Foot-Transmitted Vibration: Automotive Accelerator Pedal-Pad Vibration on Tarmac and Paved Road

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Abstract

Vibration at the pedal-pad may contribute to the discomfort of the foot plantar fascia during driving. In this study, the experiment is conducted using a "five-time repeatability" test of the same procedure and shall determine root-mean-square vibration magnitude and vibration transmissibility on Z-axis or vertical vibration magnitude for the three different sizes of pedal-pad on tarmac and paved surface. ISO 2631-1:1997 is used for frequency-weighting (Wk) in one-third octave step with a range of frequency 0.5 Hz to 80 Hz in vertical vibration. The analysis is divided into two; frequency-weighted acceleration and frequency-weighted root-mean-square acceleration on vibration magnitude; and vibration transmissibility. The result shows that small pedal-pads at a resonance frequency of 4 Hz and 10 Hz give high value on frequency-weighted acceleration compared to medium and large sized pedal-pads. The frequency-weighted RMS acceleration on the tarmac and paved road surfaces show that small pedal-pad also give high value compared to medium and large sized pedal-pads. The International Roughness Index shows that paved road surfaces affect frequency-weighted RMS acceleration differently, which is higher compared with tarmac. The vibration transmissibility result shows that the percentage pedal-pad effective amplitude transmissibility value on paved road surfaces is more than 100% compared with the tarmac road surface on three sizes of pedal-pads. A comparison of frequency-weighted RMS acceleration of pedal-pads and car bodies for three different sizes of the pedal-pad also show that the paved road surface contributes more vibration to pedal-pads compared with the tarmac road surface. It can, therefore, be concluded that the size of the pedal-pads and the type of road surface can influence foot-transmitted vibration.

Keywords: Pedal-pad, road surface (tarmac and paved), foot-transmitted vibration, frequency-weighted acceleration, frequency-weighted root-mean-square

REFERENCES

British Standard Institution (1987). BS 6841, Measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock. London: BS Copyright Office.

Daruis, D.D.I., Nor, M.J.M., Deros, B.M., Hosseini Fouladi, M., & Saifuddin, M. (2010). *Vibration transmissibility of various occupants' body parts – a field test*. Paper presented at the 3rd Regional Conference on Advances in Noise, Vibration and Comfort, Putrajaya, Malaysia.

Douville, H., Masson, P., & Berry, A. (2006). On-resonance transmissibility methodology for quantifying the structure-borne road noise of an automotive suspension assembly. *Applied Acoustics*, *67*(4), 358-382.

Duncan, A.E., Su, F.C., & Wolf, W.I. (1996). *Understanding NVH basic*. Paper presented at the International Body Design Engineering Conference, Society of Automotive Engineers, Detroit, Michigan.

Griffin, M.J. (1990). *Handbook of human vibration*. London: Elsevier Academic Press.

Griffin, M.J. (1998). A comparison of standardized methods for predicting the hazards of whole-body vibration and repeated shocks. *Journal of Sound and Vibration*, *215*(4), 883-914.

Hosseini Fouladi, M., Mohd. Nor, M.J., Inayatullah, O., & Kamal Ariffin, A. (2011). Evaluation of seat vibration sources in driving condition using spectral analysis. *Journal of Engineering Science and Technology*, *6*(3), 339-356.

Hostens, I., & Ramon, H. (2003). Descriptive analysis of combine cabin vibrations and their effect on the human body. *Journal of Sound and Vibration*, *266*(3), 453-464.

International Organization for Standardization (1997). ISO 2631, Mechanical vibration and shock - evaluation of human exposure to whole-body vibration. Switzerland: ISO Copyright Office.

Morioka, M., & Griffin, M.J. (2010). Magnitude-ependence of equivalent comfort contours for fore-and-aft, lateral, and vertical vibration at the foot for seated persons. *Journal of Sound and Vibration*, *329*(14), 2939-2952.

Nahvi, H., Hosseini Fouladi, M., & Nor, M.J.M. (2009). Evaluation of whole-body vibration and ride comfort in a passenger car. *International Journal of Acoustics and Vibration, 14*(3), 143-149.

Niekerk, J.L.V., Pielemeier, W.J., & Greenberg, J.A. (2003). The use of Seat Effective Amplitude Transmissibility (SEAT) values to predict dynamic seat comfort. *Journal of Sound and Vibration*, *260*(5), 867-888.

Nishiyama, S., Uesugi, N., Takeshima, T., Kano, Y., & Togii, H. (2000). Research on vibration characteristics between human body and seat, steering wheel, and pedals (effects of seat position on ride comfort). *Journal of Sound and Vibration*, *236*(1), 1-21.

Parsons, K.C, Griffin, M.J., & Whitham, E.M. (1982). Vibration and comfort. III. Translational vibration of the feet and back. *Ergonomic*, *25*(8), 705-719.

Yu, Y., Naganathan, N.G., & Dukkipati, R.V. (2001). A literature review of automotive vehicle engine mounting systems. *Mechanism and Machine Theory*, *36*(1), 123-142.