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HUMAN RESPONSE TO VIBRATION

ABSTRACTS

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This selection of abstracts is taken from the Proceedings of the 2000 conference of the United Kingdom Group on Human Response to Vibration. The conference was held at the Institute of Sound and Vibration Research, University of Southampton, from 13 to 15 September.

M. K. Kubo, F. Terauchi, H. Aoki, M. Isobe and K. Okubo. Riding comfort affected by the properties of flexible polyurethane foam. (10 pages, 8 figures, 6 tables, 6 references) (in English).
Authors' Abstract. The relationship between riding comfort and the properties of flexible polyurethane foams used in car seats, which were vertically shaken by vibrator. Riding comfort as estimated according to the semantic differential method using questionnaire, and was analyzed with a factor analysis that demonstrated the principal factors of riding comfort. At the same time, riding comfort was related to the properties of the flexible polyurethane foams with coefficients of correlation. It was also related to the behaviour of the vibration of humans sitting in the seats. As a result, it was demonstrated that the relationship between riding comfort and the flexible polyurethane foam properties varies according to the frequency of the vibration shaking the human sitting in the seat. And it was demonstrated that the frequency dependence of the relationship is strongly affected by the physical changes of the vibration modes of the human–seat vibration system.
Topics: Seating dynamics, Subjective assessment.

D. Smeatham. Assessment of vibration from hand-held grinders: the need for a test code based on real operation. (12 pages, 5 figures, 6 tables, 10 references) (in English).
Author's Abstract. The Supply of Machinery (Safety) Regulations puts a duty on the manufactures to quote the "weighted root-mean-square acceleration value to which the arms are subjected … as determined by the appropriate test code". The test code for grinders (BS EN ISO 8662-4: 1995) adopts an artificial approach to achieve repeatable results with the consequence that the results are not always indicative of those found when using the grinder under real operational conditions. HSL have carried out an assessment of BS EN ISO 8662-4: 1995 to establish the correlation between the data provided by the standard test method and that which is measured in industry. In addition, a test method based on real operation of grinding machines has been developed in order to assess the effectiveness of anti-vibration mechanisms to grinders. The paper concludes that BS EN ISO 8662-4 1995 does not always give an indication of the risk associated with the use of a tool and the data obtained using this method cannot be reliably used to identify tools with low vibration magnitudes. A test method, based on real grinding, has been developed and found to be repeatable enough to evaluate the performance of the vibration reducing techniques applied to the tools tested. There are design techniques which significantly

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reduce the vibration from grinding tools; work is needed to identify improvements to the current standard to make it more representative of the vibration from grinders in real use whilst maintaining a high level of repeatability and reproducibility.
Topics: Vibration measurements (hand-held tools).

N. M. Alem, K. W. Barazanji, B. J. McEntire and J. S. Crowley. Effects of head-supported devices on female aviators during exposure to sinusoidal whole-body vibration. (17 pages, 8 figures, 2 tables, 17 references) (in English).
Authors' Abstract. This paper reports a recent study to define a safe range of helmet weights and locations that may be tolerated by female helicopter pilots without affecting their health or degrading their performance. Twelve military female subjects were exposed to simulated whole-body vibration (WBV) helicopter environment while wearing simulated head-supported devices (HSD) with various mass properties.

During exposure, biomechanical, cognitive and physiological responses of the female subjects were recorded. This paper presents biomechanical response data that includes head pitch, anterior–posterior, and axial acceleration that was measured during sinusoidal vertical WBV exposure. Study results indicate that head pitch acceleration is the most sensitive biomechanical parameter to HSD weight moment. Furthermore, head pitch and axial acceleration levels for female subjects were lower than those for their male counterparts observed in previous studies. This information was used to tentatively define acceptable ranges, HSD weights and centre of mass locations.
Topics: Biodynamics (transmissibility); subject type (gender).

J. R. R. Stott, S. R. Holmes, S. King and S. Clemes. A comparison of motion-induced nausea from exposure to linear and curvilinear low-frequency lateral oscillation. (7 pages, 1 figure, 2 tables, 0 references) (in English)
Authors' Abstract. The ability to provoke motion-induced nausea has been compared between two related motion stimuli that might be expected to provoke the same degree of sensory conflict: lateral motion on a swing oscillating at its natural frequency of 0.285 Hz and lateral horizontal linear motion at the same frequency and equivalent amplitude. The study also compared the nauseogenicity of vertical oscillation at the same frequency (0.57 Hz) and intensity as the changing radial acceleration experienced on the swing, and roll oscillation equivalent to the angular excursion of the swing. Swing motion was found to be more nauseogenic than the equivalent horizontal oscillatory motion ($p < 0.05$). Both the types of motion were more nauseogenic than vertical or roll oscillation. Reasons for these differences are discussed. A more definitive study may be needed before conclusions can be drawn about the relative nauseogenicity of the forms of transport that correspond to these laboratory stimuli.
Topics: Motion sickness.

