TRANSMISSION METER FOR VIBRATION RESEARCH

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ABSTRACT

The purpose of this Master of Science thesis was to develop a device for the measurement of the transmissibility of human whole body vibration. The study covers besides the technical design, construction and testing also an experiment, which aimed at finding the different possibilities of the use of the device.

The transmissibility of vertical vibration is measured from the seat to the head over the frequency range 1...20 Hz. Piezoelectric transducers produce a voltage proportional to the acceleration of vibration. Transducer signals are amplified after which they are converted to numerical values with a 12-bit A/D converter.

A microprocessor controls the measurement and calculates the true root mean square values of the head and seat accelerations and the ratio of these, which is the transmissibility.

The device is equipped with an ISO standard 2631 weighting filter, which can be switched off. The device can give a command to the subject to change his posture when the transmissibility decreases below a specified limit.

Measurements of transmissibility are made mainly in laboratory environment. The device can, however, operate with a 12 V battery during field studies.
1. INTRODUCTION

The effects of vibration on man has been studied in a number of research projects. In these projects it is usually assumed that the effects depend on the properties of vibration only. However, the transmissibility of vibration to different parts of the body varies greatly and the actual intensity of vibration may be significantly stronger than the vibration of the sitting or the standing platform.

The transmissibility of whole body vibration varies depending especially on the frequency and direction of the vibration and the subject's posture. Vertical vibration in the frequency range below about two hertz are transmitted with equal intensity through the body. Above two hertz occurs amplification of vibration due to the resonance effect of the thorax-abdomen system. The transmissibility of vibration from seat to head reaches its maximum at about five hertz. When the frequency increases further the transmissibility decreases and above ten hertz the intensity of vibration on the head is less than that on the seat.

The device, developed in this study, is called the transmission meter. It measures the transmissibility of vertical vibration from the seat to the head over the frequency range 1...20 Hz. The device is to be used in laboratory and field studies investigating the effects of environmental factors - including vibration - on man.
2. DESIGNING CRITERIA

The most disturbing vibration is that transmitted to head. For this reason there was a need to develop a device which would measure and display the transmissibility of whole body vibration from seat to head with a single value. This device will be used mainly in the laboratory of the University of Tampere. That's why the technical specifications are based on that exposure system. The maximum acceleration should be $10 \text{ m/s}^2$ and the upper corner frequency $20 \text{ Hz}$.

It was desired that the transmission meter would give a command to the subject to change his posture if the transmissibility decreases below a specified limit. This limit can be changed by the user. The purpose of this control command was to stabilize the head acceleration inspite of individual differences and posture changes. Besides the transmissibility the device ought to display the root mean square values of the head and seat acceleration. Also there ought to be a possibility for adding other measures describing the intensity of vibration.

The transmission meter is operated by a microprocessor because then it can be easily modified. Microprocessor also made possible several accurate counters and timers. Finally the device ought to be capable to be used in field studies. For that purpose it should also be battery operated.
The transducers must be fastened tight to the measurement point and the axel of maximum sensitivity must be parallel to the direction of vibration. The sitting platform of the exposure system in the University of Tampere has no elastical materials and thus has no effect on the transmissibility of vibration. The seat transducer is fastened to the seat with a screw or with a magnet.

The fastening of the head transducer is shown in figure 2. The transducer is attached to a plastic plate. This plate is set on the subject's head and tied with rubber bands. Then the fastening is tight inspite of the individual differences in head size and shape.

Figure 2. The fastening of the head transducer.
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