Determining the Limits of Quieter Pavement Projects

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Overview

- Pavement Acoustics
- Noise Complaint Addressed w/ QP
- Caltrans Quiet Pavement Policy Bulletin
- Calc. Quieter Pavement Project Limits
- Conclusion
OBSI Quantifies Pavement Acoustics

Collect Database of Pavement Acoustics
Differences b/w ‘Loud’ and ‘Quiet’ Pavement can be Significant

Various Acoustic Mechanisms

- Rigid Pavement
  - Surface Textures
  - Joint Noise
- Flexible Pavement
  - Porosity
  - Aggregates
Responding to Noise Complaint
Use OBSI Database to Predict Lower T/P Noise Levels

1. Measure Existing Pavement w/ OBSI
2. Use OBSI Database to predict *Wayside* benefits of Quieter Pavement

Comparison I-5 Bridge Deck over Sacramento River near Anderson, CA - Pre & Post Grind
T/P Noise to Wayside Noise

Old “Loud’ Pavement to New Quieter Pavement Strategy

102 dBA

72 dBA

1 to 1 offset if all traffic is light vehicles

<1 to 1 offset if all traffic includes HTs
Caveats – will diminish or cancel quiet pavement benefits on wayside noise levels

- Jake Brakes
- Grades
- Aggressive treads
- Snow chains
- Joint noise
Ground PCC – 102 dB(A) (OBSI)

Original TT PCC – 112 dB(A) (OBSI)

Avoid Placing Loud Pavement Near Sensitive Receivers – Select a Quieter Pavement
Caltrans Quiet Pavement Policy Bulletin

- Summary of current knowledge pavement acoustics (and avoiding loud pavements near sensitive receivers)
- Procedure for quieter pavement requests
- Defines project limits of quieter pavement treatment
Line Source Calculation

\[ I = \frac{p^2}{\rho c} \]

\[ I = \frac{W}{4\pi r^2} \]

\[ p^2 = \frac{W\rho c}{4\pi r^2} \]

\[ p^2 = \int_{d_1}^{d_2} \frac{\Pi l \rho c}{4\pi r^2} dl \]
Model Geometry

Extent of Quieter Pavement

Noisier Pavement

Traffic Line Source

Receiver

\[ r_0 \]

\[ d_1 \]

\[ d_2 \]
## Calculation Modules

### Module: Quieter Pavement Segment

<table>
<thead>
<tr>
<th>Pavement Level</th>
<th>97</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_0 )</td>
<td>50</td>
</tr>
<tr>
<td>Lane Width</td>
<td>12</td>
</tr>
<tr>
<td>( d_1 )</td>
<td>(-100 \times r_0 = -5000)</td>
</tr>
<tr>
<td>( d_2 )</td>
<td>(3 \times r_0 = 150)</td>
</tr>
</tbody>
</table>

- Near Lane #1: 75.5
- Near Lane #2: 74.4
- Near Lane #3: 73.6
- Near Lane #4: 72.8
- Far Lane #1: 71.0
- Far Lane #2: 71.0
- Far Lane #3: 70.9
- Far Lane #4: 70.9
- Median: 24

### Module: Non-Quieter Segment

<table>
<thead>
<tr>
<th>Pavement Level</th>
<th>103</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_0 )</td>
<td>50</td>
</tr>
<tr>
<td>Lane Width</td>
<td>12</td>
</tr>
<tr>
<td>( d_1 )</td>
<td>(-100 \times r_0 = -5000)</td>
</tr>
<tr>
<td>( d_2 )</td>
<td>(3 \times r_0 = 150)</td>
</tr>
<tr>
<td>( d_3 )</td>
<td>(100 \times r_0 = 5000)</td>
</tr>
</tbody>
</table>

- Near Lane #1: 71.9
- Near Lane #2: 71.9
- Near Lane #3: 71.8
- Near Lane #4: 71.7
- Far Lane #1: 71.3
- Far Lane #2: 71.3
- Far Lane #3: 71.3
- Far Lane #4: 71.3
- Median: 24

### Module: Quieter Pavement Only

<table>
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<tr>
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<tr>
<td>( d_2 )</td>
<td>(3 \times r_0 = 150)</td>
</tr>
</tbody>
</table>

- Near Lane #1: 76.0
- Near Lane #2: 75.0
- Near Lane #3: 74.2
- Near Lane #4: 73.6
- Far Lane #1: 72.0
- Far Lane #2: 72.0
- Far Lane #3: 72.0
- Far Lane #4: 71.9
- Median: 24

### Output Module

- QP Segment Total: 81.9
- Non-QP Segment Total: 80.6
- All QP Total: 82.6
- Total both Pavement Segments: 84.3
- Increase over QP Only: 1.7

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### Notes:

1. Signifies where the user should make inputs, do not make entries in any other cells
2. Pavement levels are OBSI and could be taken from the Caltrans data base
3. Distances are in feet
4. Either a "1" or "0" needs to be entered for lane, "1" turns the lane on, "0" turns it off
5. The predicted levels are not calibrated, but do account for tire/pavement noise differences
6. Inputs for \( d_1, d_2 \) & \( d_3 \) are in multipliers of the receiver to near lane distance, \( r_0 \)
8 Lanes, 12 ft Wide, 24 ft Median
Quieter = 97 dBA, Noisier = 103 dBA

Distance in Multiples of $r_0$

Increase in Level over All Quieter
Pavement, dB

Distance $r_0$

- 30
- 50
- 75
- 100
- 150
- 200
- 300
- 400
4 Lanes, 12 ft Wide, 24 ft Median
 Quieter = 97 dBA, Noisier = 103 dBA
2 Lanes, 12 ft Wide, No Median
Quieter = 97 dBA, Noisier = 103 dBA

Distance in Multiples of $r_0$

Increase in Level over All Quieter

Pavement, dB

Distance $r_0$

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<tr>
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</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>150</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>300</td>
</tr>
<tr>
<td>400</td>
</tr>
</tbody>
</table>

Graph showing the increase in level over all quieter pavement levels as a function of distance in multiples of $r_0$. The graphs are color-coded for different values of $r_0$. The distance on the x-axis ranges from 0 to 6, and the increase in level on the y-axis ranges from 0 to 3.5.
8 Lanes, 12 ft Wide, 2 ft Median
Quieter = 97 dBA, Noisier = 103 dBA

Increase in Level over All Quieter Pavement, dB

Distance in Multiples of $r_0$

Distance $r_0$

- 30
- 50
- 75
- 100
- 150
- 200
- 300
- 400

Pavement, dB

0 1 2 3 4 5 6

0 0.5 1 1.5 2 2.5 3 3.5

Graph showing the increase in level over all quieter pavement as a function of distance in multiples of $r_0$. The graph includes lines for different distances, with colors and labels for each line.
8 Lanes, 12 ft Wide, 24 ft Median
Quieter = 97 dBA, Noisier = 109 dBA
Observations on Limits

• Limits not too sensitive to
  – Number of lanes
  – Median width

• Limits somewhat sensitive to
  – Distance of the receiver from the roadway
  – Distance to transition to noisier pavement

• Limits very sensitive to noise level difference between noisier and quieter pavements
"...the limits of the pavement treatment in each direction should extend for at least three times the offset distance from the end noise receiver(s) to the center of the nearest traffic lane but not exceed 500 feet beyond the end noise receiver(s) as shown in Figure 1."