Vibration Injury Network

Research Network on Detection and Prevention of Injuries due to Occupational Vibration Exposures

Design a multi-centre experimental study to determine how whole-body vibration and shock, and other ergonomic and individual factors, interact to hazard the spinal system

Appendix W3A to Final Report

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WORK PACKAGE WP3W REPORT

Task: Design a multi-centre experimental study to determine how whole-body vibration and shock, and other ergonomic and individual factors, interact to hazard the spinal system.

Objectives

The aim of the multi-centre experimental study is to examine biodynamics of sitting persons on hard and suspended seats with special attention to the effects of:

(1) the vibration magnitude on the linearity/non-linearity
(2) anthropometric data
(3) posture

as basis for improved models reflecting the effect of whole-body vibration on the spinal system.

Laboratories investigating matters of interest within their own research programs may include one common condition allowing comparison between laboratories. This common condition is characterised by the following details:

Safety.

The EN ISO 13090-1 Mechanical vibration and shock - Guidance on safety aspects of tests and experiments with people - Part 1: Exposure to whole-body mechanical vibration and repeated shock (ISO 13090-1 : 1998) shall be observed. The experiment should also be approved by an appropriate ethical committee.

Exposures.

Identical (in the time domain) time series of acceleration as input at a hard seat, white noise 1-20 Hz, 0.5, 1.0 and 1.5 ms^{-2} rms, duration 120 seconds, realisation of the spectrum either around 30 or 60 s, subsequently z-, x- and y-axes.

The time series of the control signal will be elaborated by the NIWL according to the capacity of the NIWL-vibrator. The lowest magnitude (0.5 ms^{-2} rms unweighted) should produce a flat spectrum from 1 – 20 Hz. The two higher magnitudes of 1 and 1.5 ms^{-2} should produce flat spectra with an increasing power beginning at 1 Hz and flat spectrum at higher frequencies according to the maximum capacity of the NIWL-vibrator. Tapering 1 s at the beginning and at the end. Duration 122 s including tapering, two realisations of the spectrum with a duration of 60 s each and avoiding a shock between the two realisations. NIWL will provide to ISVR and FIOSH the measured accelerations in the time domain with a sampling frequency of 1 kHz as ASCII-files.
The acceleration input will be performed via hard seat and platform for the feet. The geometry of the seat plate (width and length data) will be specified by NIWL.

Posture.

Sitting erect, hands on the thigh, no backrest, feet vibrated like the seat.
Between 60 and 70 percent of the GKL (distance between the most dorsal part of the buttocks and the most anterior part of the right knee) should be located on the seat plate in order to enable a comparable support of the body.

Design.

Balanced design with 3 intensities and 3 repetitions (e.g., 3x3 Latin square).

Subjects.

6 healthy males with a body mass between 70 and 80 kg and a body height between 170 and180 cm.

Measurements and data storage.

z, x and y accelerations at the seat; z, x and y accelerations head (bite bar according to the prototype used in FIOSH, measurement on the right side), left shoulder (acromion), spinous processes L3 and L5; z, x and y input forces at the seat. All data are sampled with 200 Hz and appropriate anti-aliasing filtering (minimum anti-aliasing filter cut-off frequency 50 Hz). In order to enable an exchange of all data, the calibrated time-domain data are stored on CD in a format suited for the database (cf. Appendix WBV-WP3-A2) for collecting experimental data on WBV.
A quantitative documentation of posture shall be performed, either by photography (with reference scales and vertical) or by motion analysis. This documentation shall provide information on joint angles of the ankle, knee, hip, elbow, shoulder, and inclinations of the pelvis, lumbar, thoracic, cervical spine. The measurements of inclinations can be derived from a photo of the subject in the sagittal plane with markers above the spinous processes of C7, T5, T12, S1 and S3. The angle between the line through S1 and S3 and the horizontal indicates the inclination of the pelvis. Anthropometric variables - mass-KPM, height-KPH, shoulder height-ACH, elbow height-EBH, elbow breadth-EBB, height of seat surface-SFH, seated height-SH, hip breadth when seated-HBS, buttocks-knee-length-GKL - are obtained according to the definitions provided by FIOSH (cf. H. SEIDEL, R. BLÜTHNER, B. HINZ and M. SCHUST, 1997, Schriftenreihe der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin Fb 777. Stresses in the lumbar spine due to whole-body vibration

containing shocks. Bremerhaven: Wirtschaftsverlag NW). Anthropometric data are stored as an Excel-File with indication of the institute and subject number. Postural data (mean values for each exposure) are stored as an Excel-File with indication of the institute, subject number, exposure condition, and number of repetition.
It is desirable to measure accelerations at the acromion, L3 and L4 in z-, x- and y-axes. As a minimum requirement these measurement should be performed in the same direction as the input acceleration.

Data analysis:

Data analysis should include impedance and transmissibility, both gain and phase. Additional data analyses will be performed on a partner by partner basis.