H. V. C. Howarth, M. J. Griffin. Effect of foreground visual information on motion sickness caused by lateral oscillation. (10 pages, 2 figures, 4 tables, 10 references) (in English)
Authors' Abstract. Motion sickness caused by lateral oscillation with an internal view and with distant views (with and without foreground) were compared in a laboratory experiment. A total of 60 male subjects (aged 18–26 years) were exposed to 30 min of 0.25 Hz lateral oscillation at an acceleration of 0.7 ms^{-2} r.m.s. (a displacement of $\pm$ 0.4 m). Prior to experiencing the motion, all subjects completed a motion sickness history questionnaire providing information on travel history and motion sickness experience. Subjects had one of the three visual fields: (i) an internal view (moving with the subjects), (ii) a distant stationary external view with no visual foreground, and (iii) a distant stationary

external view with visual foreground. Subjects employed a 7-point scale to provide ratings of motion sickness at 1-min intervals during the 30-min exposure. Self-rating of motion sickness susceptibility provided by the subjects prior to the experiment were positively correlated with their illness ratings during the experiment. There was significantly less sickness with a distant view having foreground information that with an internal view or a distant view presented without foreground. The results suggest that sickness may be reduced by providing passengers with a view containing both distant and foreground information, and that solely a distant view of the road ahead may not be sufficient.
Topics: Motion sickness.

J. Förstberg. Regression models for motion sickness provocation by the combined effects from lateral (horizontal) acceleration and roll motion in tilting trains and simulator experiments. (11 pages, 6 figures, 2 tables, 19 references) (in English)
Author's Abstract. Modelling and prediction of nausea from vertical and horizontal accelerations have been investigated and developed by the combined efforts of Lawther, Griffin and Golding (Golding, Finch & Stott, 1997; Golding, Müller & Gresty, 1999; Griffin, 1990; Lawther & Griffin, 1987). Combinations of roll and vertical accelerations have been reported with both minor influence and strong influence of roll motion on nausea (McCauley, Royal & Wylie, 1976; Wertheim, Bos & Bles, 1998). For tilting trains, where the tilt motion is used for reducing the lateral acceleration perceived by the passengers, this may be a special case because of the strong connection between low-frequency roll, lateral and vertical accelerations. Tests were conducted with three conditions in a tilting train (Förstberg, 1996; Förstberg, Andersson & Ledin, 1998a; Förstberg, Andersson & Ledin, 1998b) and test with altogether ten combinations of horizontal and roll motions in a moving base simulator. Test subjects, mostly students, rated their nausea according to a 5-point scale together with comfort, ability to work and read, etc. (Förstberg, 1999; Förstberg, Andersson & Ledin, 1999). In the train experiments, the motion doses from roll accelerations were found to be most correlated with the experience of illness. In the simulator experiments, the vertical acceleration was most correlated with nausea ratings but the horizontal (lateral) acceleration together with roll acceleration were significantly better explaining variables. Besides motion quantities, the most correlated variable was the subject's self-rated sensitivity for motion sickness (Förstberg, 2000). Good regression models have been found with horizontal and roll acceleration on nausea ratings in the simulator. However, roll and horizontal acceleration are quite closely correlated in tilting trains. Optimizing tilt motion must take into account both the risk of nausea, and also the risk of comfort disturbances caused by large perceived lateral accelerations, as well as the distribution of curves along the route of travel.
Topics: Motion sickness.

P.-É. Boileau, S. Rakheja and J. Boutin. Characterization of the vibration environment of urban buses. (12 pages, 5 figures, 3 tables, 10 references) (in English)
Authors' Abstract. The vibration environment of specific models of urban buses at or near the driver seat attachment point is defined in the 0.5–40 Hz frequency range based upon field-measured data involving some forty combinations of vehicles and bus routes. The vibration characteristics are defined for the vibrational modes involving longitudinal (x-axis), lateral (y-axis) and vertical (z-axis) motions, and angular motions along the roll and pitch axes. The vibration environment is represented by a function which approximates the amplitudes of the mean power spectral density (PSD) of measured acceleration in the 0.5–40 Hz frequency range for the various vibrational modes. A spectral class defining more severe vibration conditions approximating the upper bound spectra formed by the

maximum PSD amplitude values is further proposed to be considered as input in laboratory seat performance testing. For both mean and severe vibration conditions, the frequency-weighted r.m.s. accelerations associated with the various modes of vibration characterizing the spectral class are also provided based upon the integration of the derived acceleration PSD functions. The determination of crest factors associated with the measured data is also realized on the basis of the probability distribution function of instantaneous frequency-weighted acceleration values evaluated for all the segments of acceleration time signals of 30 s duration retained to characterize the vibration.
Topics: Vibration measurements (buses); vehicle ride.

