HAND ARM VIBRATION

International conference
6-9 JUNE 2023
Espace Prouvé,
Nancy, France

High-Frequency Vibration from Hand-Held Impact Wrenches and Propagation into Finger Tissue

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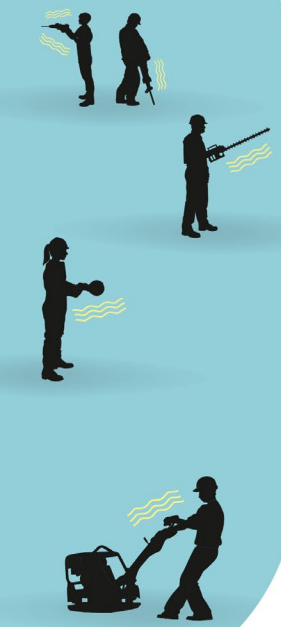
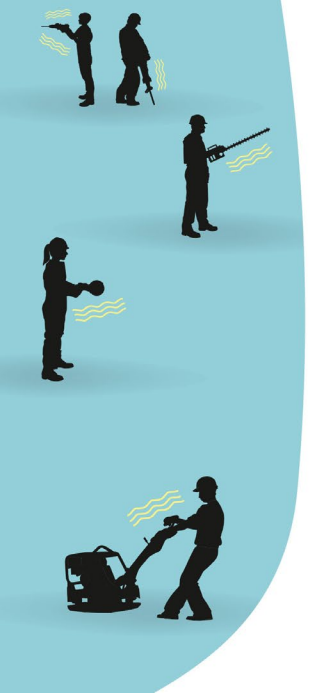
Introduction

- No standard for quantifying vibrations above 1250 Hz
- Ongoing work in ISO work groups on new standards
- Investigation:
  - How does the measured bandwidth effect the magnitude?
  - Variation over the tool surface?
  - Do higher frequencies propagate into the finger tissue?
  - Reduction possibilities at higher frequencies?



Background

- The current ISO 5349-1 standard omits all frequency content above 1250 Hz.
  - Earlier research has shown that the risk of injuries is underestimated for tools with high frequency transients. E.g. Impact wrenches, breakers scalers and riveting tools.



- Study on riveting workers:
- Dandanell, R., Engström, K. Vibration from riveting tools in the frequency range 6 Hz-10 MHz and Raynaud's phenomenon. *Scand J Work Environ Health* **1986**, *12*, 338-42.

  "*The investigation showed that special precautions must be taken to measure the acceleration of percussion tools and that the risk criteria in ISO/DIS 5349 do not cover all the risks connected with percussion tools*"

Background

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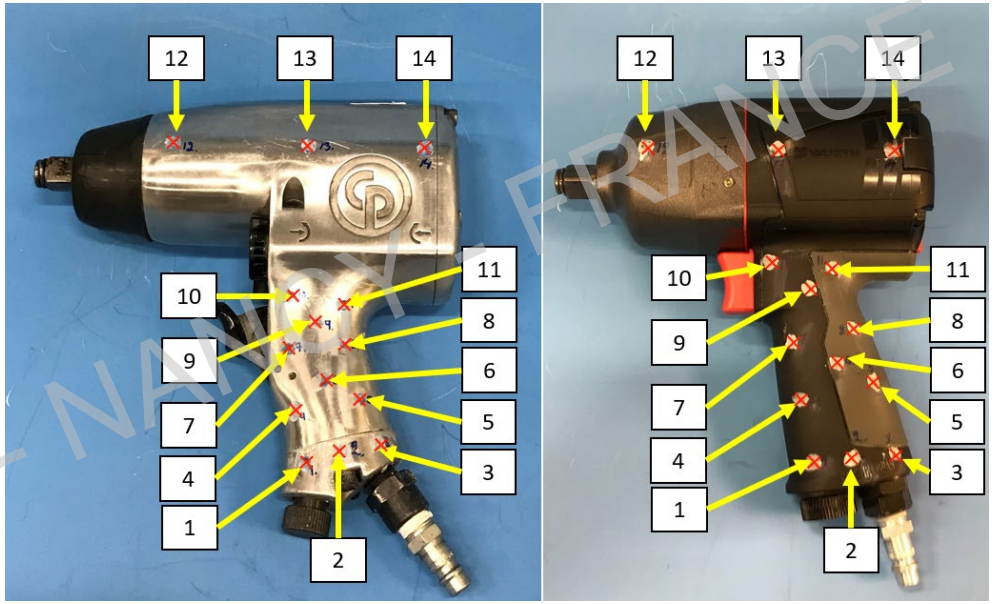
  - Earlier research has shown that the risk of injuries is underestimated for tools with high frequency transients. E.g. Impact wrenches, breakers scalers and riveting tools.

