HAND ARM VIBRATION

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Daily exposure estimation from measurements of repetitive shock vibration

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Summary

1. Introduction

- 1.1. Context

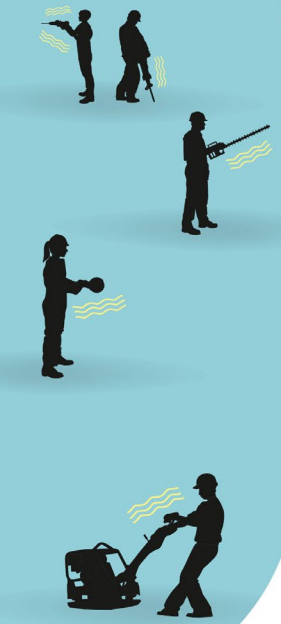
  - CRAMIF and INRS are public institutes for heath and safety at work
  - The evaluation of workers' exposure to hand-arm vibration is mandatory
  - Measurements have to be carried out using the ISO 5349-1 standard
  - Daily vibration exposure : $A(8) = a_{hv} \cdot \sqrt{\frac{T}{T_0}} \quad (m \cdot s^{-2})$

    where

    a_{hv} : vibration total value emitted by the machine $(m \cdot s^{-2})$

    T : total daily duration of exposure of the operator (s)

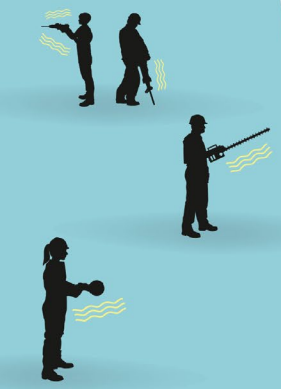
    T_0 : 28800 s (8 hours)



1. Introduction

- 1.2. Problem

  - Some hand-held power tools generate repeated shocks of high amplitudes
  - Measurements are rarely performed over the whole working day
  - a_{hv} and T are often biased
  - The estimation of $A(8)$ may not be representative of the real exposure



1. Introduction

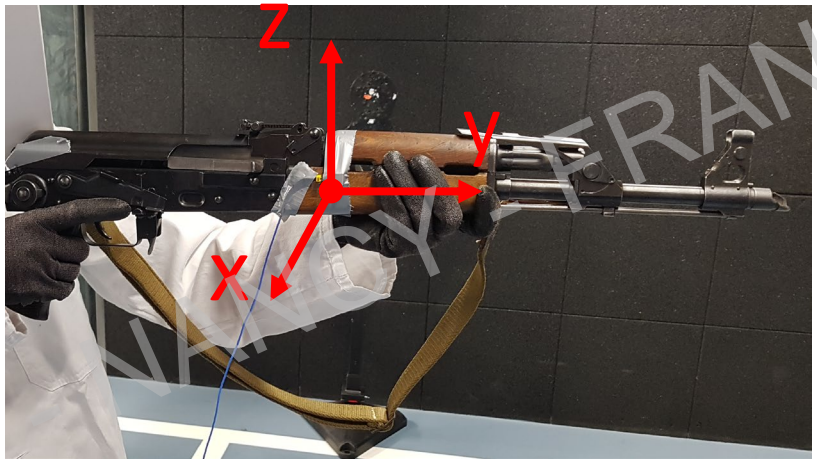
- 1.3. Objective

  - Compare 2 methods for the estimation of $A(8)$

	Conventional method	Alternative method
Measured *(sample)*	$a_{hv_{sample}}$	$A(8)_{sample}$ R_{sample}
Available information *(whole working task)*	$T_{estimate}$	$R_{estimate}$
$A(8)_{estimate}$	$a_{hv_{sample}} \cdot \sqrt{\frac{T_{estimate}}{T_0}}$	$A(8)_{sample} \cdot \sqrt{\frac{R_{estimate}}{R_{sample}}}$

