TOOL-SPECIFIC PERFORMANCE OF VIBRATION-REDUCING GLOVES AT THE FINGERS

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INTRODUCTION

The vibration isolation performance of vibration-reducing (VR) gloves is location-specific and different at the palm from that at the fingers (McDowell et al., 2014, Welcome et al., 2014). The vibration attenuation effectiveness is also tool-specific and can be estimated analytically given the 3D vibration spectra of the tool and the 3D transmissibility spectra of the glove (Rakheja et al., 2002; Dong et al., 2002). The objectives of this study are to measure the vibration transmissibility of gloves at the fingers and to estimate whether the gloves can reduce the finger vibration from many tools.

METHOD

As shown in Fig. 1, four types of typical VR gloves were considered in this study. Two gloves (one left hand and one right hand) from each type were used in the test. According to ISO 10819 (2013), the air bladder glove and air bubble glove can be classified as anti-vibration gloves (Welcome et al., 2012). The 3-D transmissibility spectra of a gel-filled glove and an air bladder glove to simultaneous broad-band random excitations in all three orthogonal axes were obtained from a previous study (Welcome et al., 2014). The transmissibility spectra of the other gloves were measured in this current study. As shown in Fig. 2, the basic test set-up and the subject postures used in these measurements are similar to those required in the standard anti-vibration glove test (ISO 10819, 2013). Different from the standard test, a 3-D scanning laser vibrometer (Polytec, PSV-500-3D) was used to measure the distributed 3-D vibrations on the fingers with and without wearing a glove. To make the laser measurement possible, the top part of the glove fingers was cut off, as shown in Fig. 1. The specific measurement locations on the fingers are shown in Fig. 3 (Area 1: locations at the fingertips, the first and second phalanxes on the left hand. Area 2: the third phalanx area on the right hand). To minimize the effects of hair and maintain a good signal, a piece of retro-reflective tape was firmly attached at each of the locations, as also shown in Fig. 3. The accelerations measured on the fingers with and without wearing a glove were used to evaluate the 3-D transmissibility spectra of the glove fingers. The spectra, together with the tool vibration spectra collected from other studies, were used to estimate the tool-specific transmissibility values of the glove fingers using a method similar to those reported before (Rakheja et al., 2002; Dong et al., 2002). Both the frequency-weighted and unweighted transmissibility values were calculated. Besides the transmissibility value of the total vibration (vector sum of the three axes vibrations), the transmissibility values of the vibration in the handle axial (y_h) direction and the vector sum of the vibrations in the x_h and z_h directions were also examined. Because of the limits of the 3-D vibration test system, the measured spectra were from 16 to 500 Hz. In the calculations of the tool-specific transmissibility values, the integrations of the frequency components were made in the one-third octave bands from 6.3 to 500 Hz. While the transmissibility at the low frequencies is likely to be close to unity, it was assumed that the transmissibility component at 6.3 Hz is 1.0 and the remaining components between 6.3 and 16 Hz were linearly interpolated.

Fig. 1: Five types of gloves (two gloves for each model): Gel; Air Bladder; Air Bubble; Dipped Neoprene.

Fig. 2: Test set-up

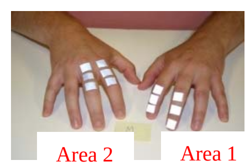

Fig. 3: Measurement locations

PRELIMINARY RESULTS AND DISCUSSION

As examples, Fig. 4 shows the total vibration transmissibility spectra of the four gloves over the entire fingers (the average of the spectra measured in the fingertip area and the proximal area). Table 1 lists some tool-specific transmissibility values estimated using the spectra shown in Fig. 4. The Neoprene glove generally amplifies the vibration below 150 Hz; as a result, it generally amplifies the frequency-weighted vibration. However, it significantly reduces the transmitted vibration at higher than 200 Hz. This makes it more effective than other gloves at reducing the high frequency vibrations or the unweighted vibration from some tools. The spectra of the remaining three gloves are very similar. Their tool-specific transmissibility values are also very similar. While their maximum reduction of the fingers-transmitted vibration is less than 10%, their average reduction is less than 5%. These observations suggest that the VR gloves are generally ineffective for reducing the fingers-transmitted frequency-weighted vibration when they are used with the vast majority of the powered hand tools. The gloves that can be certified as anti-vibration gloves according to the current glove test standard may not reduce more unweighted vibration transmitted to the fingers than the other VR gloves in some cases. These observations further suggest that the VR gloves should not be considered as a primary device for controlling HTV exposures.

