HAND ARM VIBRATION

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Using an Impact Wrench in Different Working Directions

An Analysis of The Individual Forces

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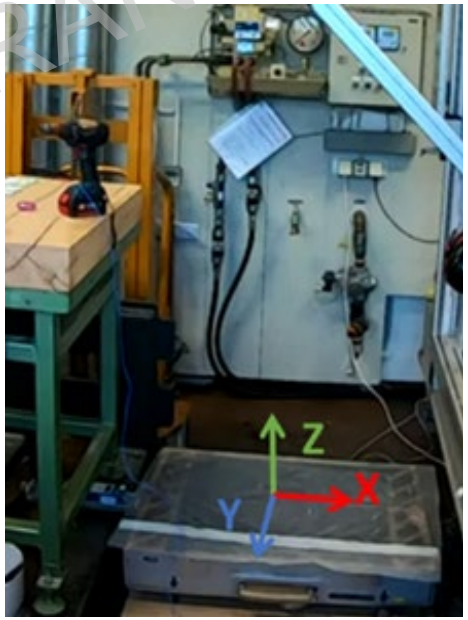
Introduction

- When working in different directions, factors such as awkward postures can lead to different physical stresses, which can have an influence on the effects of hand–arm vibrations(HAV)
- In this regard, the individual forces can have an influence on the HAV. For recognition of a HAV-related occupational disease the exposure can be measured by the acceleration values
- According to DIN 45679[1] coupling forces must be considered as a correction factor
- These factors are constant and do not take the influence of the working direction and posture into account

References: [1] DIN 45679 Mechanical vibration - Measurement and evaluation of coupling forces for assessment of vibration exposure of the hand-arm system

Methods

- 5 healthy, voluntary, right-handed, male subjects
  - 31 ± 4 years
  - 185 ± 4 cm
  - 85 ± 11 kg
- Height-adjustable experimental setup to set a basic position
- Electrical impact screwdriver
- 12-screwing operations with 100 mm long woodscrews into oak panels
- Force measuring plate (FMP) for X- and Z-axis



$$F_f = \sqrt{F_X^2 + F_Z^2}$$

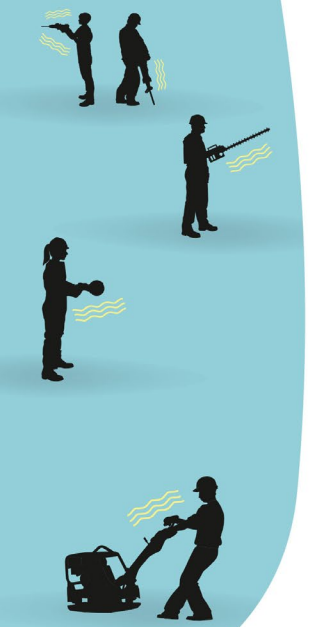
Electromyography/Data Analysis and Statistics

- Electromyography
  - Surface electrodes on the skin of the subjects
    - biceps brachii
    - trapezius descendens
  - Measured values were processed according to the recommendations of Hansson [2]
  - Relative percentage value related to the maximum voluntary contraction was calculated (MVCP)
- Data analysis and Statistics
  - Evaluation of the data was carried out in WIDAAN [3]
  - Individual screwing operations were considered

References: [2] Hansson, G.Å; Asterland, P.; Skerfving, S. Acquisition and analysis of whole-day electromyographic field recordings. In Proceedings of the Second General SENIAM (Surface EMG for Non Invasive Assessment of Muscles) Workshop, Stockholm, Sweden, 13–14 June 1997.
[3] Hermanns, I.; Raffler N.; Rolf, E.; Siegfried, F.; Benno, G. Simultaneous field measuring method of vibration and body posture for assessment of seated occupational driving tasks. *Int. J. Ind. Ergon.* **2008**, *38*, 255–263.