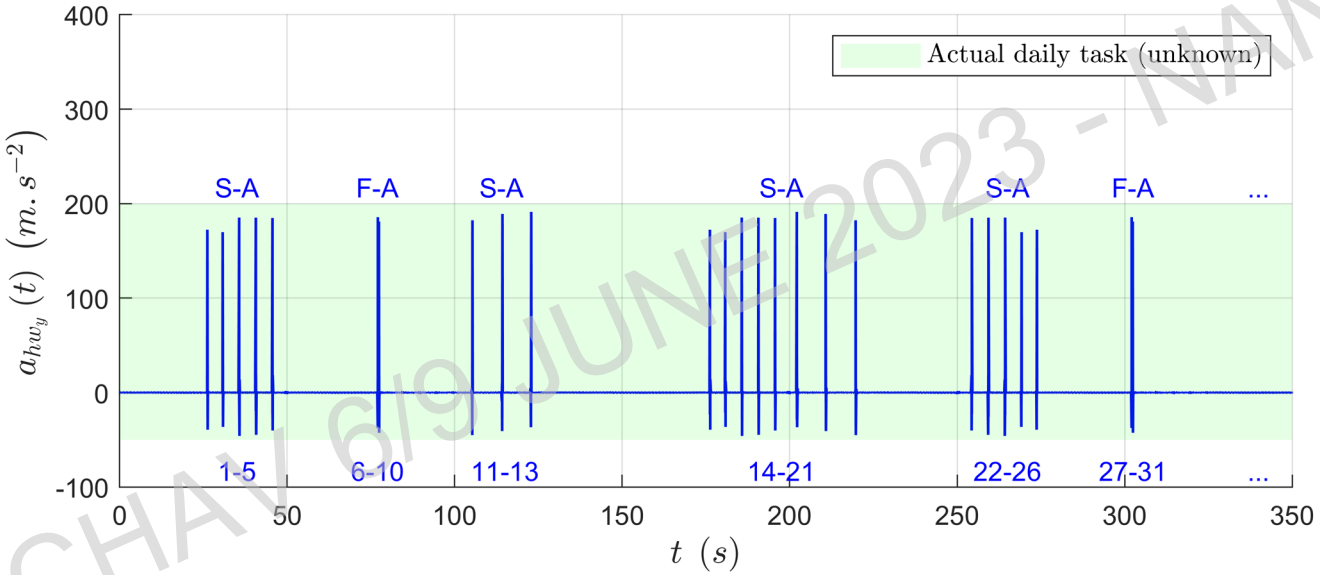
2. Material and methods

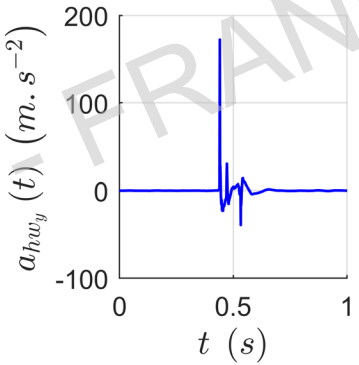
- 2.1. Assault riffle
  - Zastava M70 AB2
  - 7.62 mm caliber
  - Accelerometer mounted on the body of the weapon