- Study on assembly workers working with impact wrenches:
- Gerhardsson, L.; Ahlstrand, C.; Ersson, P. et al. Vibration-induced injuries in workers exposed to transient and high frequency vibrations. J Occup Med Toxicol 2020, 15:18.

  "*ISO 5349-1 considerably underestimates the risks of VWF for this group of workers exposed to transient and high frequency vibrations. It is therefore important to develop a risk assessment standard also covering this frequency range.*"

Measurements

- Acceleration was measured up to 100 kHz with a laser doppler vibrometer(LDV).
- Two impact wrenches tested:
  - All metal CP734
  - Composite Würth DSS ½ Superior
- 14 measurement locations.
  - 11 on the handle 3 on housing.
- Measurements on fingernail position 9
  A. Finger in contact with the tool surface.
  B. 2 mm EPDM foam between finger and tool surface.

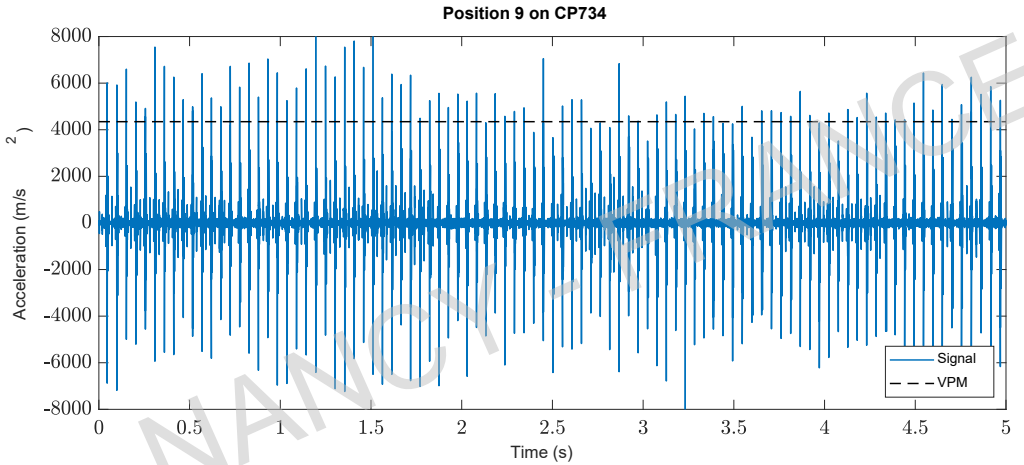


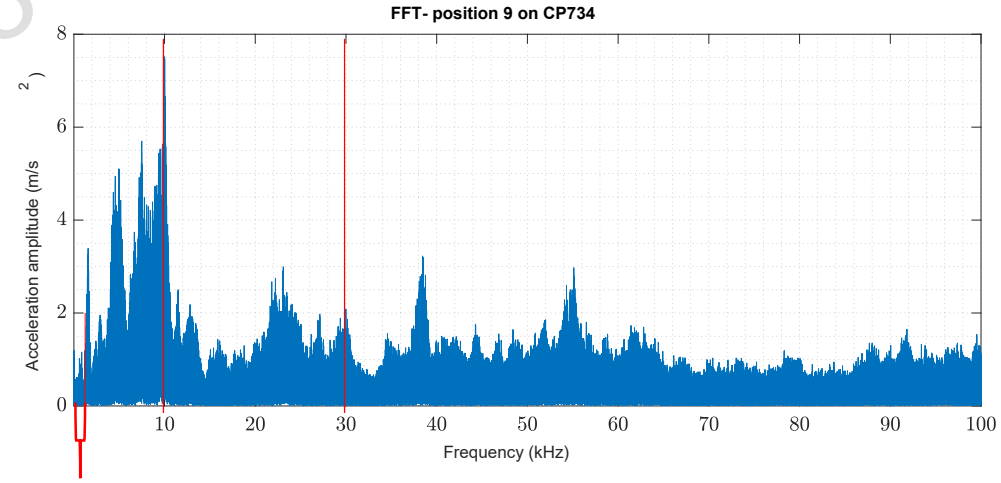
Data analysis

- No standard for quantifying high frequency vibrations.
  - Vibration peak magnitude:

$$VPM(a_n) = \sqrt{\frac{\sum_{n=1}^{N} a_n^6}{\sum_{n=1}^{N} a_n^4}}$$

- To investigate the effects of upper limit frequency the signal was lowpass with a 6th order Butterworth filter and 3 different cutoff frequencies:
  - 1250 Hz, 10kHz, 30 kHz

