Vibration at work

Toolbox Talk

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Scope - Contents

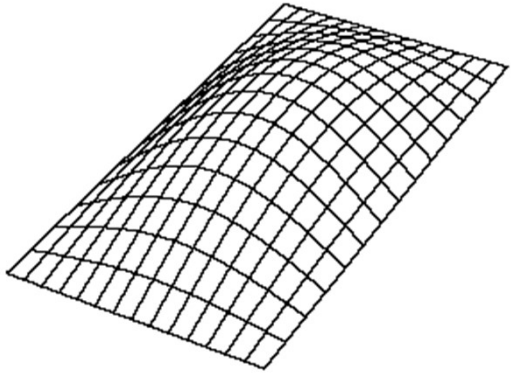
This work aims to present important information about **vibration in workplaces** where maintenance is the main task. The study has been conducted by GROUP SCIENCE GP, a Greek company that specializes in matters of noise and vibration for the last 20 years and more.

Contents:

1. Fundamental vibration definitions and principles
2. European legislation
3. Vibration control approach

Vibration

- **Vibration in humans:** The motion of a solid medium that can be perceived by human sensors (touch). Generally it refers to oscillations of the medium particles around an equilibrium (not free motion through space).
- *Main quantity of interest: Acceleration*
- **Simple oscillator examples** are a mass hanged on a spring, a pendulum, the string of a musical instrument etc.
- Vibrations perceived by humans are more **complex**: Oscillating surfaces (motion caused by machines, earthquakes etc), oscillating structures, ships etc.



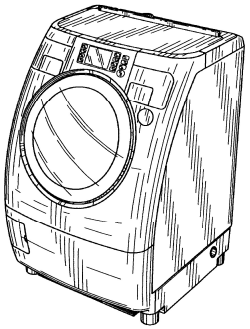
- Most complex vibration phenomena can be analyzed by **reducing** them **to simple oscillations**.
- Vibrations are transmitted though solid media by **longitudinal and transverse waves.**

Types of vibration

Useful Vibration (used to obtain a certain result)



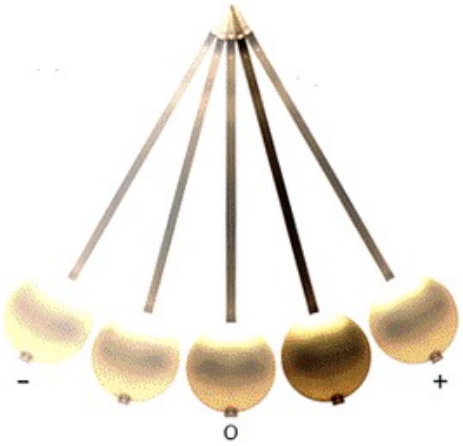

Undesired Vibration (unwanted consequence of a certain useful operation or action)



In both cases, it can be a cause of damage or disturbance to people and buildings

Resonance

- All solid entities can potentially vibrate, depending on their geometry, their elasticity and damping mechanisms.
- The rate of oscillation (= number of oscillations per second) of an item that moves freely after being released from a point away from equilibrium is called **natural frequency (=resonance frequency).**



- If an external force **excites** the item with a **frequency equal to its natural frequency**, the item will vibrate **in resonance**. In this condition, the vibration acceleration/velocity/displacement is greatly amplified and will be **maximum**.
- **Vibrations in resonance may result in damage** to the item or to the structures connected to that item, as well as increased disturbance to humans in contact to the item.

Vibration affecting humans

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Health & Safety

- **Whole-body vibration**: Strain (work safety) induced by the contact of a person's upper body or feet with vibrating surfaces (vehicle seats, moving platforms, platforms with machinery etc).
- **Hand-arm vibration**: Strain (work safety) induced by the contact of a person's hands and/or arms with vibrating surfaces or objects (power tools, moving controls etc).

Comfort

- **Building vibration**: Strain (comfort) induced by the contact of a person's body with vibrations of a building surfaces (floor, walls). Although it is similar to whole-body vibration, in practice it is almost always examined in terms of comfort due to its small magnitude.
- **Vehicle vibration**: Strain (comfort) imposed to passengers of ground vehicles.
- **Ship vibration**: Strain (comfort, nausea) imposed to passengers of sea vessels.

