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HUMAN RESPONSE TO VIBRATION

ABSTRACTS

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G. J. Stein 2000 *Proceedings of the Institution of Mechanical Engineers* **214**, Part D, 533–544. New results on an electropneumatic active seat suspension system. (12 pages, 9 figures, 1 table, 29 references) (in English)

Authors' Abstract. A vibration control system with an air spring as the actuator and proportional electropneumatic control has been developed at the Institute of Material and Machine Mechanics, Bratislava. As the electropneumatic transducer, a proportional pressure control valve is used in contrast to the previously used proportional flow control valve. The vibration control is facilitated by a combination of a "sky hook" feedback loop and a feedforward loop working on the so-called "sky cloud" principle, compensating base vertical vibration. Good agreement between simulation results and measurement on a laboratory dummy system was observed. The dummy system was also subjected to narrow-band random excitation, prescribed for standardized laboratory tests of driver's seats. The improvement in driver's seat vibration control properties owing to the feedforward vibration compensation is 2·5-fold, i.e. by 8 dB in comparison with "sky hook" feedback damping only. The system could be used for vibration control in automotive applications, especially for vehicles with an unsprung chassis (earth-moving machines, wheeled tractors) and in the heavy vehicles sector.

Topics: Seating (suspension seats).

X. Wu, S. Rakheja and P-É Boileau 1999 *Society of Automotive Engineers, SAE Paper*. 1999-01-1303, 137-146. Study of human–seat interactions for dynamic seating comfort analysis. (10 pages, 11 figures, 1 table, 9 references) (in English)

Authors' Abstract. Human–seat interactions are investigated through measurement and analysis of distribution of interface contact force and area under vibration. The time histories of dynamic ischium pressure, effective contact area and contact force on a soft seat revealed significant asymmetry, under large magnitude vibration excitations occurring near the resonant frequency of the human–seat system. The asymmetric response characteristics of the cushion are mostly attributed to the non-linear force-deflection properties of polyurethane foam materials, contour shape of human buttocks, body-hop motion and cushion bottoming tendencies. The results are utilized to propose a non-linear and asymmetric seat cushion model incorporating body-hop motion and cushion bottoming under vertical vibration. A combined human–seat model is derived upon integrating the proposed cushion model with a biodynamic model of the seated occupant. The proposed analytical model is validated under both low- and high-magnitude excitations using laboratory measured data. A parametric study is performed to study the influence of various design parameters on the comfort and body-hop characteristics of the seat. The results show that cushions with high linear stiffness, damping coefficients and large static deflection may induce less vibration transmission under large magnitude excitations. The

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vibration transmission under such conditions can further be reduced by designing the seat with a flexible seat pan.
Topics: Seating (general).

S. Schwarze, G. Notbohm, E. Hartung and H. Dupuis 1999 *Ergo-Med* **23**, 236–242. Ganzkörper-Schwingungen als Schädigungsfaktor für die Lendenwirbelsäule—Ergebnisse der epidemiologichen Studie "Ganzkörpervibration". Whole-body vibrations as damping factor of the lumbar spine—results of an epidemiologic study of whole-body. (8 pages, 3 figures, 1 table, 32 references) (in German)
English Abstract. In a follow-up study, granted by the Central Federation of the Industrial Professional Associations (HVBG), the dose–response relationships between long-term occupational exposure to whole-body vibration and degenerative processes in the lumbar spine caused by the lumbar disks were examined. In addition, the practicability of a preventive medical examination should be tested. In the first part of the study (1990–1992) 388 drivers exposed to vibration (fork-lift, trucks, earth-moving machinery) and 65 non-exposed subjects were examined medically and by lumbar X-ray. For each individual, a history of all exposure conditions were recorded, and a cumulative vibration dose was calculated allowing comparisons between groups of low, medium, and high intensity of exposure. Two hundred and eighty-one subjects were reexamined in a follow-up 4 years later, following the same pattern of data assessments as in the first part. The best fit between the occupational vibration dose and the occurrence of a lumbar syndrome was obtained applying a limit for the daily reference exposure of $a_{zw(8\,\mathrm{h})} = 0{\cdot}6\ \mathrm{m/s^2}$. With increasing vibration dose there was an age-adjusted increase of the prevalence rate ratio (PVR_{MH}) as compared to the reference group. For the group with medium exposure PVR_{MH} is 1·49 [$Cl_{95\%} = 1{\cdot}13/1{\cdot}96$]. In the highly exposed group, PVR_{MH} amounts to 1·55 [$Cl_{95\%} = 1{\cdot}24/1{\cdot}95$]. In the follow-up the cumulative incidence rate of new cases of lumbar syndrome yields a higher relative risk for the high-exposure group: $RR_{MH} = 1{\cdot}37$ [$Cl_{95\%} = 0{\cdot}86/2{\cdot}17$]. It is recommended that a limit value for daily reference exposure of $a_{zw(8\,\mathrm{h})} = 0{\cdot}6\ \mathrm{m/s^2}$ as a threshold for hazard to health should be included in the existing regulations and that the calculation of the cumulative vibration dose should be used as an indicator of risk. Important conclusions could be drawn for medical prevention for workers exposed to vibration. The preliminary evaluation criteria for lumbar disorders and possible consequences for the job have to be reviewed because of the very changeable disease process and the restricted meaningfulness of routine diagnostics.
Topics: Physiological effects (skeletal); Criteria and Limits.