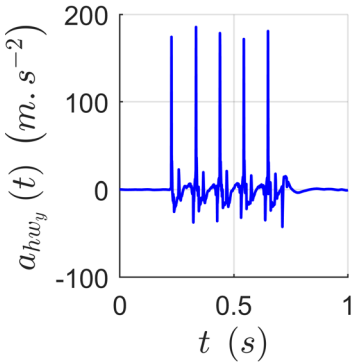
2. Material and methods

- 2.1. Assault riffle





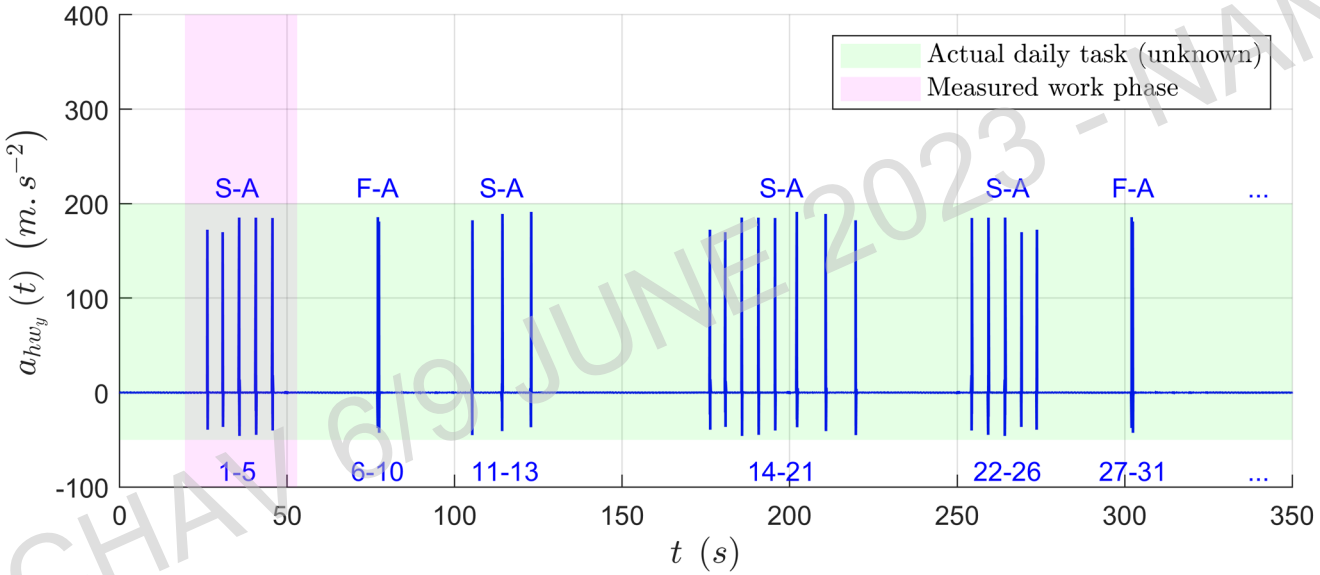
Semi-Automatic (S-A)
1 round



Full-Automatic (F-A)
5 rounds

2. Material and methods

- 2.1. Assault riffle

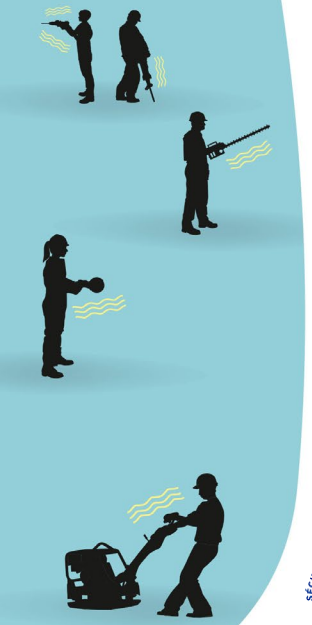


Measured *(sample Pink zone)*	Available information
$a_{hv_{sample}}$	$T_{estimate}$
$A(8)_{sample}$ R_{sample}	$R_{estimate}$

2. Material and methods

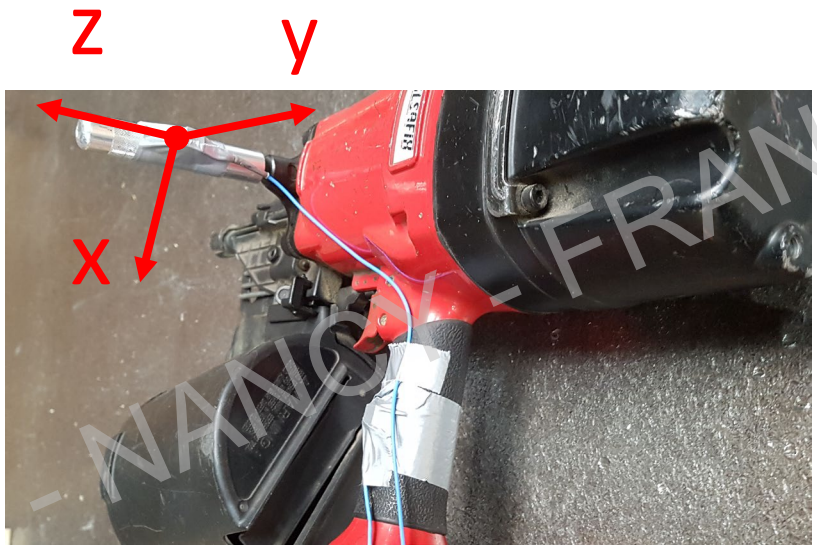
- 2.1. Assault riffle

Conventional method			Alternative method			
$a_{hv_{sample}}$ $(m.s^{-2})$	$T_{estimate}$ (s)	$\boldsymbol{A(8)_{estimate}}$ $\boldsymbol{(m.s^{-2})}$	$R_{estimate}$ $(-)$	R_{sample} $(-)$	$A(8)_{sample}$ $(m.s^{-2})$	$\boldsymbol{A(8)_{estimate}}$ $\boldsymbol{(m.s^{-2})}$
2.6	5400	**1.1**	300	5	0.090	**0.7**



