EXAMINATION OF THE ADAPTOR APPROACH FOR THE MEASUREMENT OF HAND-TRANSMITTED VIBRATION EXPOSURE

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1. INTRODUCTION

According to the current ISO 5349-2 (2001) [1], hand-transmitted vibration (HTV) exposure should be measured using accelerometers rigidly fixed on the vibrating surface in the hand contact areas. If it is difficult to apply this approach, HTV can be alternatively measured using an adaptor held in the hand (ISO 5349-2, 2001) [2]. Compared with the direct approach, the adaptor approach has several advantages if applied appropriately. For example, it could be more efficient for the measurement and less intrusive to the tool operation; hence, it may be suitable for a long-term monitoring measurement. Probably for this reason, the adaptor approach has been considered in the development of some convenient or direct-reading devices for HTV measurement. However, it is not the preferred option in the standardized methodology, primarily because the adaptor vibration could be affected by the inconsistency of the hand-applied forces and the biodynamic response of the hand. The objectives of this study are to find the specific mechanisms of the biodynamic effects and to identify the optimized design of the adaptor and/or its hand-holding strategy so that the undesired effects could be minimized.

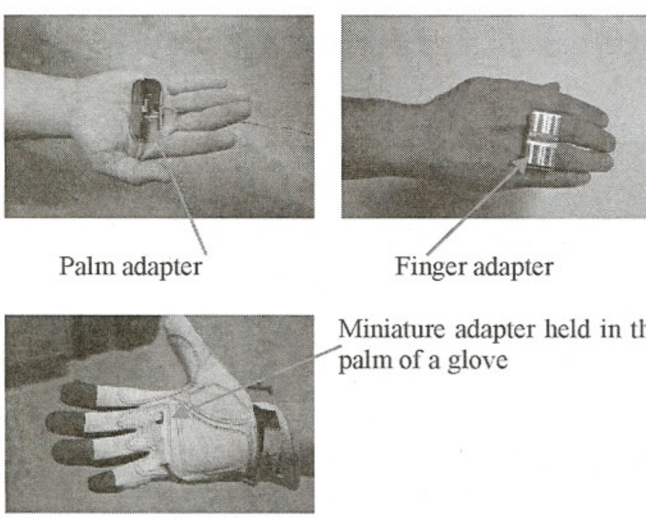

Figure 1: A pictorial view of three adapters

2. METHOD

Three typical adapters were considered in this study, as shown in Figure 1. The first one is a palm adapter designed based on the requirements of ISO 10819 (1996) [3], and it was built in house. The second one is a finger adapter similar to a commercially available model [4], and the t one is a miniature adapter held in the palm of a glove All three adapters were equipped with tri-a accelerometers. The experiment was carried out on a ha arm vibration test system equipped with an instrumen handle that can measure the tri-axial vibration excitati and the applied grip force. A force plate was used measure the applied push force on the handle.

To establish the baseline measurement, each adapter attached to the handle along the vibration direction, shown in Figure 2. The vibrations in three orthogo directions on both the adapter and handle w simultaneously measured.

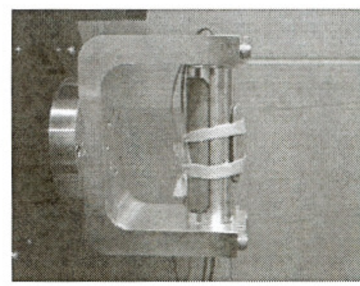

Figure 2: Test setup for measuring the baseline value of th palm adapter. The other two adapters were separately attached to the handle in a similar manner.

In the subject test, each of the adapters was held at designed position at the fingers or palm of the hand, shown in Figure 3. Three subjects participated in the test the palm adapter and two of them participated in the tests the other two adapters. Each of the subjects applied 30 grip force and 50 N push force on the handle in the tests.

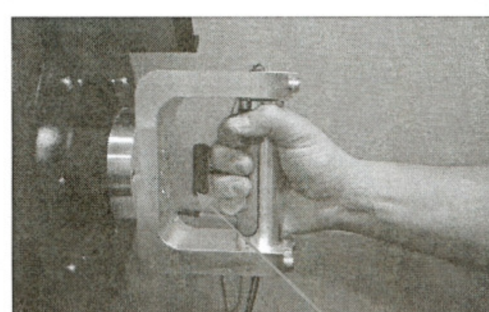

Figure 3: Subject test of the finger adapter

3. RESULTS AND DISCUSSIONS

The vector sums of the three axes accelerations (root-mean-square values) at each one-third octave band frequency were calculated and used to evaluate the adapters.