Interaction of the forces

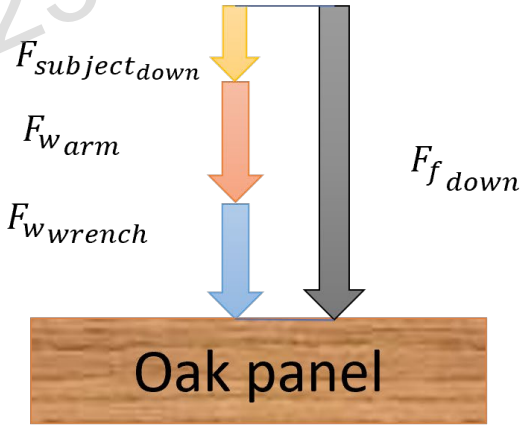
- F_f = feedforce according ISO 15230 [4]
- F_w = weight force (arm/wrench)
- $F_{subject}$ = total force of the subject



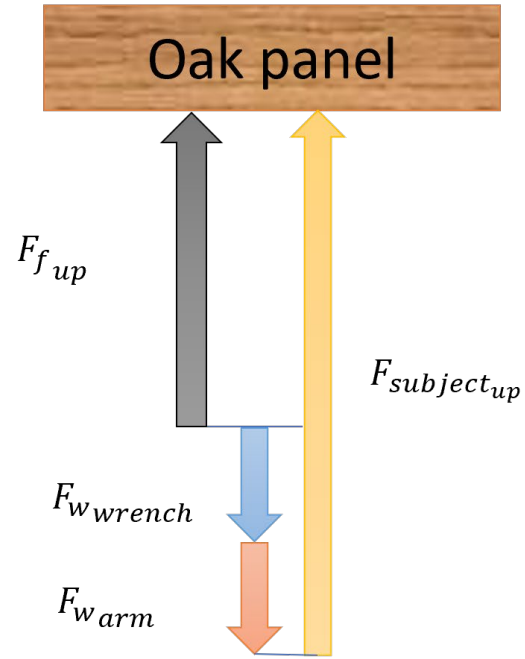
$$F_{subject_{up}} = F_{f\ up} + F_{w_{wrench}} + F_{w_{arm}}$$

$$F_{subject_{down}} = F_{f\ down} - F_{w_{wrench}} - F_{w_{arm}}$$

Downwards



Upwards



References: [4] ISO 15230 Mechanical vibration and shock — Coupling forces at the man-machine interface for hand-transmitted vibration

HAV

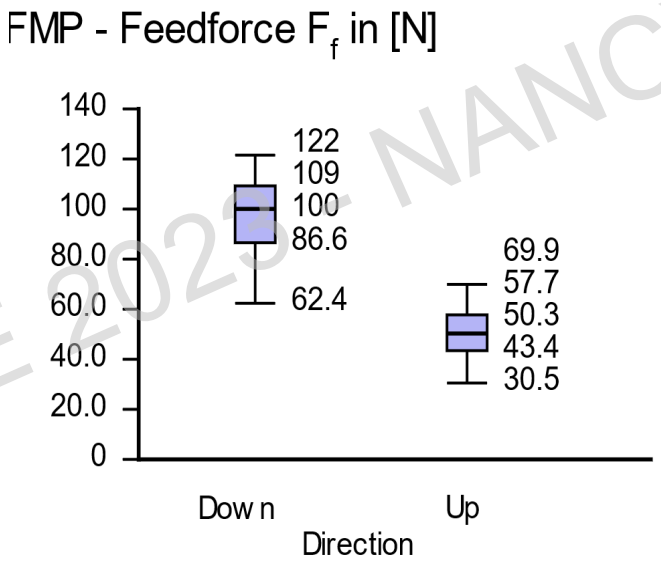
- Measured on the handle of the tool in accordance with ISO 5349-1 and -2 [5]
- The accelerometer was glued to the handle accordance with ISO 28927-5 [6]
- As total vibration value the a_{hv} was calculated as sum of the frequency-weighted acceleration of the three measuring axes

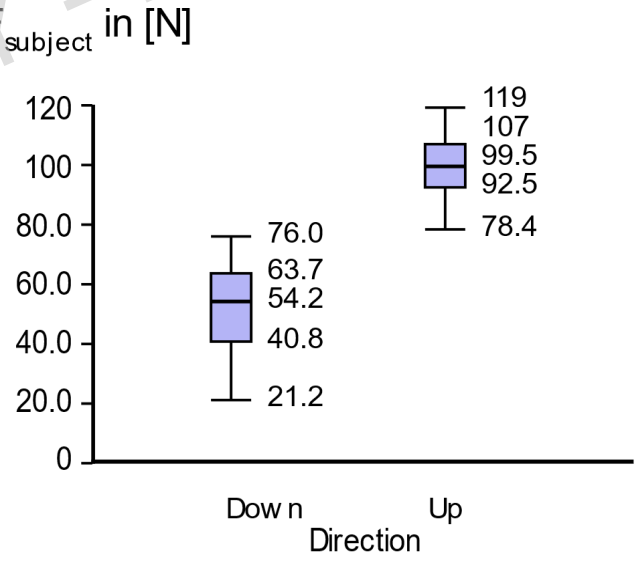
$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2}$$

