

**HAND ARM
VIBRATION**



Evaluation and Damping of High-Frequency Vibrations on a Percussive Tool

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Presentation Outlines

- Introduction and Background
- Measurement Procedure and Experimental Set-Up
- Test results
 - Time Signals
 - Acceleration Spectra
 - Vibration Peak Magnitudes
- Conclusion



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A Few Applications with Atlas Copco Tools

Grinding



Scaling



Drilling



Tightening



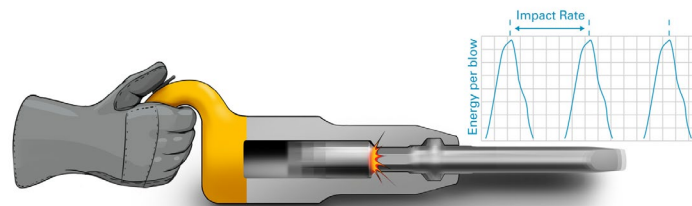
Chipping



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Background

- Percussive tools for chipping and scaling are used for material removal in foundries, metal workshop and shipyards
- The percussive mechanism may generate high vibration levels
- A damping system is thus required to reduce vibration transmission to tool handle
- Chipping hammer damped with soft spring => Atlas Copco RRF31
- Relatively low vibration emissions according to ISO 28927-10
- Significant accelerations at high frequencies in the tool handle due to piston-chisel impacts
- Experimental study for evaluation and damping of high frequency vibrations



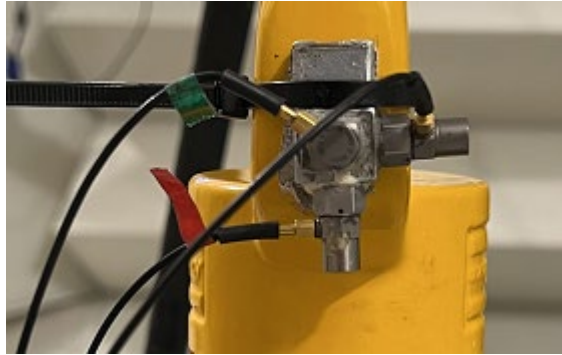
Measurement Procedure

- Vibration levels were measured by using three accelerometers located on the handle of the RRF31 Tool run in the Dynaload Energy Absorber described in ISO TR 20571.
- The measurements were conducted according to the guidelines given in ISO 28927-10. However, the procedure was simplified by using only one machine run by two operators that each performed five runs of 10 s.
- Three accelerometer B&K 4393 were mounted with mechanical filters on a block attached to the tool handle by means of double-sided tape and a cable tie.
- The time signals were acquired with a sampling frequency of 65.536 Hz and in addition to a digital low-pass filter at 20 kHz, the signals were subjected to the effects of the mechanical filters that provided a low-pass filter at 10 kHz.



