An Evaluation of Concrete Saw Blades for Noise Reduction

Susan Shepherd ScD, M. Abbas Virji ScD and Susan Woskie PhD CIH
University of Massachusetts Lowell

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Noise exposure levels in construction

- Large equipment, but also hand held tools
- Concrete cutter: 105 dBA\(^1\)
- Cut-off saw: 98 – 102 dBA; peak: 118 dBA\(^2\)
- Gas saw, carbide blade: 95 dBA (5 ft.) est. source: 109 dBA\(^3\)

1. Methner etal. JOEH 15(11), 2000
2. OSH Service, Dept of Labor, New Zealand, 2002
3. Greenspan etal, Appl Occ Env Hyg, 10(1), 1995
Hearing Loss in Construction

- 90% of SMW ages 50-59 lost >30dB @ 4kHz (Byggahlsan study)\(^1\)
- 49% of 5000 construction workers studied by Workers Comp Bd of BC\(^1\)

1. Schneider et al. STAR Construction Health & Safety, 1995
Experimental Methods

- Personal noise dosimeter (Larson Davis 706 Type 2)
- 3 Area noise dosimeters
- 1 Sound level meter (Larson Davis Type 1) with octave band analysis
- 5 saw blades
- Reinforced concrete pipe
- Each worker uses all five blades (wet and dry)
- Personal dust exposures (Thermo pDR w/cyclone)
Factors contributing to noise

- Saw motor
- Blade
  - Configuration
  - Speed
  - Material
- Material being cut
- Work practice
- Environment
Concrete Chop Saws

- Gas powered circular saw used to cut concrete pipe, paving & curb stones, sidewalk
- Reduction of noise via blade design proposed
Saws

- Stihl TS 400: 4.4 HP
- Makita DPC 7311: 5.6 HP
- Partner K700: 4.8 HP
Saw motor noise

<table>
<thead>
<tr>
<th>Saw</th>
<th>dBZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stihl 400</td>
<td>87.4</td>
</tr>
<tr>
<td>Makita DPC 7311</td>
<td>91.7</td>
</tr>
<tr>
<td>Partner K700</td>
<td>NT</td>
</tr>
</tbody>
</table>

Test with SLM @ 16 in.
Octave Band Analysis
Stihl motor

![Octave Band Analysis Graph](image-url)
Five blades

1. Diamond regular
2. Carbide regular
3. Carbide “holes” blades
4. Carbide “turbo”
5. Diamond noise-reducing (NR)
Diamond Regular Blade

- 24 segments
- 13 7/8 in. diameter
- Gullet depth: 21 mm
- Gullet width: 3 mm – 7 mm
- Relief: 6 mm diameter
Carbide blade

- 24 segments
- 13 1/4 in. diameter
- Gullet depth: 15 mm
- Gullet width: 2 mm – 3 mm
- Relief: 5 mm diameter
Noise reducing diamond blade

- 24 segments
- 13 5/8 in. diameter
- Gullet depth: 25 mm
- Gullet width: 3 mm – 5 mm
- Relief: 6 mm diameter
- “Smileys”: 32 mm diam
Carbide Turbo Blade

- Unsegmented blade
- 13 3/8 in. diameter
- No gullets
- “teeth” space: 3 mm
Carbide “holes” blade

- 24 segments
- 13 7/8 in. diameter
- Gullet depth: 22 mm (10 mm x 15 mm)
- Gullet width: 3 mm – 6 mm
- Relief and holes: 6 mm diameter
Carbide “holes” blade

L_{eq}
Diamond Regular Blade

Graph showing the L eq levels for Left, Center, and Right positions.
Carbide Turbo Blade
Carbide Regular Blade
NR Diamond Blade
## Noise Levels
### Preliminary Results

<table>
<thead>
<tr>
<th></th>
<th>Free-running</th>
<th>Cutting concrete pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saw motor only (Stihl 400)</td>
<td>89 dBA</td>
<td>NA</td>
</tr>
<tr>
<td>Carbide Regular</td>
<td>107 dBA</td>
<td>105 dBA</td>
</tr>
<tr>
<td>Carbide Turbo</td>
<td>100 dBA</td>
<td>101 dBA</td>
</tr>
<tr>
<td>Carbide Hole Blade</td>
<td>110 dBA</td>
<td>104 dBA</td>
</tr>
<tr>
<td>Diamond Regular</td>
<td>113 dBA</td>
<td>106 dBA</td>
</tr>
</tbody>
</table>
### Noise Levels by Blade

**Personal Dosimeter ($L_{Aeq}$)**

<table>
<thead>
<tr>
<th>Blade Type</th>
<th>$L_{Aeq}$ (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR diamond</td>
<td>105.8</td>
</tr>
<tr>
<td>Carbide regular</td>
<td>106.1</td>
</tr>
<tr>
<td>Turbo carbide</td>
<td>105.8</td>
</tr>
<tr>
<td>Carbide holes blade</td>
<td>105.1</td>
</tr>
<tr>
<td>Diamond regular</td>
<td>105.5</td>
</tr>
</tbody>
</table>

Not statistically different.
What is $L_{Aeq}$?

$$L_{eq} = 10 \log_{10} \left( \frac{1}{T} \int_{T_1}^{T_2} \frac{p^2(t)}{p_o^2} dt \right) dB$$

$P(t) =$ instantaneous frequency weighted (A or C), sound pressure in pascals

$P_0 =$ reference sound pressure, 20 µPa

$T =$ measurement period (Run Time or time history period, $T = T_2 - T_1$)
People

- Statistical difference between individual workers average $L_{Aeq}$.
- Due to problems with the saws, only 4 out of 15 people completed all 10 trials (range of n=3 to 10 per person)
- Four person: 105.0 dBA, 106.0 dBA, 107.5 dBA, and 102.0 dBA
- Overall range of $L_{Aeq}$: 97.8 dBA to 111.2 dBA
Octave Band Analysis
All blades - Stihl

Frequency, Hz

Person 1

dBZ

C. Reg
C. Hole
C. Turbo
D. Reg
D. NR
Work practices

- Dependent on saw maintenance
- Choke open
- Tightening blade (blade shim)
- Sawing direction
- Depth of cut
- Height of worker (vs. height of cutting)
- Position while cutting
Bystander exposure

- If Leq at 1.5 feet (operator ear) is 105 dBA:
  - 90 dBA is at 8 feet
  - 85 dBA is at 15 feet
- If Leq at the operator is 111 dBA:
  - 90 dBA is at 16 feet
  - 85 dBA is at 29 feet
- Not considering reverberation in a concrete building site
Administrative Controls

- A 105 dBA task:
  - can be performed for one hour and still be under the 90 dBA TWA
  - Requires hearing protection with an NRR of 44
Conclusions

- Not ready to recommend a saw blade design to control noise
- Saw maintenance is important to blade stability, which may help to control noise
- Hearing protection for all workers in the area is necessary.
Further work

- Look more closely at work practices that may decrease noise exposure
- Relate rpm measurements to noise output