2. Material and methods

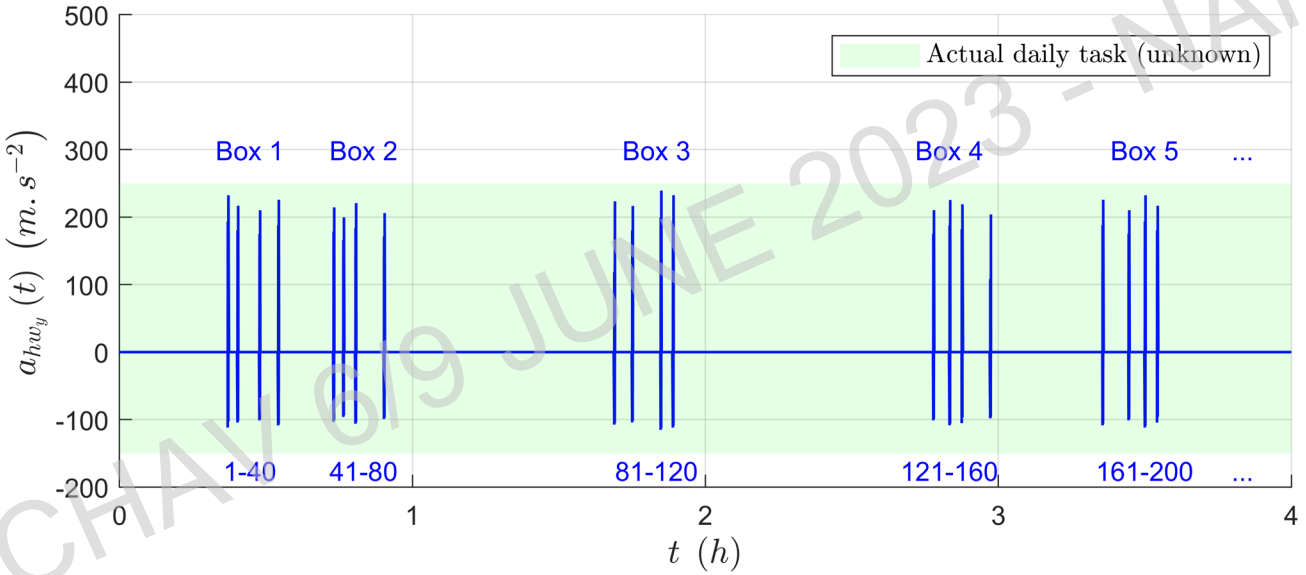
- 2.2. Nail gun
  - ALSAFIX C38/130 A1, 5.8 kg
  - 125 mm nails
  - Accelerometer placed on the auxiliary handle