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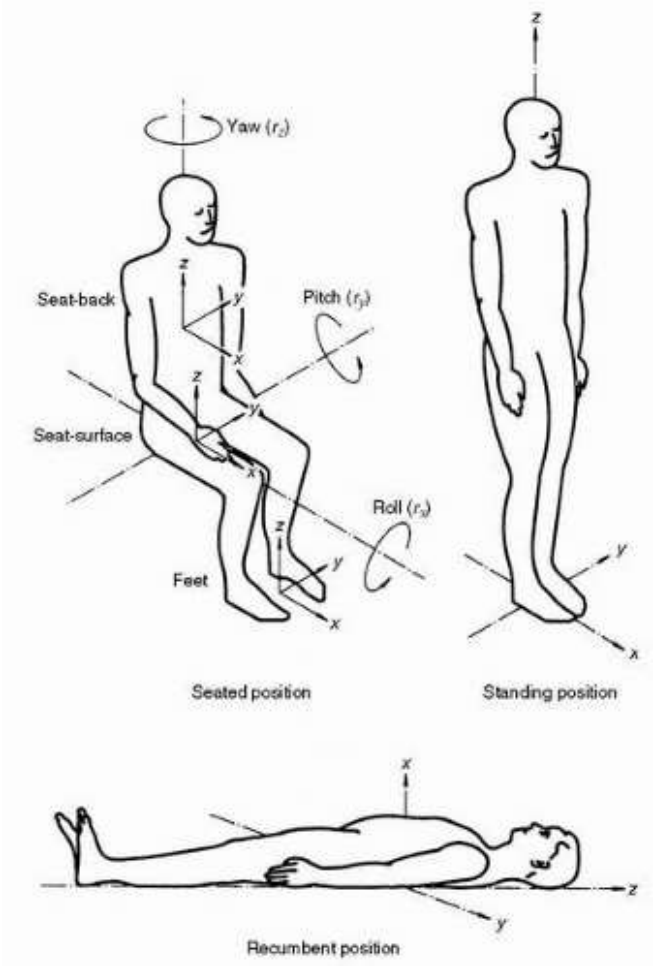
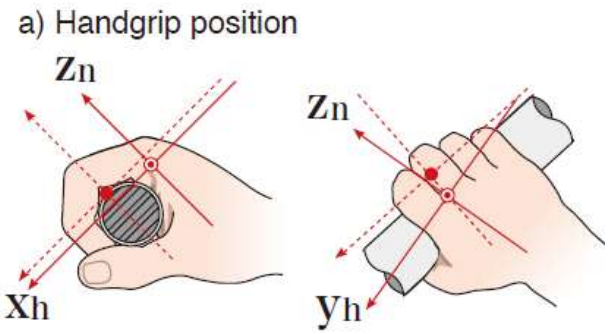
Whole-body vibration

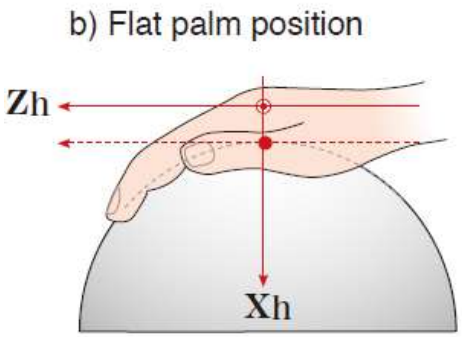
- **Whole-body vibration *in maintenance applications*** is primarily transmitted to a person's body through a forklift seat or a heavy truck seat. In less common cases, vibration can be transmitted to a person's feet through a vibrating platform.
- **Vibration frequency range**: 0.5Hz to 80Hz
- **Standard in Europe:** ISO 2631



Hand-arm vibration

- **Hand-arm vibration *in maintenance applications*** is primarily transmitted to a person's hands through the use of power tools.
- **Vibration frequency range**: 0.5Hz to 500Hz
- **Standard in Europe:** ISO 5349





Vehicle and ship vibration

- Often ***maintenance*** **takes place in moving vehicles or sea vessels**. Vibration is primarily transmitted to a person's body through the vehicle/ship surfaces.
- **Standard for vehicles in Europe:** ISO 2613 (comfort guidelines)
- **Standard for ships in Europe:** ISO 6954
- **Frequency range for motion sickness:** 0.1Hz to 0.5Hz

Vibration limits

The vibration limits according to 2002/44/EC are set in scales for the daily exposure value A(8):

Hand-arm vibration

- Daily exposure limit value: A(8) =5m/sec^2
- Daily exposure action value: A(8)=2.5m/sec^2

