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HUMAN RESPONSE TO VIBRATION

ABSTRACTS

Prepared by M. J. and J. Griffin, Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton, Southampton SO17 1BJ, England

This selection of abstracts is taken from the 1998 meeting of the United Kingdom Group on Human Response to Vibration, held at the Health and Safety Executive, Buxton, Derbyshire, 16–18 September.

Z. Jandák. Response of the hand-arm system at exposure to random vibration. (9 pages, 4 figures, 1 table, 16 references) (in English)
Author's Abstract. The driving-point mechanical impedance and the energy transfer from the handle to the human hand–arm system have been studied in the laboratory at exposure to random vibration on a group of 18 male subjects. The grip force in the range of 25–100 N, the feed force in the range of 30–100 N, their combination up to 110 N and two different postures of the hand and arm characterised by angles in the elbow of 15° and 90° were the basic variables. The vibration was excited in the directions X_h, Y_h and Z_h according to ISO 5349. The results are based on two channel FFT analysis and the statistical evaluation of the responses. The hand response to impulse and random vibration is compared and the energy concept is discussed.
Topics: Biodynamics (impedance, energy); hand-transmitted vibration.

S. Hewitt. Comparison of needle scaler emission test vibration with vibration during use. (10 pages, 4 figures, 5 tables, 4 references) (in English)
Author's Abstract. Needle scalers are tools commonly used in shipbuilding and repair for preparation of metal surfaces prior to surface coating and they have been long recognised as a source of considerable risk in terms of exposure to hand-transmitted vibration. Recently, needle scalers which are claimed to be vibration-reduced have become available This report describes measurements of the vibration emission of needle scalers according to EN ISO 8662-14 and measurements of the vibration produced by the same tools under typical working conditions. The purposes of the work were to verify the tool manufacturer's declared vibration emission, to investigate whether vibration emission data correlated with the vibration under real working conditions, and to confirm that reduced vibration needle scalers do exist. The investigation showed that the manufacturer's declared vibration emission did not agree with the emission measured by HSL and unfortunately, no general relationship could be established between declared vibration emission, vibration emission measured according to EN ISO 8662-14 and vibration during real use. However, when

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used under real working conditions, five of the six needle scalers produced highest axis vibration magnitudes between 2·9 and 6·4 m/s^2, compared with magnitudes of 10 to 23 m/s^2 for traditional designs. This indicates that it is possible to purchase needle scalers which give relatively low vibration in real use.
Topics: Hand-held tools (needle scalers); standardisation.

B. M. Haward. The assessment of hand function in subjects with vibration-induced upper limb conditions. (14 pages, 0 figures, 3 tables, 37 references) (in English)
Author's Abstract. Although there are several clinical tests available for the diagnosis of vibration-induced hand and upper limb conditions, there are few standardised procedures for evaluating the degree of hand dysfunction experienced by a person with symptoms or for use in health surveillance programmes. This paper reviews criteria for objective tests. The currently available tests for evaluating hand function are reviewed against objective test criteria. Grip strength testing to assess muscle force changes and the Purdue pegboard test, to measure tactile sensibility satisfy most of the objective test criteria and are recommended for use at the present time. These tools can be used to detect hand impairments caused by vibration-induced changes. The need for the development of further objective tests is recognised.
Topics: Vibration syndrome (muscle, nerve).

C. J. Lindsell. Vibrotactile thresholds: effects of measurement duration with different skin-stimulus contact conditions. (7 pages, 1 figure, 1 table, 12 references) (in English)
Author's Abstract. Sensitivity to a vibration stimulus applied to the finger tip by means of a probe is used to detect peripheral neuropathies. Measurements of vibrotactile thresholds are made either using a constant probe contact force, or by using a constant skin indentation with a fixed probe height. The contact conditions may be expected to change over time as the subcutaneous tissue deforms under the applied forces. A study to investigate the effects of measurement duration on vibrotactile thresholds measured using different contact conditions has been performed. Ten healthy males each attended one experimental session during which mechanoreceptor specific vibrotactile thresholds were measured for the Meissner's and the Pacinian corpuscles. Measurements were made using the up-and-down method of limits (von Békésy method). A 6 mm diameter probe concentric to a 10 mm hole in a surround was used to apply the stimulus during a 5 min period. Thresholds were obtained for the index finger of the right hand with a push force on the surround of 2 N using both a constant probe height and a constant probe contact force. The results indicate that equivalent mechanoreceptor specific vibrotactile thresholds can be obtained using either a constant probe height or a constant probe force with the same push force on the surround. The measurement duration did not influence the thresholds elicited from the Pacinian pathways and for practical reasons a short measurement duration is recommended. Thresholds for the

Meissner's corpuscles increased as the measurement duration increased. A short measurement duration should be used to minimise this effect.
Topics: Vibration sense (thresholds).