Experimental Set-Up

Regular Handle



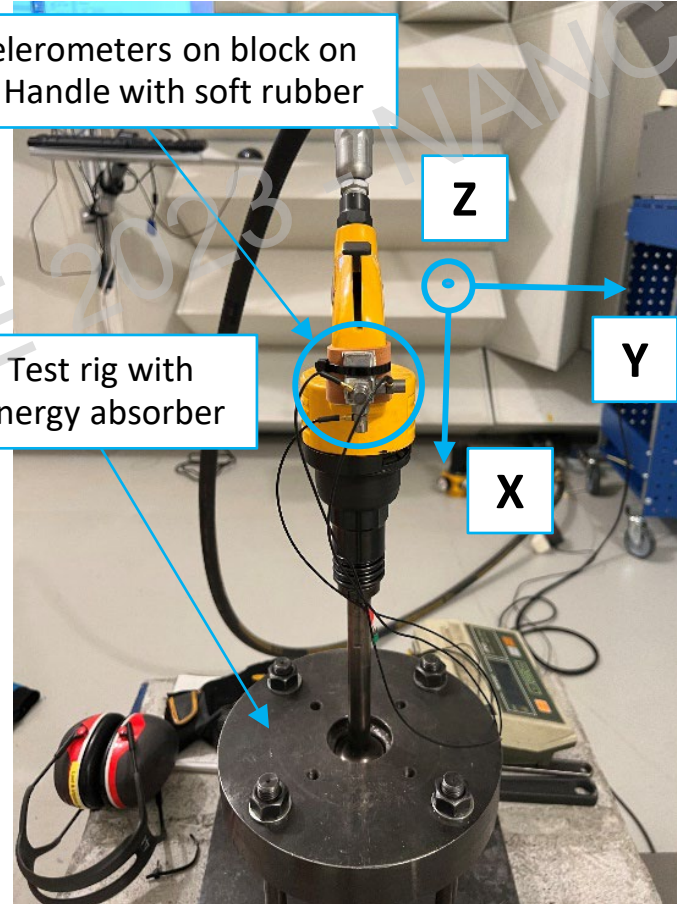
Handle with Soft Rubber



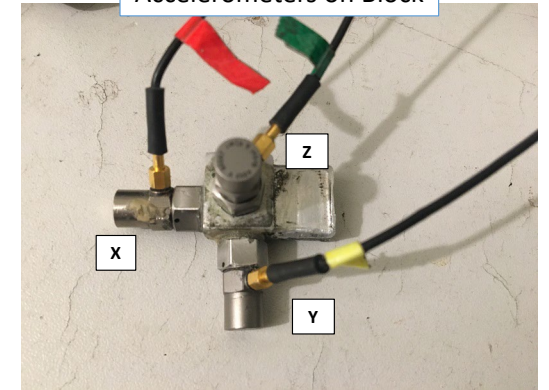
Chipping Hammer in Dynaload Energy Absorber