The daily exposure value A(8) is normalized to an 8-hour reference period

Whole-body vibration

- Daily exposure limit value: A(8)=1.15m/sec^2 or VDV=21m/sec$^{1.75}$
- Daily exposure action value: A(8)=0.5m/sec^2 or VDV=9.1m/sec$^{1.75}$

The daily exposure value A(8) is normalized to an 8-hour reference period

Daily vibration variation

In maintenance:

- Vibration conditions are not always predictable and repeatable,
- Vibration conditions may vary significantly throughout the employee's shift,
- Vibration conditions may vary significantly from day to day,
- Vibration conditions may not depend on permanent machines/installation,
- Vibration conditions may depend on hand tools with fluctuating operation.

Therefore the determination of the employee's daily vibration exposure may be **very difficult by sample measurements of short duration**.

Instead, it is advised:

- Either to determine vibration conditions in maintenance using repeated **8-hour dose measurements** (e.g. 5 daily measurements throughout the week). The examined week should feature representative conditions of the actual vibration conditions affecting the employee.
- Or to collect accurate information about the exposure duration of the employees to the specific vibration conditions measured in short-duration samples.

Work vibration measurements

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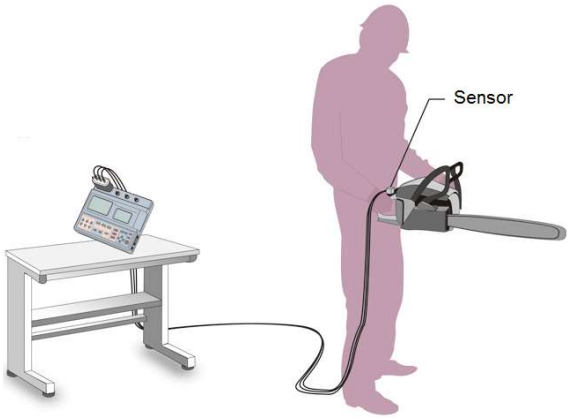
Hand-arm vibrations

- Small size sensor/interface between the hand and the tool. Usually measurements in both hands.
- The sensor is connected to a measuring device recording and processing acceleration signal.



Whole-body vibration

- Flat sensor between vehicle seat and operator body.
- The sensor is connected to a measuring device recording and processing acceleration signal.

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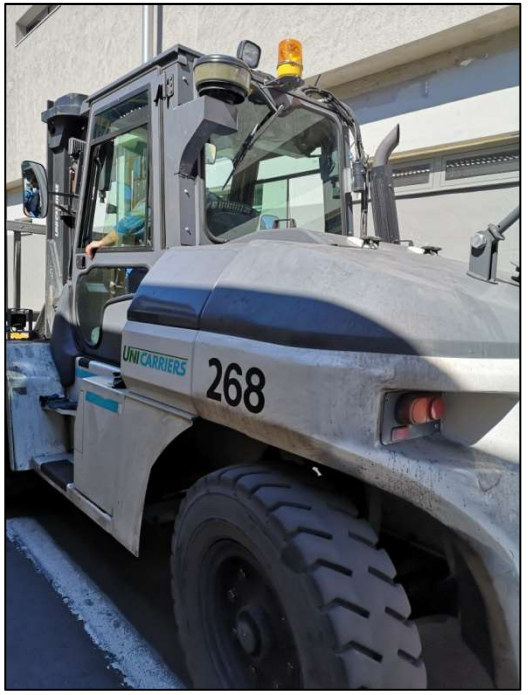
Hand-arm vibration control

1. Measurements – study to determine actual exposure and risk
2. Use of personal protection (appropriate gloves for corresponding task/tool)
3. Selection of modern technology tools (internal protection systems)
4. Smart distribution of exposure time (i.e. limit duration of single operator exposure based on vibration source, circular workload distribution to more than one operators)

Remember: The goal is to reduce the *time-average vibration* (i.e. 8-hour exposure), not necessarily the vibration levels at all times.

Whole-body vibration control

1. Measurements – study to determine actual exposure and risk
2. Installation/use of comfortable seating or seating with anti-vibration protection in forklifts
3. Selection of modern technology vehicles (internal anti-vibration)
4. Use of anti-vibration flooring/supports in vibrating platforms
5. Smart distribution of exposure time (i.e. limit duration of single operator exposure based on vibration source, circular workload distribution to more than one operators)



Remember: The goal is to reduce the *time-average vibration* (i.e. 8-hour exposure), not necessarily the vibration levels at all times.