5 dB(A)

Noise Barrier

Receiver
Problems with Sound Barriers

- Must be high enough to intercept sight line, cannot have gaps
  - Can be difficult to practically apply in urban areas with bridges, frontage roads, etc
- Extremely expensive
  - Avg. height in Louisiana-15 ft
  - Over $2 million per linear mile!
- Easels for adolescent artists
- What about drivers?
Noise Walls

Effective only for those not in line-of-sight.

Do not reduce noise at source.
Parallel Barriers

Parallel barriers reduce the effectiveness of noise walls due to reflection by up to 2 dBA—and what about the noise *between* the barriers?
Effect of Pavement Surface


- A decrease of 3 dB(A) is significant. Has the same effect as doubling distance.

- Noise studies in U.S. and Europe show asphalt surfaces quieter than PCC. (Wayson, NCHRP Synthesis 268)
Effect of Pavement Surface

- OGFC is the quietest surface type. (Wayson, NCHRP Synthesis 268)
- SMA has also proven to be a quiet surface. (Wisconsin DOT, 1993)
  - Recent Canadian study noted that SMA is more effective with truck noise reduction than automobiles
- Dense graded HMA surfaces are quieter than PCC pavements. (Hibbs and Larson, Report FHWA-SA-96-068, May 1996)
Why is a OGFC/PFC so effective?

- Porosity reduces air pumping
  - As if carpeting a tile floor
- Very smooth profile-rolling only needed to seat the aggregate particles
- Thicker or multiple lifts further improve the reduction of noise generation
- Different sound frequency than other surfaces-lower amplitude at higher (whining) frequencies
PFC: Up Close and Personal
PFC/OGFC Benefits

- Safe riding surface
  - Best wet-weather visibility of any surface
    - Least splash/spray
    - Least glare
  - Reduced possibility of hydroplaning
- Smooth riding surface
  - Very little rolldown-excellent surface profile
- Least noise generated at tire-pavement interface
US 287 (Wichita Falls District)
International Roughness Index (IRI)
Comparison of 2 Projects Completed in the Fall of 2001

Reference Markers

Flexible (PFC + Superpave)  Rigid (11" CRCP)
Construction Issues

- For overlays, make sure to correct any surface drainage problems before placing PFC
- Place when roadway surface temperature is 70°F or greater
- Tack coat: CSS-1H, SS-1H, or PG58…do not dilute emulsified asphalt
- Tack coat rate between 0.04 and 0.10 gal/sy
- Roll with steel-wheeled rollers in static mode only
PFC Limitations

• Special needs for drainage in curbed sections
• Loss of beneficial qualities in slow, light traffic due to clogging
• More difficult to remove snow and ice
• Underlying surface must be impermeable
Summary

• Highway noise is now an important issue
• Tire-pavement interface accounts for most noise under free-flowing traffic
• Barrier walls are expensive and have limitations
• OGFC/PFC addresses noise at the source and provides other functional benefits not possible with other materials