THE EFFECT OF EXPOSURE DURATION ON WHOLE-BODY VIBRATION COMFORT

Priscila A. de Araújo, Maria Lúcia M. Duarte*, Frederico C. Horta, Lucas A. Penna de Carvalho, Guilherme G. Roca Arenales
PPGMEC/UFMG: Post-Graduation Program in Mech. Engineering, Universidade Federal de Minas Gerais; GRAVI$_{HB}$: Group of Acoustics and Vibration in Human Beings, BRAZIL
mlduarte@dedalus.lcc.ufmg.br

Introduction

The effects of whole-body vibration (WBV) are related to both objective factors, such as amplitude, frequency and duration of excitation, as well as subjective factors, such as the kind of function performed by the individual, expectation, vibration perception and sense of discomfort.[1]

The ISO 2631-1 (1997) standard states that two exposures become equivalent when they have the same vibration energy[2]. Therefore, it is expected that the level of comfort should be the same in both situations. The aim of this work is to investigate such hypothesis, that is, if the exposure duration is an important factor in WBV discomfort levels evaluation. The analysis of such parameter (as all as the previous knowledge of the vibration stimulus) is essential for interpreting comfort evaluations due to WBV in human being studies[3]. Several evaluations have been performed by the GRAVI$_{HB}$ researchers in order to understand such interaction[4, 5].

Methods

Fifty male volunteers took part in this experiment. The volunteers sat on a wooden chair with backrest, without cushioning, coupled to a vibrating platform. Each volunteer was exposed to a 5 Hz sinusoidal whole-body vibration in the z-axis (vertical). Weighted RMS acceleration (m/s^2) was measured by a tri-axial accelerometer aimed to measure human responses. This acceleration amplitude sent by the signal generator to the shaker was then maintained for a certain period of time until the desired estimated vibration dose value (eVDV) for each test performed is achieved. Two RMS values (1.56 and 2.34 m/s^2) were established[4,5].

Five groups of 10 individuals were randomly formed, varying exposure duration (t), weigthed accelation (a_w) and eVDV (Table 1). Immediately after vibration exposure, the individuals rated their sense of discomfort during the vibratory stimulus.

The Mann-Whitney test was used to verify the differences between groups, which were analyzed in pairs. Box plot graphics were built for visual analysis of data dispersion around the medians of the groups. The confidence level used was $\alpha = 0.05$.

Results

The A, B, C, D and E groups medians were respectively 5.0, 7.0, 7.0, 6.5, and 7.0 (Figure 1). Comparisons were made between the groups, two by two. Of the ten comparisons performed, only three showed statistically significant differences when using the Mann-Whitney test (Table 2), that is, pairs 2, 3 and 4.

Figure 1 - Box plot

Table 1 - Groups (n=10 each group)

Parameters			
Group	eVDV $m/s^{1.75}$	RMS m/s^2	Time min
A	9,1	2,34	1
B	9,1	1,56	5
C	12	1,56	15
D	13,6	2,34	5
E	13,6	1,56	26

Table 2 - Comparison between groups by Mann Whitney test (n=50)

Pairs of groups		p	Pairs of groups		p
1	AxB	0,09	6	BxD	0,32
2	**AxC**	**0,01***	7	BxE	0,49
3	**AxD**	**0,03***	8	CxD	0,24
4	**AxE**	**0,03***	9	CxE	0,48
5	BxC	0,48	10	DxE	0,31

* Tests that showed statistical significance.

Discussion

Five comparisons are accordingly to the hypothesis that two exposures become equivalent when they have the same VDV, and that the discomfort sensation increases when the vibration energy increases. However, other five comparisons do not confirm these hypotheses. The claim that exposure duration, or the VDV, are influential factors by themselves could not be confirmed by this work. The most probable cause is that these factors overlap each other, exerting different influences accordingly to the other concurrent parameters, such as the weighted acceleration amplitude. In order to verify this hypothesis, new experiments should be developed, with different groups formations, so to provide a better variable control.

This work showed how complex the vibration response research is and that there is a high interaction among the factors exposure duration, acceleration amplitude and VDV for discomfort level perceived by individuals subjected to WBV.

Acknowledgment

The authors would like to thanks the financial support given to this work by FAPEMIG and CNPq.

References

1. Griffin, M. J. (1990) *Handbook of Human Vibration*. London, Academic Press.

2. ISO 2631-1 (1997) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration. *Apêndices B e C.* Genebra, International Organization for Standardization.

3. de Carvalho, L.A.P (2006). *Exposure Time and Previous Knowledge Influence in Whole-Body Vibration Tests in Human Beings* (in Portuguese), Scientific Initiation Essay, Mechanical Eng. Department. Universidade Federal de Minas Gerais, Brazil.

4. Duarte, M.L.M., Horta, F.C., Arenales, G.G.R., de Carvalho, L.A.P. (2008), *Exposure Time Influence in Whole Body Vibration Tests: Same Vibration Dose Value Investigation,* SAE Technical Paper Series, 2008-36-0534

5. de Araújo, P.A. (2010) *Exposure Time´s Influence over comfort levels due to Whole-body Vibration*, Internal Report, $GRAVI_{HB}$, Mechanical Eng, Department, Universidade Federal de Minas Gerais, Brazil