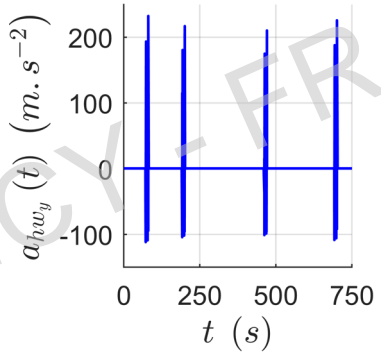


4 soles per box

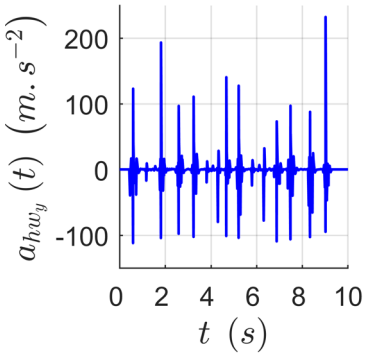
2. Material and methods

- 2.2. Nail gun

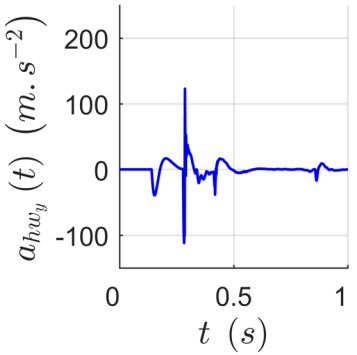




1 box - 4 soles



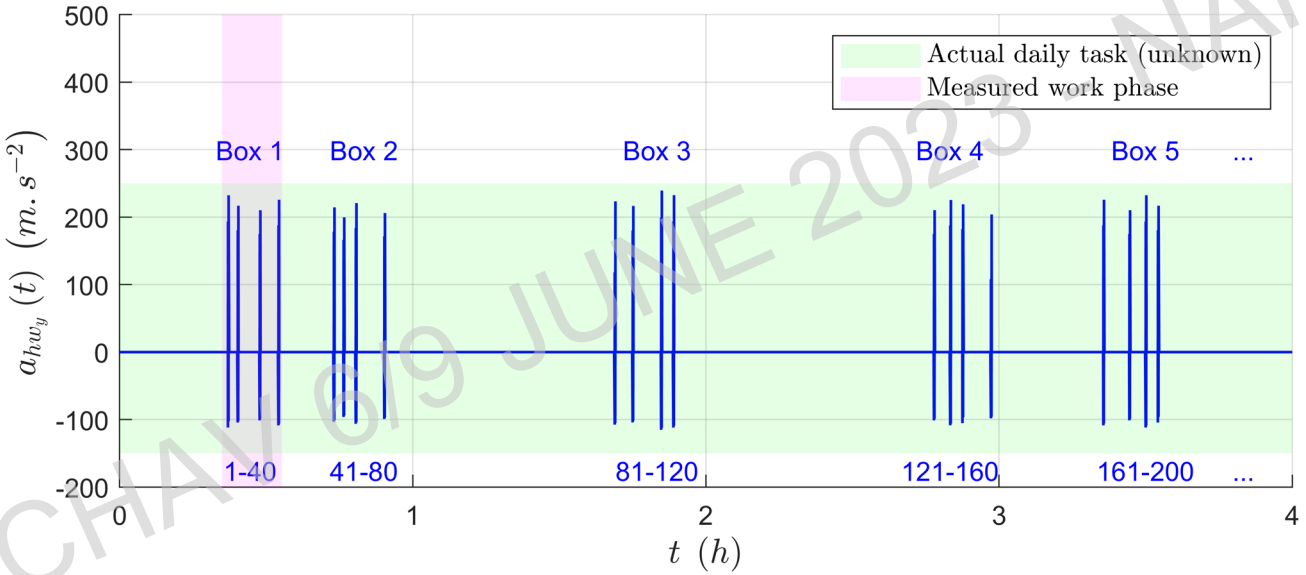
1 sole - 10 nails



1 nail

2. Material and methods

- 2.2. Nail gun



Measured *(sample Pink zone)*	Available information
$a_{hv_{sample}}$	$T_{estimate}$
$A(8)_{sample}$	$R_{estimate}$
R_{sample}	

