Asphalt - The Quiet Pavement

February 9-10, 2010
Soaring Eagle Casino & Resort
Mt. Pleasant, Michigan
Controlling Highway Noise at the Source

• Sound
  – mechanical energy transmitted by pressure waves (sound waves) (as in air) that is the stimulus to hearing

• Noise
  – one that lacks agreeable musical quality or is noticeably unpleasant
Controlling Highway Noise at the Source

Urban Noise Sources

- Road Traffic: 60.0%
- Neighbors: 12.9%
- Enterprises: 11.9%
- Planes: 0.9%
- Railway: 5.1%
- Others: 3.0%
- Trams/Buses: 5.0%
- Recreational: 1.0%
- Unknown: 0.3%
Controlling Highway Noise at the Source

FHWA Guideline = 67 dB(A)

- Pain Threshold
- Hearing Hazard
- Hearing Threshold

<table>
<thead>
<tr>
<th>dB</th>
<th>Pa</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00002</td>
<td>Quiet bedroom</td>
</tr>
<tr>
<td>0.02</td>
<td>0.002</td>
<td>Whispersing</td>
</tr>
<tr>
<td>0.2</td>
<td>0.02</td>
<td>Truck (@ 30’)</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Jet plane (@ 1000’)</td>
</tr>
<tr>
<td>20</td>
<td>20000</td>
<td>Space shuttle (@ 100’)</td>
</tr>
</tbody>
</table>

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Traffic Stream (Line Source)

Individual Vehicle (Point Source)

$2 \times d$  $L-3\text{dB}$

$2 \times d$  $L-6\text{dB}$
Doubling Traffic adds 3dBA
Controlling Highway Noise at the Source

Side-Line Measurements
- Microphones at 5 & 50m
- Measures all Sources
- Requires Flat, Open Terrain

- Statistical Pass–By
  – Existing Traffic

- Controlled Pass–By
  – Control Vehicles
Controlling Highway Noise at the Source
Controlling Highway Noise at the Source

Close Proximity Method CPX
Controlling Highway Noise at the Source

On-Board Sound Intensity Measurements
Controlling Highway Noise at the Source

OBSI vs CPB Levels

- 12 pavements (PCC & AC)
- 3 tire types
- 2 speeds (97 & 72 km/h)
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FHWA - Noise Abatement Criteria

• Projects that Require Evaluation
  • Increase Capacity
  • New Alignments

• Maximum level = 67 dB(A)
• Maximum Change = 10 dB(A) change

“this is not an absolute value or design standard, only a level where noise mitigation must be considered”
Controlling Highway Noise at the Source

Control Options

• Source
  – Eliminate
  – Reduce

• Distance
  – Lengthen Path/Relocate Receiver

• Obstructions
  – Obstacles in Path
  – Insulate
Controlling Highway Noise at the Source

Control Options

• At the Source
  – Vehicles
    • Smaller, Lighter
    • Quieter Less Aggressive Tread Patterns
  – Traffic
    • Lower Speeds
    • Traffic Calming (avoid Starting & Stopping)
  – Pavement Surfaces
    • More on this later
Control Options

• Source
  – Eliminate
  – Reduce

• Distance
  – Lengthen Path/Relocate Receiver

• Obstructions
  – Insulation at Receiver
  – Obstacles in Path
Controlling Highway Noise at the Source

Lengthen Path

- Land Use Planning
  - Type of Use
  - Location
  - Orientation

- Existing Buildings/Subdivisions
- New Routes Only
- No Outdoor Reduction
Controlling Highway Noise at the Source

Control Options

• Source
  – Eliminate
  – Reduce

• Distance
  – Lengthen Path
  – Relocate Receiver

• Obstructions
  – Insulation at Receiver
  – Obstacles in Path
Controlling Highway Noise at the Source

- Insulate Buildings/Windows
  - Effective for interiors only
- Impractical & Expensive
- Public Buildings Only
- No Outdoor Reduction
Control Options

- Through Obstructions
  - Vegetation
  - Berms
  - Barrier Walls
  - Combination of both
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Vegetation
- Trees and Shrubs
  - 10 dB(A) Reduction
  - 250 FT of Dense Growth
  - No line of sight
- Additional ROW
- Psychological Effect Only
- No overall Noise Reduction
Controlling Highway Noise at the Source

