Vibration Characteristics of Ultrasonic-Activated Straightening and Forming Machines

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Introduction

• Vessel shipbuilding
• Need to perform straightening and forming operations by mechanical shocks with conventional tools including:
  • Sledgehammer and flattener
Introduction

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- Need to perform straightening and forming operations by mechanical shocks with conventional tools including:
  - Sledgehammer and flattener
  - Pneumatic riveting hammer
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  - Pneumatic chipping hammer mounted on trolley
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- Vessel shipbuilding
- Need to perform straightening and forming operations by mechanical shocks with conventional tools including:
  - Sledgehammer and flattener
  - Pneumatic riveting hammer
  - Pneumatic chipping hammer mounted on trolley
- Support by CARSAT to reduce the risks associated with these operations by evaluating the vibration characteristics of the various processes including tests of ultrasonic activated hammers
Ultrasonic activated hammers: operating principle

- The hammering process activated by ultrasound:
Ultrasonic activated hammers: machines measured

- The hammering process activated by ultrasound:
  - SONATS Stress Voyager and its different heads (PR10/PR13/PR17)
Materials and Methods: classical machines

- Tests carried out in the Boilermaking workshop
- Accelerometer fastened to the machine or hammer handle
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- Tests carried out in the Boilermaking workshop
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Materials and Methods: ultrasonic activated hammers

- Tests carried out in the Boilermaking workshop
- Accelerometer fastened to the machine or hammer handle
Materials and Methods: experimental condition

• Steel sheets (thickness = 10 mm) for conventional processes
Materials and Methods: experimental condition

• For ultrasonics activated hammers:
  • Aluminium sheets (thickness = 1.5 mm):
  • Welded steel parts (3.0 mm):
Materials and Methods: experimental setup

• Vibration data acquisition with:
  - triaxial accelerometer PCB 356B20 (1 mV/g ; 5000 g ; 2-7000 Hz)
  - Acquisition front end Siemens LMS SCADAS XS
    (Sampling rate = 2560 Hz et 10240 Hz)
Materials and Methods: standards

- Vibrations measurements were carried out in accordance with NF EN ISO 5349-1&2 and the documentation booklet FD ISO/TR 18570 for process with ultrasonic activated hammers:
  - Frequency-weighting $W_h$ and $W_p$:
Results: conventional processes

<table>
<thead>
<tr>
<th>Measured Configuration</th>
<th>Vibration Level (m/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riveting hammer Atlas Copco RRH12</td>
<td>6.3</td>
</tr>
<tr>
<td>Chipping hammer Atlas Copco RRC 75B-01</td>
<td>3.3</td>
</tr>
<tr>
<td>Flattener (7 shots—duration: 15 s)</td>
<td>12.9</td>
</tr>
<tr>
<td>Masse (5 shots—duration: 9 s)</td>
<td>21.9</td>
</tr>
</tbody>
</table>
## Results: ultrasonic activated hammers

<table>
<thead>
<tr>
<th>Measured Configuration</th>
<th>Vibration Level (m/s²)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$a_{hv}$</td>
</tr>
<tr>
<td>Head PR10 aluminium sheet, main handle</td>
<td>4.6</td>
</tr>
<tr>
<td>Head PR10, steel piece, main handle</td>
<td>4.8</td>
</tr>
<tr>
<td>Head PR17, steel piece, main handle</td>
<td>1.0</td>
</tr>
<tr>
<td>Head PR17, aluminium sheet, main handle</td>
<td>1.2</td>
</tr>
<tr>
<td>Head PR13, aluminium sheet, main handle</td>
<td>2.4</td>
</tr>
<tr>
<td>Head PR13, steel sheet, main handle</td>
<td>1.7</td>
</tr>
</tbody>
</table>
Discussion

- Reduction of vibration levels with ultrasonic activated hammers according to the regulations
- Test conditions deemed unsuitable by the manufacturer of ultrasonic activated hammers ➔ *Sheet thickness too low*
- Additional tests at the manufacturer workshop:
  - Aluminium specimen: 300 x 100 x 25 mm
- Confirmation of lower levels for the PR 10 head with the aluminium specimen

<table>
<thead>
<tr>
<th>Measured configuration</th>
<th>Test Ship manufacturer</th>
<th>Test HFMI manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( a_{hv} )</td>
<td>( a_{pv} )</td>
</tr>
<tr>
<td>Head PR10 aluminium sheet, main handle</td>
<td>4.6</td>
<td>26.0</td>
</tr>
</tbody>
</table>

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Discussion: Spectral Analysis

- Significant spectral content above 400 Hz

- Raw signal
- $A_{\text{hw}x}$ (weighted frequency $W_h$)
- $A_{\text{px}}$ (weighted frequency $W_p$)
Conclusion

- Possibility to reduce vibration levels with these hammers activated by ultrasound but they need to be used according to the manufacturer’s conditions.
- Interest in evaluating vibration levels according to frequency weighting for the vascular component of hand-transmitted vibration syndrome ($W_p$), especially for these high-frequency vibrating tools.
- Filling our database (Colphy).
- Without a limit value, it is difficult to assess the level of risk.