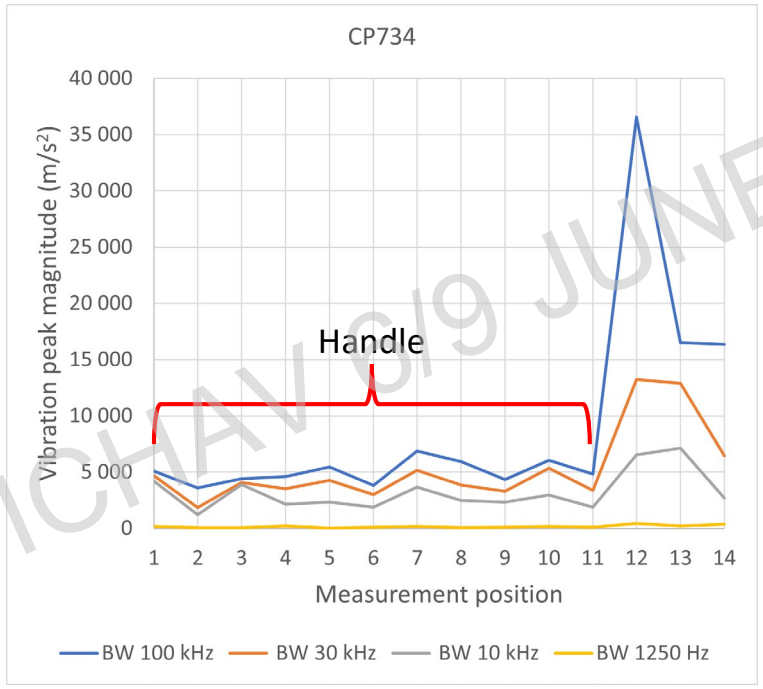


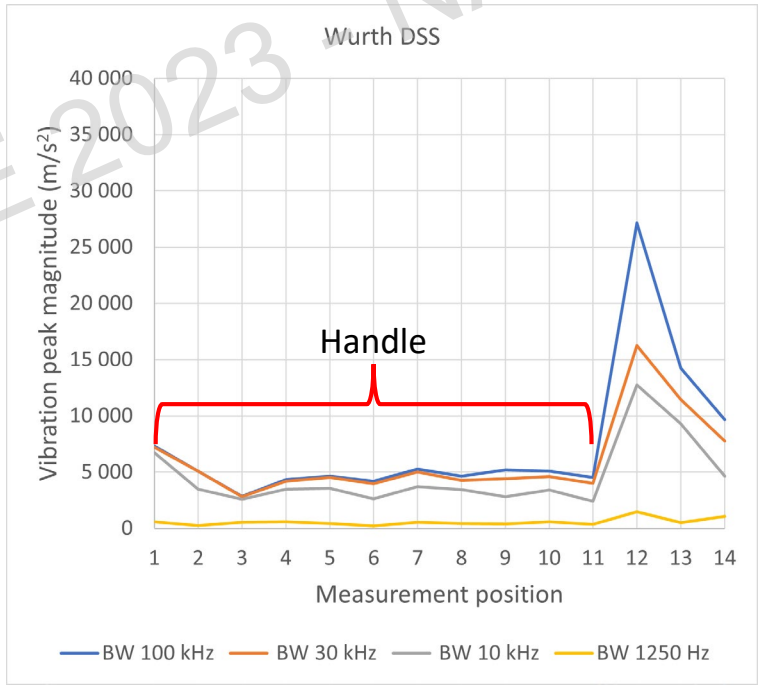


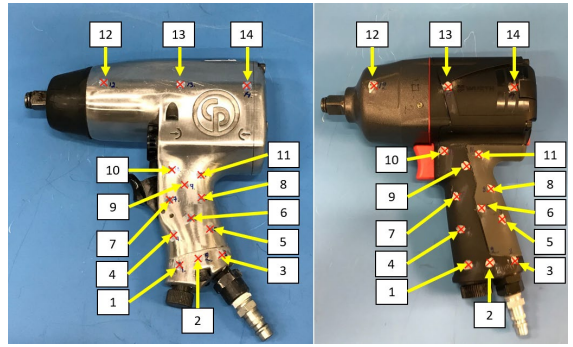
ISO 5349-1

Results – Variation

- VPM highest close to outgoing axle

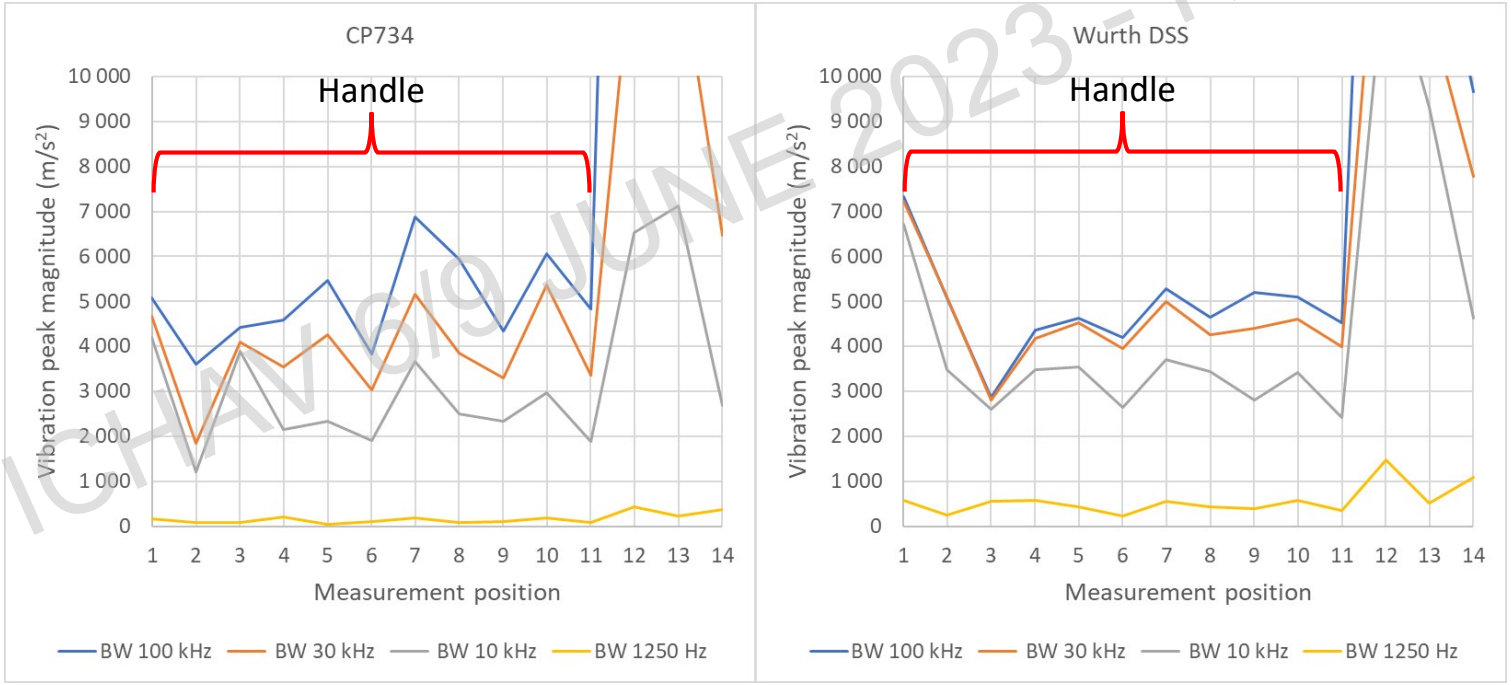


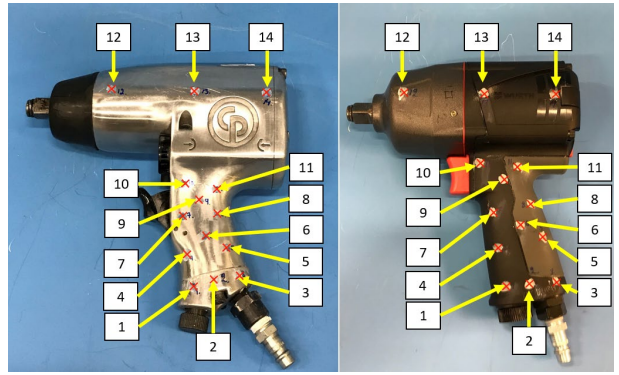




Results – Variation

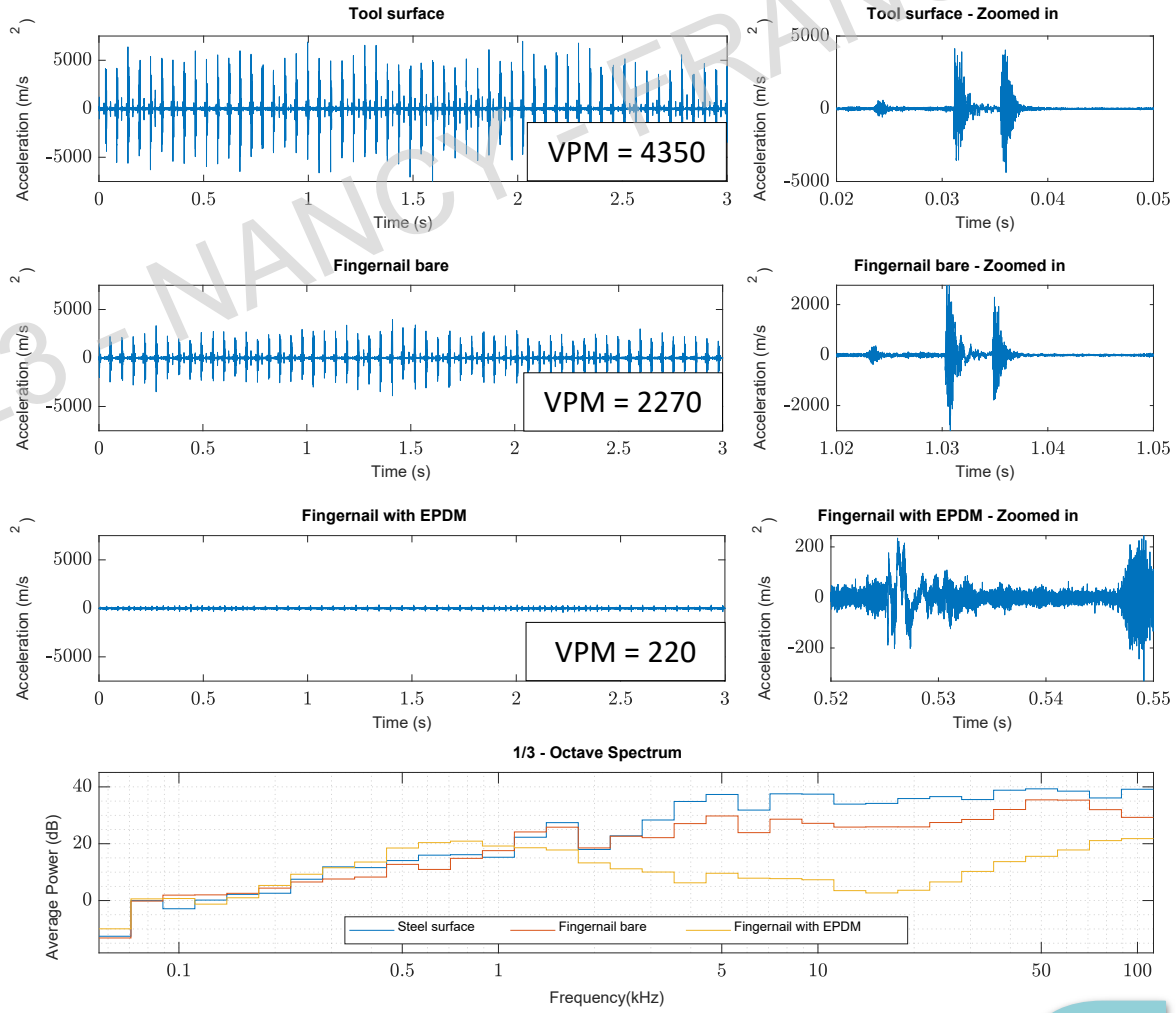