References: [5] ISO 5349-1 Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 1: General requirements
ISO 5349-2 Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 2: Practical guidance for measurement at the workplace
[6] ISO 28927-5 Hand-held portable power tools - Test methods for evaluation of vibration emission - Part 5: Drills and impact drills

Results & Discussion – HAV/FMP

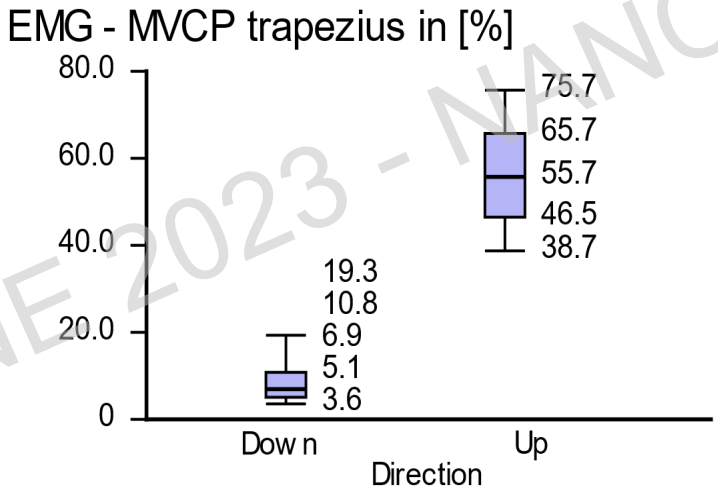
- HAV
  - downwards a_{hv}= 5.0 ± 0.5 ms^{-2}
  - upwards a_{hv}= 4.8 ± 0.6 ms^{-2}
    - **similar workload**
- FMP
  - significant higher feedforce when working **downwards**
  - $F_{subject}$ is significant higher when working **upwards**

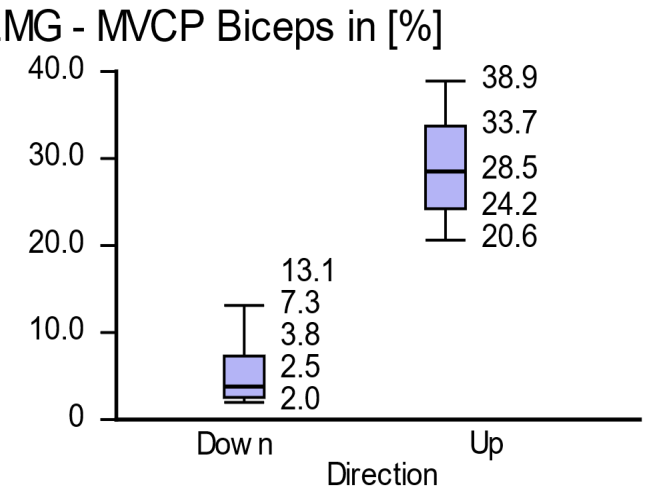




Results & Discussion – EMG

- Different workloads in the working directions
  - Much higher MVCP value while working upwards
  - This result is comparable with the result of $F_{subject}$