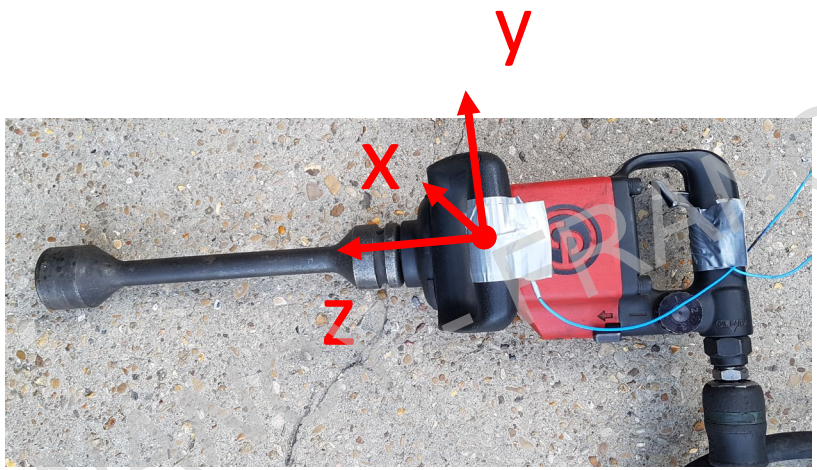
2. Material and methods

- 2.2. Nail gun

Conventional method			Alternative method			
$a_{hv_{sample}}$ $(m.s^{-2})$	$T_{estimate}$ (s)	$\boldsymbol{A(8)_{estimate}}$ $\boldsymbol{(m.s^{-2})}$	$R_{estimate}$ $(-)$	R_{sample} $(-)$	$A(8)_{sample}$ $(m.s^{-2})$	$\boldsymbol{A(8)_{estimate}}$ $\boldsymbol{(m.s^{-2})}$
2.7	7200	**1.3**	200 nails (5 boxes)	40 nails (1 box)	0.400	**1.0**

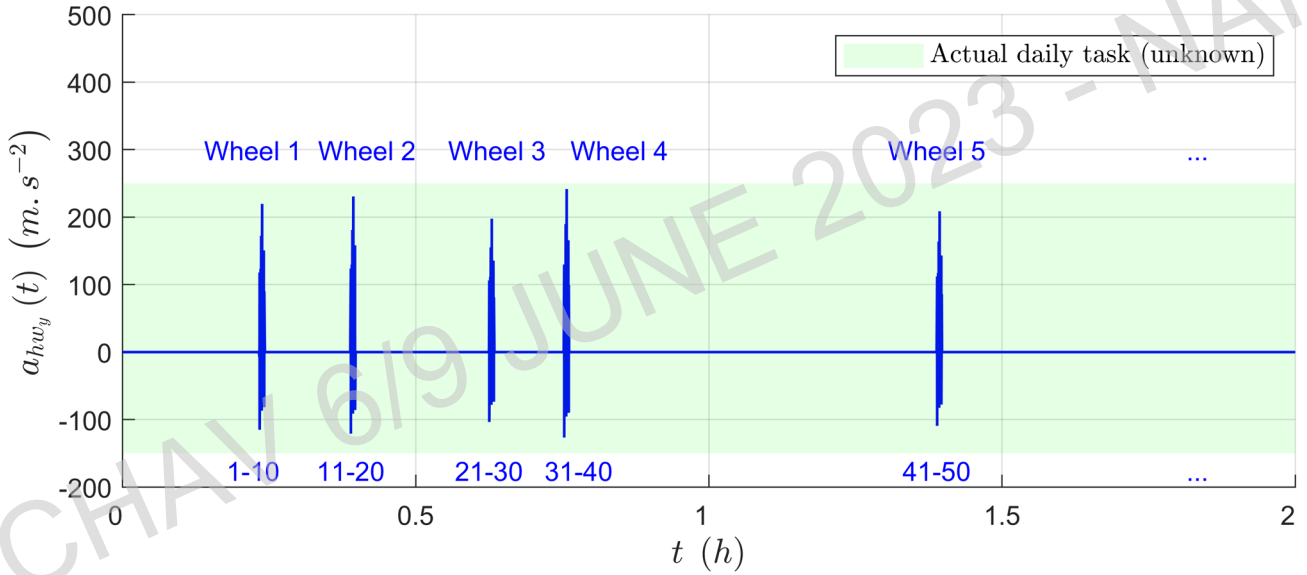
2. Material and methods

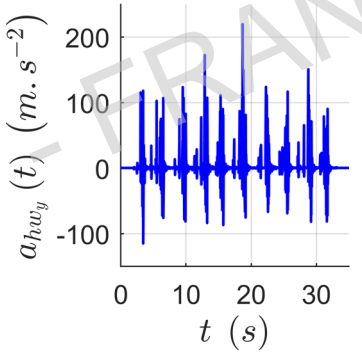
- 2.3. Impact wrench
  - Chicago Pneumatic CP7783
  - 8.4 kg
  - 600 N.m torque socket
  - Accelerometer placed on the auxiliary handle