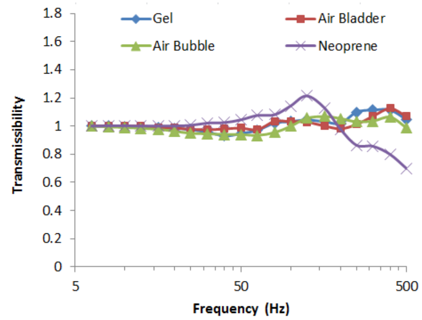

Fig. 4: Glove transmissibility spectra of the total vibration over the entire fingers for 30 N grip and 50 N push.

Table 1. Estimated isolation effectiveness of the four gloves at the fingers

Tool	a_{hv} (m/s^2)	Weighted Transmissibility				Unweighted Transmissibility			
		Gel	Air bladder	Air bubble	Neo-prene	Gel	Air bladder	Air bubble	Neo-prene
Vibrating fork	12.65	0.98	0.98	0.96	1.01	1.00	0.99	0.98	0.96
Floor rammer	23.69	0.99	0.99	1.00	1.01	1.02	1.00	1.01	1.00
Rivet hammer	23.22	1.00	1.00	0.98	1.04	1.07	1.06	1.04	0.91
Chipping hammer	10.95	0.95	0.96	0.95	1.01	1.05	1.02	1.00	0.86
Rock drill	11.70	0.92	0.93	0.93	1.01	1.00	1.02	0.99	0.93
Chain saw	9.93	0.91	0.95	0.93	1.04	0.94	0.96	0.96	1.06
Pavement cutting saw	12.12	1.04	1.03	1.05	1.16	1.06	1.04	1.06	1.12
Impact wrench	6.59	1.01	1.01	1.00	1.04	1.08	1.08	1.04	0.91
Angular grinder	9.99	0.99	1.03	0.98	1.09	1.04	1.07	1.02	0.98
Random orbital sander	4.79	1.02	1.04	1.00	1.12	1.07	1.07	1.03	1.06

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DISCLAIMERS: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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Forward – Welcome Address

On behalf of my conference co-chairs, I am pleased to welcome you to Guelph, Ontario, Canada for the 5th American Conference on Human Vibration. The 5th ACHV is being co-hosted by the University of Guelph, Laurentian University, Western University and the University of Toronto. We are honored to be hosting this biennial conference on the University of Guelph campus. As the premier North American conference for human exposure to vibration, the conference provides a unique and convenient opportunity for researchers, engineers, medical professionals and industry representatives to exchange information on all aspects of vibration control and human responses to hand-transmitted vibration and whole-body vibration. The theme for this year's meeting is "Human Vibration - From Theory to Industrial and Clinical Applications".

Founded in 1827, Guelph was named after the British Monarch King George IV, who was from the House of Hanover. Selected as the headquarters of a British development firm called "The Canada Company", Guelph was designed by John Galt, who was a Scottish Novelist. The town was designed to resemble a European city center comprised of squares, wide main streets and narrow side streets. Guelph was home to Lieutenant Colonel John McCrae, the author of "In Flanders Fields". Its references to the red poppies that grew over the graves of fallen soldiers resulted in the remembrance poppy becoming one of the world's most recognized memorial symbols for fallen soldiers. Guelph was also the home of North America's first cable TV system. Fredrick T. Metcalf created MacLean Hunter Television (now part of Rogers Communications) and their first broadcast was of current monarch Queen Elizabeth II's Coronation in 1953. With a population of over 120,000, Guelph is part of a technology triangle which is comprised of the cities of Guelph, Kitchener, Cambridge and Waterloo. Guelph is consistently rated as one of Canada's best places to live because of its low crime rate, clean environment, high standard of living and low unemployment rate. Almost one quarter of Guelph employment is provided through the manufacturing sector with over 10% provided through Educational services. The City of Guelph has identified life science, agri-food and biotechnology, environmental management and technology companies as industries on which to focus future economic development activities.

Many thanks to Elyse Dubé from Conference Services at the University of Guelph for all of her hard work in helping to plan and sort through the conference logistics. We'd also like to thank Guelph Engineering students Gregor Scott and Dan Leto as well as School of Engineering technician Carly Fennell for their help in setting up the laboratory tours. We hope that your visit to the 5th ACHV and Guelph will be both educational and enjoyable.

Sincerely,

Michele Oliver, Jim Dickey, Tammy Eger and Aaron Thompson