- Berms
  - Effective only where no line of sight exists
  - Require a large amount ROW
  - Massive amounts of earthwork
  - May not be an Option in Urban Areas
  - No Overall Noise Reduction
Controlling Highway Noise at the Source

Berms & Walls

• Require a large amounts ROW
• Massive amounts of earthwork
• May not be an Option in Urban Areas
• No Overall Reduction from Source
Controlling Highway Noise at the Source

Barrier Walls

• Only Method Approved for FHWA $$ Participation

• 5-8 dB(A) Effective Reduction

• Predictable Results from TNM

• Expensive

• Effective Only if no line of sight

• Limited Mitigating Effect

• Reflected Noise Problem

• Eliminates Scenic Vistas

• No Overall Noise Reduction
Controlling Highway Noise at the Source

Noise Walls
Effective only for those not in the line-of-sight.

Does nothing reduce noise at source.
Controlling Highway Noise at the Source

Noise Walls
Shadow Effect

Not as Effective
For second
And Third
Tier Homes

0 dB(A) Reduction

5-8 dB(A) Reduction

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Noise Wall - Shadow Effect

Applies at Ends and Breaks
- Intersections
- Streams
- Driveways
- Etc

5-8 dB(A) Reduction

0 dB(A) Reduction
• Noise walls
  – They are expensive.
  – They don’t work in all types of terrain.
  – Effective for first tier
  – Reflected noise may compound problem
  – Source of noise is still there
Controlling Highway Noise at the Source

European Experience

- Dense Population
- Limited ROW
- Historical Vistas
- Need to Reduce Overall Noise Level
Texture

Chip Seal

Positive Texture

Source: Transtec
Positive Texture

Exposed Aggregate Concrete
Texture

Tined Concrete

Negative Texture
Texture

Source: Ulf Sandberg

Smooth Rolled OGFC

Negative Texture
European Pavements at 97 km/h

Sound Intensity Level, dBA

- PA
- PCC
- DGA
- DLPA
- SMA
Data Base - California & Arizona

Sound Intensity Level, dBA

- OG/RAC Pavements
- PCC Pavements
- DGA Pavements
Controlling Highway Noise at the Source

**France**

Two layer Open Graded Friction Course
- Expedite Drainage
- Prevent Clogging

- Aggregate Lift / Thickness
  - Bottom 11-14/40-50 mm
  - Top 6-8/25-30 mm

- Won an Environmental Award for Quiet Pavement
Controlling Highway Noise at the Source

Typical IPG double-layer porous asphalt

Top layer: 4/8 mm aggregate, 25 mm thick, air voids 21%

Bottom layer: 11/16 mm aggregate, 45 mm thick, air voids 21%
Twin Layer Paving
Two Screeds – Two Mixes Placed at Same Time
Twin Layer Porous Friction Course

North

Avg. Global dBA

Section

N1 N2 N3 N4 N5 N6 N7 N8 N9 N10 N11 N12 N13
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PCC Negative Texture

Longitudinal Tined Diamond Grind
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Controlling Highway Noise at the Source

Unintended texture introduced by automatic longitudinal float.
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Sound Levels at 50 ft - AZ 101 Pre & Post Project
Uncorrected for Traffic Volume/Speed/Mix

Before and After Comparison
Site 3A
Controlling Highway Noise at the Source

Arizona 101 Wayside Data at 50 ft - Pre & Post Project OGFC
Uncorrected for Traffic Volume/Speed/Mix

Before and After Comparison
Site 3A
Controlling Highway Noise at the Source

Noise is Important to the Public.

Current Mitigation Techniques
- Expensive
- No Overall Reduction
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A Decrease of 3 dB(A)
- Equals Doubling Distance
- Cutting Traffic in Half
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Decrease of 10dB(A):  
- Perceived as a 50% reduction in volume
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- Improves Smoothness
- Improves Skid-Resistance
- Reduces Overall Emissions
- Uses Existing Technology
Controlling Highway Noise at the Source

- Routine Overlay Program
- No need to wait
- Done as Maintenance
- SMA & OGFC Mixes
- Designed for Hi-Stress
Thank You!

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Asphalt Information on the Web

Asphalt Pavement Alliance

www.asphaltalliance.org

www.quietpavement.com