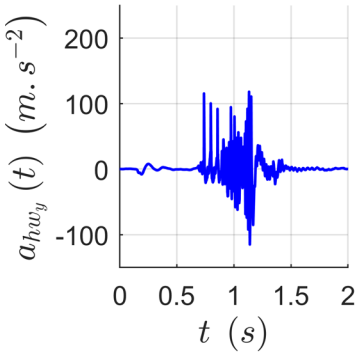
2. Material and methods

- 2.3. Impact wrench





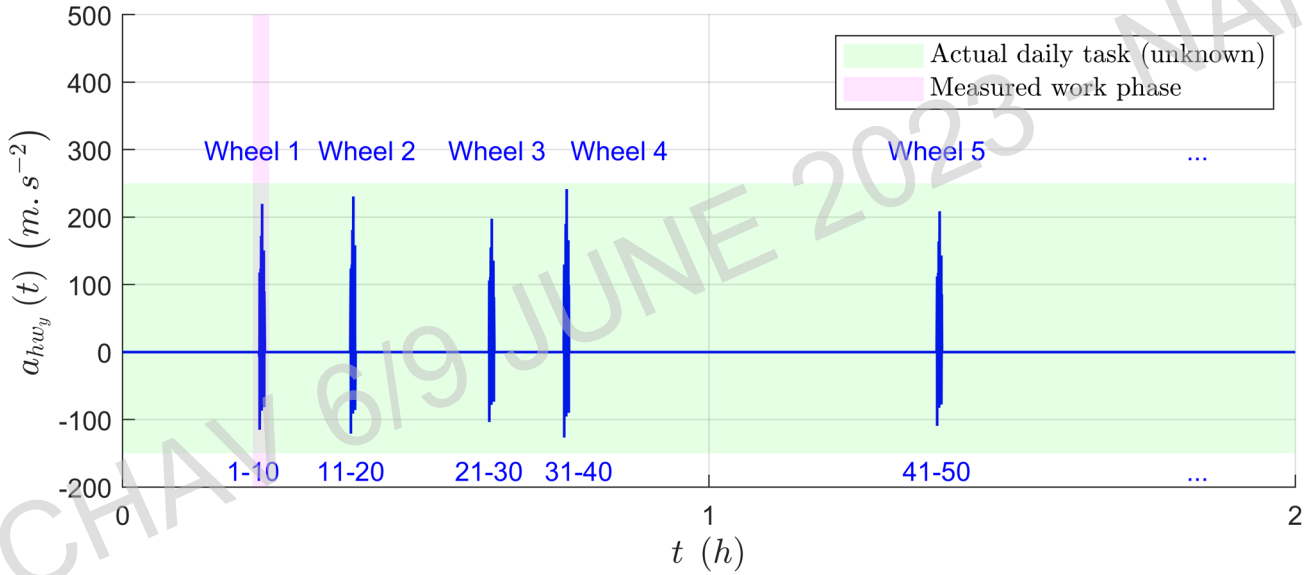
1 wheel - 10 bolts



1 bolt

2. Material and methods

- 2.3. Impact wrench



Measured *(sample Pink zone)*	Available information
$a_{hv_{sample}}$	$T_{estimate}$
$A(8)_{sample}$ R_{sample}	$R_{estimate}$

2. Material and methods

- 2.3. Impact wrench

Conventional method			Alternative method			
$a_{hv_{sample}}$ $(m.s^{-2})$	$T_{estimate}$ (s)	$\boldsymbol{A(8)_{estimate}}$ $\boldsymbol{(m.s^{-2})}$	$R_{estimate}$ $(-)$	R_{sample} $(-)$	$A(8)_{sample}$ $(m.s^{-2})$	$\boldsymbol{A(8)_{estimate}}$ $\boldsymbol{(m.s^{-2})}$
12.9	1800	**3.2**	150 bolts (15 wheels)	10 bolts (1 wheel)	0.430	**1.8**



3. Results

- 3.1. Method comparison

	Conventional method $A(8)_{estimate}$ $(m.s^{-2})$	Alternative method $A(8)_{estimate}$ $(m.s^{-2})$	Actual working task $A(8)$ $(m.s^{-2})$
Assault riffle	1.1	0.7	0.7
Nail gun	1.3	1.0	1.1
Impact wrench	3.2	1.8	1.8


4. Discussion and conclusions

- 4.1. Discussion

  - Field measurement conditions are not always controlled.
  - The sample is not always representative of the real working task.
  - When possible, the estimation of the total number of shocks is easier to perform and more accurate than the estimation of T.

4. Discussion and conclusions

- 4.2. Conclusions

  - The alternative method is often more reliable than the usual one.
  - It also facilitates the implementation of technical prevention solutions.
  - It should be preferred for single and repeated shocks.

Thank you for your attention

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