EFFECT OF DIAMOND GRINDING ON NOISE CHARACTERISTICS OF CONCRETE PAVEMENTS

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Shubham Rawool
• To determine the effect of diamond grinding on the tire/pavement noise characteristics of unground and diamond ground concrete pavements.

• To identify candidate routes to monitor the long-term sustainability of favorable noise characteristics of concrete pavements.
What Is a Decibel (dB) Level?

<table>
<thead>
<tr>
<th>dB</th>
<th>Pa</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00002</td>
<td>Quiet bedroom</td>
</tr>
<tr>
<td>20</td>
<td>0.002</td>
<td>Whispering</td>
</tr>
<tr>
<td>60</td>
<td>0.2</td>
<td>Truck (@ 30')</td>
</tr>
<tr>
<td>100</td>
<td>2</td>
<td>Jet plane (@ 1000')</td>
</tr>
<tr>
<td>180</td>
<td>20,000</td>
<td>Space shuttle (@ 100')</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in Sound Level (dB)</th>
<th>Change in Perceived Loudness</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Just perceptible</td>
</tr>
<tr>
<td>5</td>
<td>Noticeable difference</td>
</tr>
<tr>
<td>10</td>
<td>Twice (or 1/2) as loud</td>
</tr>
<tr>
<td>15</td>
<td>Large change</td>
</tr>
<tr>
<td>20</td>
<td>Four times (or 1/4) as loud</td>
</tr>
</tbody>
</table>
EXECUTION

6 Routes — 42 Sections

Pre-grind dBA
Post-grind dBA
Δ dBA

Effect of Grinding on Noise
Test Protocol

- Constant speed = 60 ± 2 mph
- Michelin Standard Reference Test Tire (SRTT)
- Cold tire pressure = 30 psi
- No significant grades
- Dry pavements only
OBSI Measurement Equipment

Intensity pair on trailing edge
Intensity pair on leading edge

Microphone pair & mounting fixture

B&K analyzer

Pulse software
TEST SITES

I-15 RIV

I-5 SAC

I-5 ORA

I-405 ORA

ARA

Caltrans
<table>
<thead>
<tr>
<th>Site No.</th>
<th>Route</th>
<th>County</th>
<th>Pre-Grind SI (dBA)</th>
<th>Post-Grind SI (dBA)</th>
<th>Reduction (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SR-60</td>
<td>SBD</td>
<td>105.1 (↑)</td>
<td>103.9</td>
<td>1.2</td>
</tr>
<tr>
<td>2</td>
<td>I-15</td>
<td>RIV</td>
<td>103.9</td>
<td>101.8</td>
<td>2.1</td>
</tr>
<tr>
<td>3</td>
<td>I-5</td>
<td>ORA</td>
<td>104.0</td>
<td>101.3</td>
<td>2.6</td>
</tr>
<tr>
<td>4</td>
<td>I-405</td>
<td>ORA</td>
<td>104.4</td>
<td>102.0</td>
<td>2.5</td>
</tr>
<tr>
<td>5</td>
<td>I-5</td>
<td>KER</td>
<td>103.2</td>
<td>100.0</td>
<td>3.2</td>
</tr>
<tr>
<td>6</td>
<td>I-5</td>
<td>SAC</td>
<td>104.7</td>
<td>100.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>104.2</td>
<td>101.5</td>
<td>2.7</td>
</tr>
</tbody>
</table>
TEST RESULTS — GRAPHICAL

Pre-Grind SI (dBA) vs. Post-Grind SI (dBA)

- SR-60
- I-15
- I-5
- I-405
- Average

dBA

97 98 99 100 101 102 103 104 105 106

Caltrans
Detailed Spectral Analysis

I-5 Kern County

• Total No. of Sections = 14
• All data collected within one month.

<table>
<thead>
<tr>
<th>Noise Levels (dBA)</th>
<th>NB</th>
<th>SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Grind</td>
<td>104.0</td>
<td>102.8</td>
</tr>
<tr>
<td>Post-Grind</td>
<td>100.0</td>
<td>101.1</td>
</tr>
</tbody>
</table>
I-5 Kern County - Octave Band Analysis

I-5 Kern County - Southbound

Distance (ft)
- Sect 1
- Sect 2
- Sect 3
- Sect 4
- Sect 5
- Sect 6
- Sect 7
- Sect 8
- Sect 9
- Average

Sound Intensity (dBA)
- Pre-Grind
- Post-Grind

1/3 Octave Band Spectra for I-5 SB

Center Frequency Bands (Hz)
- Pre-Grind
- Post-Grind
I-5 Kern County - Octave Band Analysis

I-5 Kern County - Northbound

1/3 Octave Band Spectra for I-5 NB
There is an audible reduction in SI levels after grinding.

- The highest reduction was 6.7 dBA
- The lowest reduction was 1.2 dBA (an anomaly)
- On an average the reduction was approx. 3 dBA
- The highest reductions occurred in the 1600 Hz 1/3 octave band—the “whining” band.
- The lowest reductions occurred in the 1000 Hz 1/3 octave band—a relatively low but still audible band.
CONCLUSIONS

• Diamond grinding is very effective in significantly reducing the annoying “whining” noise generally associated with tined concrete pavements.

• Diamond grinding projects in California last an average of 17 years before further maintenance or rehabilitation is needed (based on reductions in IRI).

• Long-term OBSI tests can also determine the longevity of noise reductions during this 17 year period.

• Many more advantages are also achieved through diamond grinding of candidate projects (fuel efficiency, skid resistance, life extension, lower user costs, etc).
QUESTIONS OR COMMENTS?

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