Evaluation of vibration emission values of nailers: can an automatic test stand be used instead of human operators?

Maxime Vincent ¹, Thomas Padois ¹,², Marc-André Gaudreau ³, Thomas Dupont ¹ and Pierre Marcotte ²

¹ Département de Génie Mécanique, École de Technologie Supérieure, Montréal, QC, Canada
² Institut de Recherche Robert-Sauvé en Santé et en Sécurité du Travail, Montréal, QC, Canada
³ Département de Génie Mécanique, Université du Québec à Trois-Rivières, Trois-Rivières, QC, Canada
Presentation outline

- Background
- Objective
- Methods
- Results
- Conclusion
Background

• Portable nailers can generate high levels of impact noise and vibration, posing a risk for hearing loss and hand-arm vibration syndrome (HAVS).

• There is a need to identify nailers with low noise and vibration emission values (VEV) using standardized test methods.

• ISO 28927-13:2022 provides a method to assess VEV of nailers; however, it is lengthy, costly, and requires three trained operators.

• An Automatic Test Stand (ATS) has been developed to replace human operators, but it has only been validated for low-frequency vibration ($W_h$ weighting).
Objective

• Evaluate the ability of the ATS to reproduce the VEV obtained with the human operators.

• Evaluate the variability of the VEV obtained with the three human operators.
## Methods

<table>
<thead>
<tr>
<th>ISO 28927-13:2022 Standard</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram" /> x 10 x 5</td>
<td>150 nails</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ATS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image2" alt="Diagram" /> x 10 x 1</td>
<td>10 nails</td>
</tr>
</tbody>
</table>
## Framing nailers

<table>
<thead>
<tr>
<th>PR2</th>
<th>GB1</th>
<th>PB3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pneumatic)</td>
<td>(Gaz)</td>
<td>(Pneumatic)</td>
</tr>
</tbody>
</table>

Methods
Methods

- Slider
- Nailer
- Accelerometer
- Remote trigger
Methods
Methods

Band limited « $hF$ » frequency weighting (ISO/TS 15694:2004) to take into account the higher frequency content of hand-arm vibration:

$$a_{hF,3s} = a_{hF} \sqrt[3]{\frac{T}{3n}}$$

$$a_{hF,\text{PEAK}} = \max_{0 \leq t \leq T} \left| a_{hF}(t) \right|,$$

$$CF = \frac{a_{hF,\text{PEAK}}}{a_{hF,3s}}.$$
Results

PB3 nailer; sample rate = 51.2 kHz
Predominant axis (z\textsubscript{h} biodynamic)

Unweighted signal

ATS
Human 1

Unweighted acceleration (m/s\textsuperscript{2})

Duration (s)

0.138 0.14 0.142 0.144 0.146 0.148 0.15 0.152 0.154
Results

(a) 3-seconds RMS (m/s²)

(b) Peak Value (m/s²)

(c) Crest Factor
Results

(a) PR2 nailer ; (b) GB1 nailer ; (c) PB3 nailer

![Graph showing hand-arm vibration levels for different nailers](image-url)
Conclusion

- The ATS appears to be a valid alternative as it simplifies the procedure and reduces the number of nails required for VEV measurement.

- Significant differences in VEV were observed between humans and the ATS for two out of seven tested nailers.

- Significant variations in VEV were observed among the three human operators: more operators are needed to characterize nailers’ VEV.

- ATS needs to incorporate hand-arm biodynamics, since it could lead to underestimation of VEV.
Thank you for listening!