H. Seidel and M. J. Griffin 2001 *Clinical Biomechanics* **16**, Supplement No. 1, S3–S7. Modelling the response of the spinal system to whole-body vibration and repeated shock. (5 pages, 0 figures, 0 tables, 63 references) (in English)
Authors' Abstract. Back problems are very common and contribute to discomfort and days off work. Some back disorders are attributed to inappropriate loading of the spine that can be combined with other influential factors such a body posture, whole-body vibration and shock. Many models have been developed to predict the forces in the spine associated with vibration and shock. However, the problem is complex due to the incompletely understood dynamic responses of the body, the influence of many variables and the effect of muscle force. This paper summarizes the current state of knowledge relevant to the prediction of forces in the spine with whole-body vibration and shock. The paper also introduces presentations at a workshop on the modelling of spinal loads associated with vibration and shock held in Berlin in October 1999.
Topics: Physiological effects (skeletal).

J. M. Wakeling and B. M. Nigg 2001 *Journal of Biomechanics* **34**, 539–543. Soft-tissue vibrations in the quadriceps measured with skin mounted transducers. (5 pages, 2 figures, 1 table, 12 references) (in English)
Authors' Abstract. The purpose of this study was to develop a method to characterize the frequency and damping of vibrations in the soft tissues of the leg. Vibrations were measured from a surface-mounted accelerometer attached to the skin overlying the quadriceps muscles. The free vibrations in this soft tissue were recorded after impact whilst the muscle was performing isometric contractions at 0, 50, and 100% maximum voluntary force and with the knee held at 20, 40, and 60° angles of flexion. The acceleration signals indicated that the soft tissue oscillated as under-damped vibrations. The frequency and damping coefficients for these vibrations were estimated from a model of sinusoidal oscillations with an exponential decay. This technique resolved the vibration coefficients of 2 and 7% of the mean values for frequency and damping respectively.
Topics: Biodynamics (resonance); Vibration measurement (general).

J. F. Golding, A. G. Mueller and M. A. Gresty 2001 *Aviation, Space, and Environmental Medicine* **72**, 188–192. A motion sickness maximum around the 0·2 Hz frequency range of horizontal translational oscillation. (5 pages, 2 figures, 2 tables, 25 references) (in English)
Authors' Abstract. Background—Low-frequency translational oscillation can provoke motion sickness in land vehicles, ships and aircraft. Although controlled motion experiments indicate a progressive increase in nauseogenicity as frequency decreases toward 0·2 Hz, few data are available on the existence of a definite maximum nauseogenic potential of motion around 0·2 Hz, or decreased nauseogenicity below this frequency. Hypothesis—Nauseogenicity should be maximal around 0·2 Hz. Methods—We selected 12 subjects for high motion sickness susceptibility and they were exposed to horizontal sinusoidal motion (1·0 m/s^2 peak acceleration) at three different frequencies (0·1, 0·2 and 0·4 Hz), at 1-week intervals at the same time of day, according to a factorial design. Subjects were seated comfortably in the upright position with head erect. Fore-aft motion was through the body and head x-axis. Motion was stopped (motion endpoint) at moderate nausea or after 30 min. Results—The proportion of subjects experiencing moderate nausea was maximal at the intermediate frequency: 8/12 at 0·1 Hz, 12/12 at 0·2 Hz, 7/12 at 0·4 Hz. The mean time to motion endpoint was significantly ($p < 0·01$) shorter at the intermediate frequency: 18·0 min at 1·0 Hz; 11·2 min at 0·2 Hz; 20·2 min at 0·4 Hz. Similar frequency patterns emerged for other sickness ratings. The equivalent times to achieve moderate nausea using estimated values to correct for subjects who reached the 30 min time cut-off were 22·7 min at 0·1 Hz, 11·2 min at 0·2 Hz; 28·1 min at 0·4 Hz. Conclusions—A maximum nauseogenic potential around 0·2 Hz was substantiated.
Topics: Motion sickness (causes of); Non-vertical oscillation (horizontal).

T. Dobie, D. McBride, T. Dobie and J. May 2001 *Aviation, Space, and Environmental Medicine* **72**, 13–30. The effects of age and sex on susceptibility to motion sickness. (8 pages, 8 figures, 2 tables, 19 references) (in English)
Authors' Abstract. Background—The present investigation is concerned with the role of sex, age and experience in determining motion sickness susceptibility. Hypothesis—Motion sickness susceptibility varies with sex and age, and may be related to the level of physical activity sustained by the individual. Methods—Three surveys were conducted. The first included school-age children (9–18 yr) and addressed motion experience and motion sickness on 13 forms of transport. The second questionnaire sought to determine whether these sex differences could be understood in terms of differential involvement in various forms of physical activity. The third survey addressed the role of age and sex effects in

a college age population. Results—The first study revealed significantly greater motion sickness for female as compared with male subjects on devices with which both groups were equivalent in terms of exposure history. The second study showed little relation between an individual's level of physical activity and susceptibility to motion sickness. The results of the third study were in essential agreement with the first survey and revealed no significant interactions between age and sex, suggesting that sex differences remain stable across this age range. Conclusions—Our conclusions regarding these surveys are that sex differences in motion sickness do not vary significantly with age and cannot be accounted for by differences in exposure to motion or physical activity. There was also little evidence for the notion that men are more reticent to report motion sickness.
Topics: Motion sickness; Subject type (age, gender).

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*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.*