Figure 4 shows the vibration transmissibility functions of the palm adapter under different test conditions. Large drifts from the baseline values were observed at the low and middle frequencies (<100 Hz). The variations were also subject- and test trial-dependent. It is thus difficult to correct the potential errors in the post-data analyses. The drifts primarily resulted from the rocking movements of the adapter that is largely influenced by the biodynamic response of the hand. This principle suggests that the potential measurement errors could also be adapter-specific.

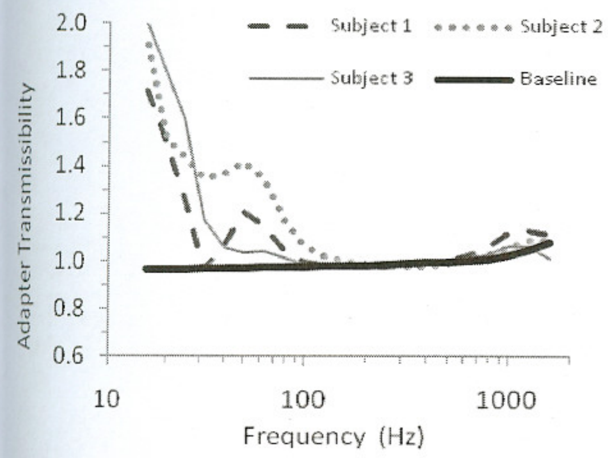

Figure 4: Comparison of baseline transmissibility of the palm adapter with those measured with three subjects.

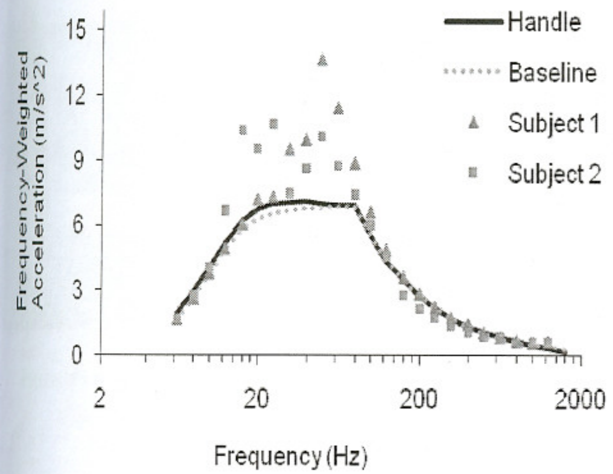

Figure 5: Comparisons of excitation/handle accelerations, baseline values of the finger adapter, and test results.

Figure 5 shows the results of the finger adapter tests. The vibration of a finger adapter could be greatly affected in the frequency range from 25 to 80 Hz, especially in the range (30 to 50 Hz) of the fundamental resonance of the hand-arm system. The rotational vibration was also identified as one of the major sources affecting the translational vibration measurement required in the risk assessment of HTV exposure.

Figure 6 shows the results measured with the miniature adapter held in the palm of the glove. This adapter approach provided with the most reliable measurement of the frequency-weighted acceleration [1].

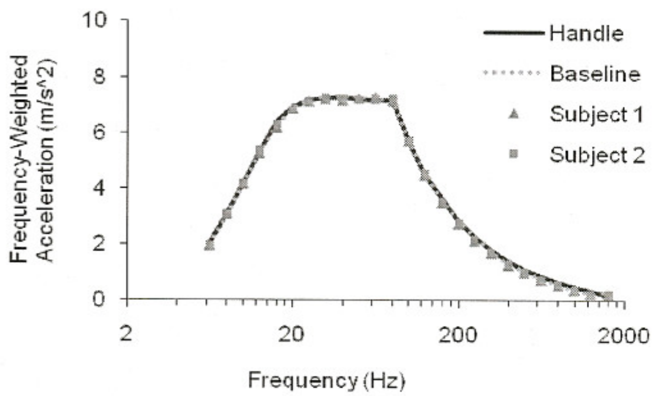

Figure 6: Comparisons of excitation/handle accelerations, baseline values of the miniature adapter held at the palm of a glove, and its subject test results.

REFERENCES

[1] ISO 5349-1 (2001). *Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 1: General requirements* (International Organization for Standardization, Geneva).

[2] ISO 5349-2 (2001). *Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration - Part 2: Practice guidance for measurement in the workplace* (International Organization for Standardization, Geneva).

[3] ISO 10819 (1996). *Mechanical vibration and shock -- hand-arm vibration -- method for the measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand* (International Organization for Standardization, Geneva).

[4] http://www.larsondavis.com/VibTrack/index.htm

[5] http://www.scantekinc.com/vibration/vibrationcvk.htm

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