K. Kato. The effect of vibration and audible sound on discomfort caused by infra- and low-frequency sound in car. (6 pages, 3 figures, 2 tables, 5 references) (in English)
Author's Abstract. Laboratory simulations of the noise and vibration in car have been used to investigate the relation between infra- and low-frequency sound and audible sound or vibration. The levels of infra sound (below 20 Hz), low-frequency sound (20–100 Hz), high-frequency sound (above 100 Hz) and vibration (1–100 Hz) were modified individually. Subjects sat on a car seat attached on the vibration table, and were exposed to the stimuli and assessed the discomfort caused by infra- and low-frequency sound. The results showed that the increase of the level of high-frequency sound or vibration decreased the discomfort caused by infra- and low-frequency sound.
Topics: vehicle ride; combined stress (noise and vibration).

Other papers presented were

J. L. W. Niekerk, W. J. Pielemeier and J. A. Greenberg. The correlation between SEAT values estimated from averaged transmissibility data and subjective ratings for evaluating the dynamic comfort of 16 automobile seats.

L. Wei and M. J. Griffin. Effect of subject weight on predictions of seat cushion transmissibility.

M. G. R. Toward. Use of an anthropodynamic dummy to measure seat dynamics.

M. Yoshimura, S. Lakser, S. Shirono, M. Iwamoto and N. Harada. Finger skin temperature during cold-stress tests involving water at 10°C for 10 min and at 15°C for 3 min for diagnosing of hand–arm vibration syndrome.

N. Mansfield and J. Marshall. Symptoms of WBV/HAV injury amongst stage rally drivers and co-drivers.

D. D. Reynolds. Assessment of the vibration exposure of engine assembly line workers.

L. Burström and S. H. Bylund. The influence of vibration-free periods on the absorption of power.

M. W. Dobry. Advanced analysis of human–machine systems in energy flow domain.

J. G. Markle and D. D. Reynolds. A test fixture for measuring the impact forces and vibration of impact-type tools.

C. Nelson. The role of the EU Machinery Directive in the control of risk from whole-body vibration.

D. Allsop, J. Smith, R. Stayner and J. Trafford. Handle vibration of grass-cutting machines (strimmers). Can a simple standard test indicate exposure of operators to hand-transmitted vibration?

B. Harazin. A new draft of the occupational limits for hand–arm vibration in Poland.

P. F. Brereton. Reducing hand–arm vibration risk through the design, supply and selection of equipment.

S. D. Smith, J. A. Smith and R. J. Newman. Helmet system performance in vibration environments.

T. Ji. On the combination of structural dynamics and biodynamics methods in the study of human–structure interaction.
D. S. Gong. Investigation of time delay and time advance properties of induced postural responses.
T. P. Gunston. An investigation of suspension seat damping using a theoretical model.
J. Rebelle. Development of a numerical model of seat suspension to optimise the end-stop buffers.
M. A. Ksiazek. Sensitivity of optimal vibration isolation system to the non-linearities of human body.
C. H. Lewis. Evaluating the vibration isolation of soft seats using an active anthropodynamic dummy.
B. Lobb. The performance of a motion simulator capable of combined horizontal motion of 10 m and 8° of roll motion.
G. Birlik and O. C. Sezgin. Railway passengers complain about the increase in their musculoskeletal pains during voyage.
G. S. Paddan. Effect of measurement period on the analysis of whole-body vibration.
M. Goulain. Estimation of new control laws on aircraft with existing standards.
M. Bellmann, V. Mellert, H. Remmers and R. Weber. Experiments on the perception of whole-body vibration.
S. Maeda and Y. Yonekawa. A pilot study of vibration perception thresholds induced by spectral vibration on recumbent subjects.
Y. Yonekawa and S. Maeda. Effect of spatial summation of vibration sensation on perception threshold.
J. E. Piercy and A. J. Brammer. Mean vibrotactile perception thresholds at the fingertips of healthy males.

Copies of the proceedings of the Conference may be purchased from the Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton.

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.*