- Relatively low variation on the handles
- Similar trends with higher bandwidths
- Very low VPM with 1250 Hz bandwidth





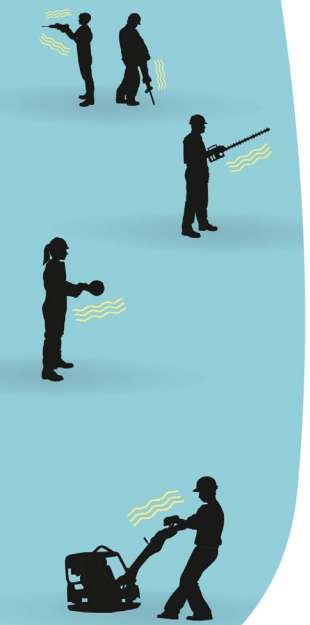
Results – Propagation through the finger

- VPM at the fingernail half of tool surface
  - Indicates that the high frequency content propagates through the finger tissue
- 90% reduction with 2 mm EPDM foam
  - Reducing high frequency vibrations is simple
- The foamed EPDM reduces content above 1 kHz.
  - Some amplification 500 Hz-1 kHz



Conclusions

- VPM increases with increased bandwidth
  - 1250 Hz much lower than 10 kHz,
- Relatively low variation of VPM on the impact wrenches.
- High VPM on the fingernail suggest propagation trough the tissue
- Simple measures can be used to eliminate high frequencies



Thank you

- Financed by Sweden's innovation agency Vinnova.
  - Project: Zero vibration injuries
- Financed by Afa Försäkring
  - Project: Mätmetodik, bedömning och åtgärder av högfrekventa vibrationer för minskade vibrationsskador