Sound Emission of Hand-Struck Tools Designed Using High-Performance Engineering Polymers

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Introduction

- Noise may be the most common occupational hazard.
- 30 million Americans are exposed to noise levels at their workplace greater than current safe limits.
- 50% of these workers will develop permanent, noise-induced hearing loss.

Objectives

- Measure the sound emission characteristics of polymer capped chisels.
- Analyze the spectral content of sound in the audible frequency range of the human ear.
- Quantify the effect of material properties on sound emission.

Methods

- **Measurements**
  Sound pressure is measured with a calibrated microphone that produces a voltage linearly proportionally to pressure. The decibel is a measurement unit that describes a sound’s perceived relative loudness:
  \[ \text{dB} = 20 \log \left( \frac{P}{P_0} \right) \]
  where \( P_0 = 20 \mu \text{Pa} \), the reference sound pressure for air.
- **Test Setup**
- **Analysis**
  Using a Discrete Fourier Transform (DFT), measured sound waveform data, \( f(n) \), can be approximated with a finite sum and converted from the time domain \( (n) \) to the frequency domain \( (m) \):
  \[ F(m) = \sum_{n=0}^{N-1} f(n) e^{-j2\pi mn/N} \]
  where \( N \) = number of data.

Results

The test results presented will be for an assortment of experimental treatments including bare chisels, polymer capped chisels, and chisels with protective grips.

Key of Experimental Chisel Treatments

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>LABEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>conventional bare chisel (65° tip angle)</td>
<td>bare65</td>
</tr>
<tr>
<td>modified bare chisel (60° tip angle)</td>
<td>bare60</td>
</tr>
<tr>
<td>Minlon® 11C40 polymer cap on a modified bare chisel</td>
<td>minlon</td>
</tr>
<tr>
<td>Crastin® polymer cap on a modified bare chisel</td>
<td>polyester</td>
</tr>
<tr>
<td>Zytel® ST801 polymer cap on a modified bare chisel</td>
<td>st801</td>
</tr>
<tr>
<td>Zytel® 8018 (natural color) polymer cap on a modified bare chisel</td>
<td>8018nat</td>
</tr>
<tr>
<td>Zytel® 8018 (dyed) polymer cap on a bare chisel, modified</td>
<td>8018red</td>
</tr>
<tr>
<td>hand guard on a conventional bare chisel</td>
<td>guard</td>
</tr>
<tr>
<td>conventional bare chisel with a foam grip</td>
<td>f/bare65</td>
</tr>
</tbody>
</table>

Conclusions

1. Polymer caps on chisels significantly reduce peak sound pressure levels.
2. Polymer caps significantly reduce noise at the frequency in the speech band most crucial for speech intelligibility and at high frequencies in the human audible range where the ear is particularly susceptible to damage.
3. Increased cap modulus increases impact noise.

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Additional Information