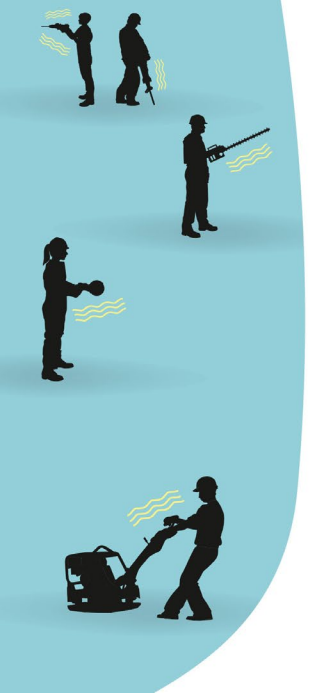


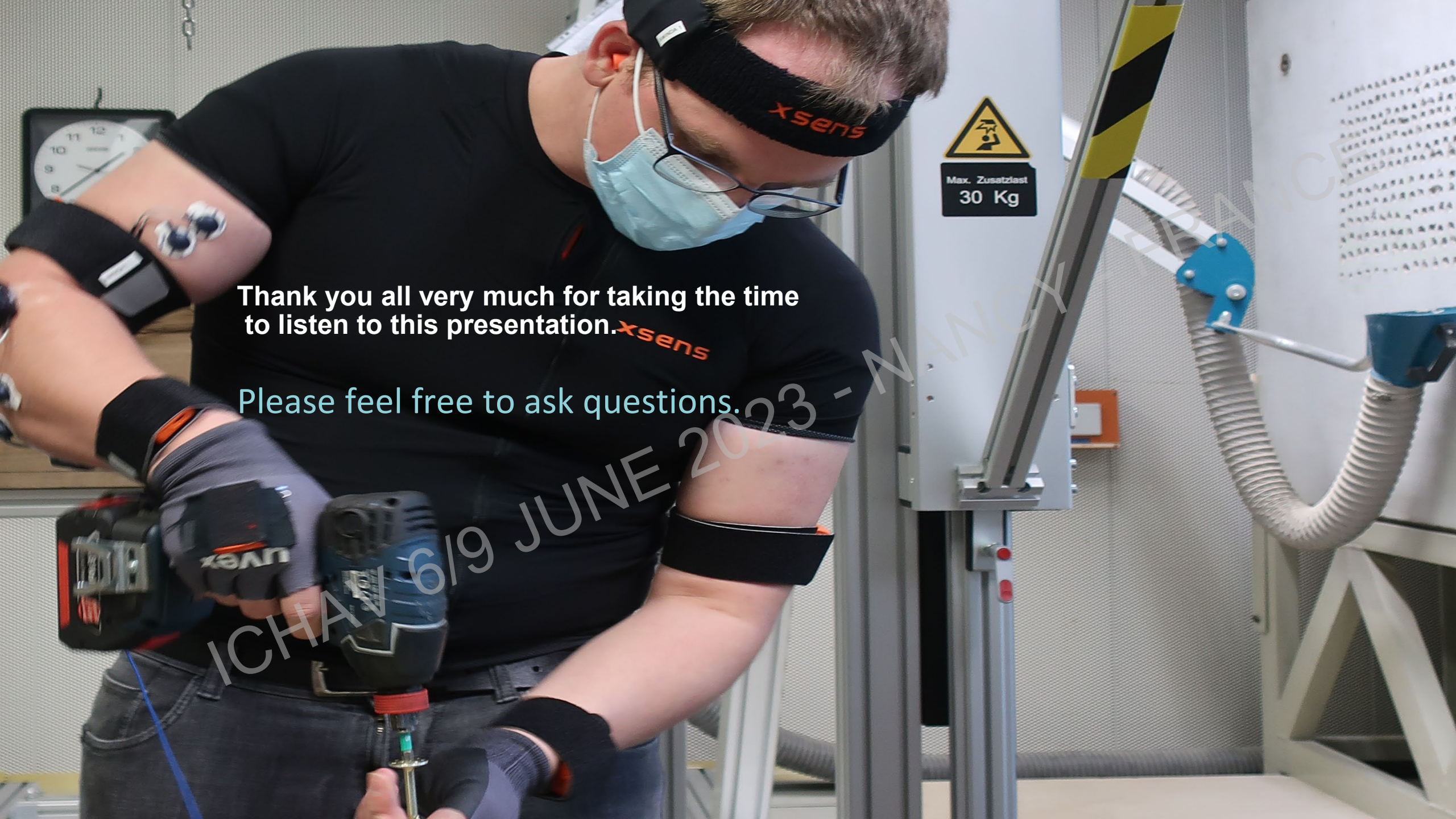


Conclusion

- The vibration load did not show any differences in the working directions
  - Forces and muscle activity show significantly different workloads
- Summarizing these results, it is obvious that analyzing the workload only by means of acceleration measurements, neglects other relevant impact factors

  Result: unfair and insufficient assessment of the actual workload
- To achieve a fair assessment in addition to the correction factors from DIN 45679 further factors like the working direction must be taken into account

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Max. Zusatzlast
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Thank you all very much for taking the time to listen to this presentation.
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Please feel free to ask questions.
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