P. Brereton. Occupational exposure to vibration and an EC proposal for a physical agents directive. (7 pages, 0 figures, 1 table, 5 references) (in English)
Author's Abstract. Excessive occupational exposure to hand–arm or whole-body vibration can cause injury. An EC proposal for specific legislation requiring control of injury risks arising from occupational exposure to physical agents, including occupational exposure to hand–arm and whole-body vibration, has existed for many years but is yet to be submitted as a priority work item by a member state during its presidency. General European legislation already exists that requires control of health risks, including those arising from excessive exposure to vibration. This paper considered how existing general duties might be clarified by a Directive specific to physical agents along with some of the difficulties likely to be encountered in specifying criteria for injury preventive action.
Topics: Standardisation; injury and disease.

S. D. Smith. Vibration response characteristics of the helmeted head-orientation effects. (12 pages, 4 figures, 1 table, 9 references) (in English)
Author's Abstract. The effects of head/helmet orientation on head/helmet low frequency vibration response were investigated. Subjects were exposed to a simulated F-15 aircraft buffet signal and to sinusoidal frequencies in the range of 3–10 Hz. Head and helmet r.m.s. accelerations, power spectral densities, and transmissibilities were compared. The results showed that head/helmet orientation had minimal effect on the frequency locations of the peak transmissibility responses (resonance frequencies) and primarily occurred between 4 and 6 Hz. However, orientations in which the longitudinal axis of the head/helmet system were not aligned with the input vertical axis at the seat showed significant increases in the peak helmet pitch transmissibility. The buffet and sinusoidal exposures showed similar trends although the sinusoidal responses tended to be higher, particularly for the helmet. Off-axis head/helmet orientations are expected during military aircraft flight manoeuvres where buffet vibration occurs. The increased motions compromise the effectiveness of helmet-mounted cueing systems which depend on accurate tracking of the helmet system line-of-sight (LOS).
Topics: Biodynamics (transmissibility); head vibration.

J. Förstberg, E. Andersson and T. Ledin. The influence of roll acceleration motion dose on travel sickness: study on a tilting train. (14 pages, 8 figures, 4 tables, 25 references) (in English)
Authors' Abstract. Background: low frequency translational accelerations can provoke motion sickness in land vehicles, trains, ships and aircraft. Tilting trains and banking aircraft introduce roll motions, which may provoke motion sickness. Hypothesis: roll acceleration can contribute considerably to

nauseogenicity when the low frequency lateral and vertical accelerations are small in amplitude. The ISO 2631-1 weighting filter (W_f) for calculation of motion dose for prediction of motion sickness from vertical acceleration may also be extended to use for roll accelerations. Methods: some seventy healthy volunteers (mean age 25 years, 45% females) were employed. They were tested in a tilting high speed train with three different tilt control strategies during three days. Different degrees of tilt compensation were used, which means that subjects felt more or less lateral acceleration on the curves but also different, roll velocity and roll acceleration. The test ride lasted about three hours, two times 180 km long. Four times per test ride the subjects answered a questionnaire concerning vegetative symptoms, fatigue, sleepiness and nausea. Discomfort was measured in symptoms of motion sickness (SMS), which is defined as: dizziness, nausea or not feeling well. The train motion environment was monitored and recorded during the test rides. Motion doses for prediction of motion sickness, were calculated with vertical and also with lateral and roll accelerations over the different length of the test track. Over a part of the test track, about 5 min long, where speed and curvature were about the same, a frequency analysis was performed. Corresponding motion doses were calculated from these PSD-spectra. Results: a 55% degree of tilt compensation of the lateral acceleration (in the track plane) instead of the normal 70%, reduced the incidence of SMS (SMSI) by about 30–50%. No decrement of subjective ride comfort or working ability were recorded with 55% compensation. Females reported SMS rates 3–4 times higher than males. SMSI correlates fairly well with motion dose of roll acceleration ($r^2 = 0{\cdot}43$) but not significantly with vertical or lateral motion doses. Motion doses calculated from the PSD spectra gave similar results. Conclusions: SMSI does not correlate to any greater extent with vertical and lateral motion dose, but instead correlates better with a motion dose of roll acceleration in railway tilting environments. This implies that vehicle ride (land and air) should minimise roll acceleration in order to minimise provocation of motion sickness.
Topics: Motion sickness; non-vertical oscillation.

N. A. Webb. Motion sickness with normal and degraded vision. (7 pages, 4 figures, 4 tables, 6 references) (in English)
Author's Abstract. Studies of visually induced motion sickness have often used optokinetic drums (black and white striped cylinders) in which subjects sit whilst watching the stripes move as the drum rotates. This can be simulated in virtual reality and previous studies have shown an association between the visual acuity of subjects and the motion sickness symptoms experienced. Twenty subjects with good eyesight (20:25 vision or better) watched two optokinetic stimuli on a virtual reality head-mounted display: (i) moving black and white stripes and (ii) moving black and white stripes artificially blurred to simulate poor visual acuity (the edges of the stripes were not sharply defined). During 30 min exposures, symptoms of motion sickness and experience of vection (the illusion of motion) were recorded every minute. There was a trend towards more sickness in the blurred condition ($p < 0{\cdot}10$) and there were significantly more symptoms that are associated with motion sickness in the blurred condition ($p < 0{\cdot}05$). The visual

acuity of the subjects was again significantly associated with motion sickness ($p < 0{\cdot}05$). The association was seen in both conditions. The results indicate that the blurring of the stripes increased sickness and that the effect of visual acuity also occurs among subjects with good visual acuity.
Topics: Motion sickness; visual stimuli.