Accelerometers on block on Tool Handle with soft rubber

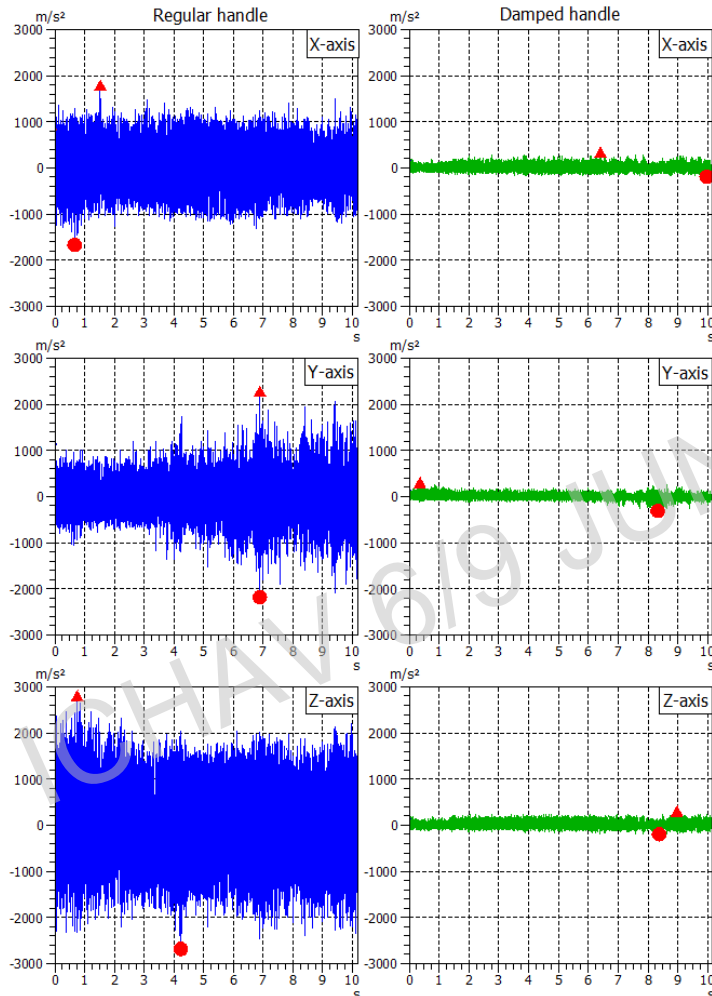
Test rig with energy absorber



Accelerometers on Block

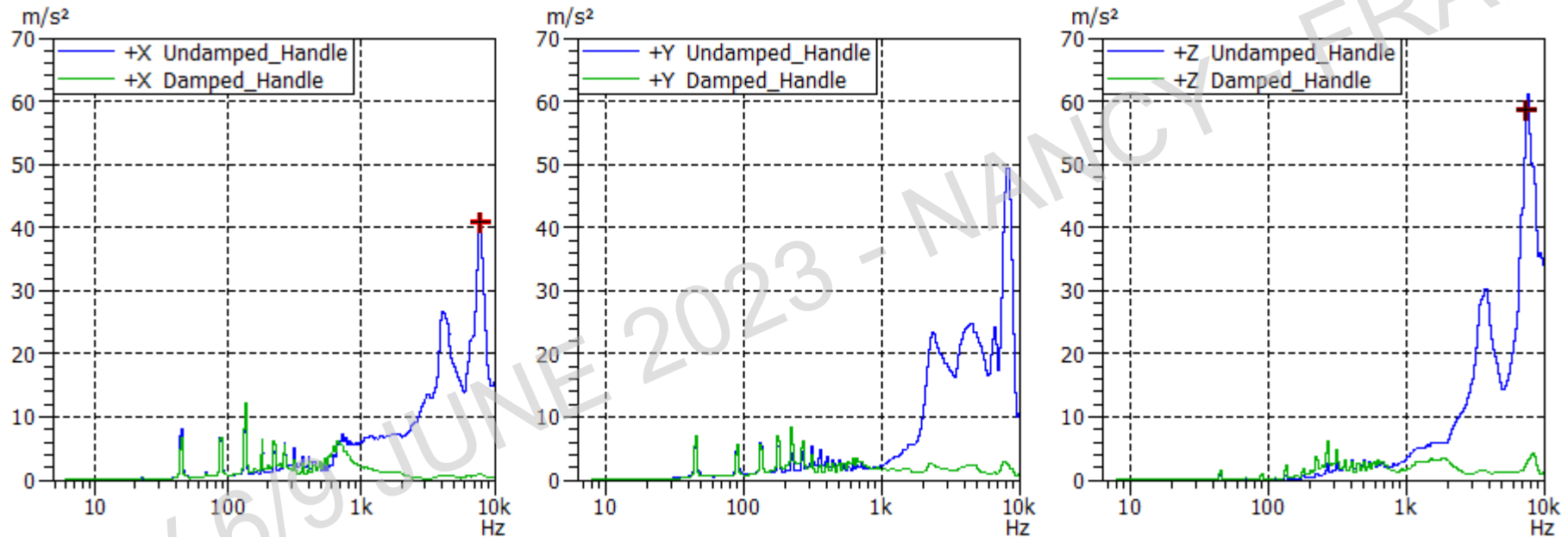


Time Signals for Regular and Damped Handle



- The acceleration signals recorded by the three accelerometers are shown in X, Y and Z-directions for one run performed with the Regular Handle and the other run with the Damped Handle.
- The acceleration amplitudes can vary significantly on a run of 10 s.
- The acceleration amplitudes are clearly reduced by using a soft layer of damping material in the X, Y and Z-directions.
- The max-min peaks measured for the Regular Handle are above 2000 m/s² whereas the max-min amplitudes recorded on the Damped Handle do not exceed 500 m/s², as shown in the plots by the red triangles for max values and the red circles for min values.

Acceleration Spectra for Regular and Damped Handle



- The acceleration spectra obtained by averaging the vibration data from 10 runs are shown for Regular and Damped Handle in 1/24th octave bands in X, Y and Z-directions.
- A large reduction in the acceleration amplitudes can be observed at frequencies above 1 kHz when a soft layer of damping material is used to cover partly the tool handle.

Vibration Peak Magnitude

- The data from the three accelerometers were used to evaluate the declared vibration emission value a_{hw} for the chipping hammer and the Vibration Peak Magnitude (VPM) defined as

$$VPM = \sqrt{\frac{\sum a^{2+2k}}{\sum a^{2k}}} \text{ with } k = 2$$

- The value produced by the VPM calculation can be used to quantify the high-frequency content of the vibrations generated, for example, by repeated shocks.
- The VPM value is used in the present study to characterize the effect of vibration damping.

Tool	Regular tool		Damped handle	
	VPM (Std. deviation) m/s ²	a_{hw} (Std. deviation) m/s ²	VPM (Std. deviation) m/s ²	a_{hw} (Std. deviation) m/s ²
X:	859,8 (32,6)	4,2 (0,6)	156,8 (59,2)	3,8 (0,4)
Y:	1332,4 (311,3)	3,1 (0,6)	136,0 (25,1)	3,6 (0,7)
Z:	1585,2 (92,6)	0,8 (0,4)	112,4 (13,7)	1,1 (0,2)
Norm (X,Y,Z) :	2260,5 (155,2)	5,3 (0,7)	242,8 (33,1)	5,3 (0,7)

Conclusion

- The damping effects of a thin layer of soft rubber on high frequency vibrations are demonstrated by using time signals, acceleration spectra and VPM values.
- The soft rubber has no impact on the declared vibration emission value measured at $5,3 \text{ m/s}^2$ and the official declaration value for the tool is 5 m/s^2 with an uncertainty $K = 1,6 \text{ m/s}^2$.
- The damping effects of the soft layer shown by the time signals and the acceleration spectra are clearly indicated by the VPM values. This tends to prove that the VPM value can be used as a suitable parameter to quantify high-frequency vibrations.
- The soft layer gives a substantial damping effect on high-frequency vibrations and provides extra insulation against the cold surfaces generated by the pneumatic tool.
- For further development, a suitable damped handle has to be designed and the material durability has to be studied in industrial applications.

