INFLUENCE OF BACK SUPPORT CONDITIONS ON THE ABSORBED POWER OF SEATED OCCUPANTS UNDER HORIZONTAL VIBRATION

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Introduction

The absorbed power (P_{Abs}) has been suggested as a better measure of human responses to whole-body vibration, since it relates to the cumulative energy dissipated by the body exposed over a given duration. Moreover, unlike the other measures, the P_{Abs} *can* adequately account for the intensity of exposure. Although, the vast majority of off-road vehicles impose considerably severe vibration along the horizontal axes, the vast majority of studies on biodynamic response characterization consider only vertical vibration. Only a few studies have reported P_{Abs} responses of the seated human body exposed to horizontal vibration and the major contributing factors [1]. This study aims to characterize the P_{Abs} responses of seated human subjects to horizontal (uncoupled *x*- and *y*-axis) vibration as functions of the vibration intensity, subject mass, seat height and the, type of back support.

Methods

Experiments were conducted using a rigid seat with an adjustable backrest inclination and seat height. The seat was installed on a horizontal vibration simulator and the forces at the seat base and the backrest were measured by three-axis force plates. Two single-axis accelerometers were installed on the seat back and the platform, oriented along the axis of motion. The experiments were performed using three different seat heights (350, 390 and 410 mm), back support conditions (NB- no back support and sitting erect; Wb0- Upper body supported against a vertical back support; and WbA- back supported against an inclined backrest, while sitting relaxed) and three different magnitudes of broad band excitations in the 0.5-10 Hz frequency range (0.25, 0.5 and 1 m/s^2 rms acceleration under x-axis and y-axis, applied independently). A total of 8 healthy adult male volunteers with total body mass ranging from 59.4 kg to 92 kg and aged between 21-51 years took part in the experiments. The subjects were seated with their hands in lap, and feet supported on the moving platform for each posture. Each measurement was repeated 2 times, while the data were analysed using a bandwidth of 50 Hz and frequency resolution of 0.0625 Hz.

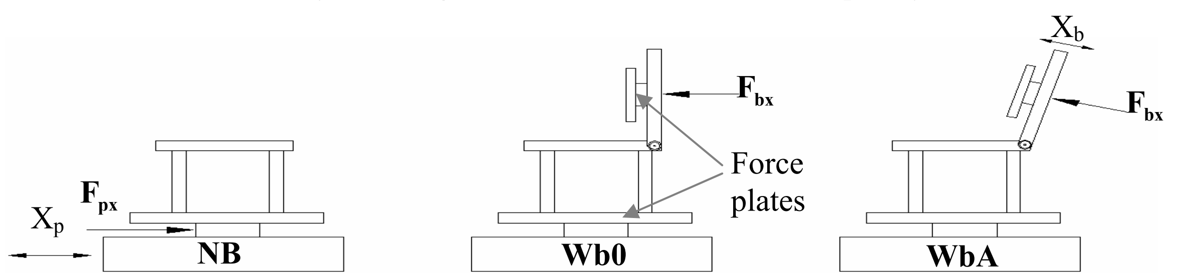

Fig 1: Back support conditions used in the study.

The data were analyzed to derive the absorbed power characteristics of the body at both seat pan and backrest interfaces, while the coherence among the measured forces and accelerations were particularly monitored. The P_{Abs} of the seated body subjected to *x*- and *y*-axis vibration were computed in the one-third octave bands, while the total power was derived through integration of the real component of the force and velocity cross-spectrum under each test condition.

Results and Discussions

The measured absorbed power responses suggested significant inter-subject variability, irrespective of the experimental condition employed, while the total P_{Abs} showed nearly quadratic relation with the excitation magnitude. The seat-buttock interface P_{Abs} responses obtained for all the subjects seated assuming the NB posture and exposed to *x*- and *y*-axis vibration consistently revealed distinct peaks in the bands with center frequencies of 0.63 and 1.25 Hz. These frequencies are comparable with those observed from reported studies on P_{Abs} and APMS responses [1, 2]. The P_{Abs} responses revealed strong influences of the back support condition, apart from the vibration intensity under *x*-axis vibration, while the effect of seat height was observed to be small. Under y-axis vibration, the contributions due to back support were relatively small (Fig. 2).

Sitting with inclined back support (WbA) resulted in the peak P_{Abs} response in the 2.5-4 Hz bands under x-axis vibration, while the magnitude of the peak in the 0.63 Hz band diminished most significantly. The P_{Abs} derived at the backrest also revealed similar trends in magnitude and the corresponding frequency under *x*-axis vibration. The magnitude of the peak P_{Abs} measured at the back rest was around 50-60% of that measured at the seat pan, suggesting important interactions of the upper body with the backrest (Fig. 2). The WbA posture showed lower power absorption by the body when compared to that with the Wb0 posture, which can be attributed to more stable upper body posture when supported by an inclined backrest. Total P_{Abs} derived from the seat pan and the backrest measurements under *x*-axis motions showed good correlations with the body mass ($r^2 > 0.8$ and 0.7, respectively). The intermittent loss of contact of the upper body with the backrest resulted in relatively lower correlation with the body mass

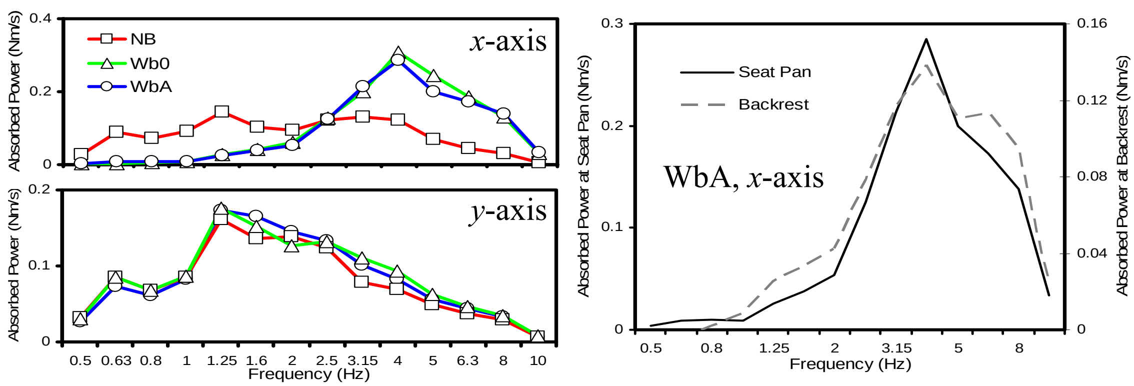

Fig. 2: Influence of back support condition on the absorbed power responses.

References

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