Y. Matsumoto. An investigation of linear lumped parameter models with rotational degrees of freedom to represent the dynamic response of the human body. (15 pages, 5 figures, 5 tables, 23 references) (in English)
Author's Abstract. Lumped parameter models of the dynamic response of the seated human body to vertical whole-body vibration at frequencies below 20 Hz have been investigated. Rotational degrees of freedom have been included in the models such that the body motions in the fore-and-aft and pitch axes observed in previous experimental data could be modelled. Any rotational displacements were assumed to be small: the non-linearity caused by the geometry of a model was neglected. Any fore-and-aft degrees of freedom were not included. Several models with a maximum of four degrees of freedom have been developed by comparing the apparent mass and the transmissibilities calculated from the models with those obtained in an experiment conducted previously. Rotational degrees of freedom in the model appeared to improve the representation of the dynamic responses of the body, especially for the transmissibilities. It is likely that the principal resonance of the apparent mass at about 5 Hz is attributed to a vertical motion of the pelvis and legs and a pitch motion of the pelvis, both of which cause a vertical motion of the upper-body, and a vertical motion of the viscera. Models of the upper-body could be extended to a series of rotational masses for further investigation.
Topics: Biodynamics (transmissibility, apparent mass).

Other papers presented at the meeting were as follows.
V. A. Coveney, D. E. Johnson, G. Hunter, H. T. Williams and J. Lanchbery. Factors affecting the transmission of vibration from hand-held tools to the operator.
D. Wells. Identification of potential sources of HAV exposure in foundries.
T. Ward and S. B. Ahmed. Reduction in vibration exposure from pneumatic sand rammers by engineering solution.
A. Piette, N. Cock and J. Malchaire. Vibration perception thresholds, vibration exposure and workload.
A. Stevenson and P. Corbishley. The use of temporary threshold shifts in vibration perception (TTS_v) as a model to assess the effectiveness of anti-vibration gloves.
M. Morioka. Difference thresholds for intensity perception of hand-transmitted vibration.
P. M. Pitts. D-I-Y hand-transmitted vibration measurement—an introduction to ISO CD 5349-2.
K. Hill. The management of exposure to hand/arm vibration within Glasgow City Council.

M. R. Peckham. A mathematical model of the neck–head–helmet system.
N. J. Mansfield, R. Lundström and P. Holmlund. Progress in the development of a WBV and HAV database on the internet.
S. R. Holmes. Heart rate and motion sickness incidence during exposure to nauseogenic optokinetic stimulation.
P. Bröde and B. Griefahn. Combined effects of whole-body vibrations and low ambient temperatures on a manual control task.
D.-S. Gong. Stepping response in a standing posture caused by horizontal floor vibration.
J. Sandover. Predicting the health risk from occupational exposure to whole-body vibration.
F. Guillon and A. El-Khatib. Recognition of the lumbar degenerative lesions due to occupational whole-body vibration (WBV) in France.
A. El-Khatib and F. Guillon. Vertical seat fore-and-aft vibration transmission through the lumbar spine of the seated subject.
P. Mistrot, P. Boulanger and P. Donati. From the laboratory to the practice: suspension platform for road finishers.
A. M. Darby and P.M. Pitts. The use of an artificial test track in the measurement of vibration emission from all terrain vehicles.
G. S. Paddan. Seat effective amplitude transmissibility (SEAT) values in work vehicles.
D. Boast, N. Callaghan and M. Marfell. Design and optimisation of cab and seat suspension units for vehicles in high vibration dose environments.
J. A. Lines and R. M. Stayner. Suspended seat end-stops: a review of available information.
N. J. Mansfield and R. Lundström. Variability in the apparent mass of the seated person to horizontal vibration.
L. Wei and M. J. Griffin. The influence of seat cushion inclination on subject apparent mass and seat transmissibility.
T. Gunston. The development of a suspension seat dynamic model.
C. H. Lewis. The implementation of an improved anthropodynamic dummy for testing the vibration isolation of vehicle seats.
J. C. Howard and R. M. Stayner. Dynamic dummies for seating: what the industry wants in a standard.
K. Ebe. Models of overall seat discomfort.
R. Bosworth, and M. Davis. Land Rover's Freelander first class ride comfort.
W. J. Pielemeier, J. A. Greenberg, V. Jeyabalan and R. C. Meier. Multi-axis seat vibration transmissibility for 3 vehicles.

Copies of the proceedings of the 1998 U K Group on Human Response to Vibration may be obtained from: Ms V. A. McLelland, Health and Safety Executive, DST E4, Technology Division, Room 405, Magdalen House, Trinity Road, Bootle, Merseyside L20 3QZ, England.

NOTE: copies of all papers in this section will be found in the Human Response to Vibration Literature Collection at the Institute of Sound and Vibration

Research, University of Southampton. The papers may be used by persons visiting the Institute.

*Contributions to the Literature Collection are invited. They should be sent to Professor M. J. Griffin, Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton, Southampton, SO*17 1*BJ, England.*