SELECTING TOOL-SPECIFIC VIBRATION-REDUCING GLOVES USING ISO 5349 AND ISO 10819 MEASUREMENTS

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Introduction

Ear plugs are a good example of Personal Protective Equipment (PPE) used in various occupational settings. They are selected not only for their fit into the ear canals but also for their ability to reduce the level and frequency content of unwanted sounds, which is indicated in the value of their Noise Reduction Rating (NRR). This NRR value helps to make the selection process much easier for the health and safety professional who may need to make selections based on various noise exposure characteristics. In order to choose appropriate PPEs, it is a good idea to understand what the hazardous sources are and how its propagations can be reduced. When hand-transmitted vibration (HTV) from power tools becomes a significant issue in the work place, tool vibration measurements and health risk assessments can be carefully conducted following ISO 5349-1, ISO 5349-2, and ISO 8041. Ideally, based on these vibration measurements and risk assessments, appropriate vibration-reducing (VR) gloves could be identified from variety of commercially available gloves. ISO 10819 evaluates the actual effectiveness of a VR glove and utilizes the frequency weighting factors (W_h) defined in ISO 5349 in its transmissibility calculations but the outcomes from both these standards cannot be directly related. ISO 5349 specifies a frequency range from 6.3 to 1,250 Hz, while ISO 10819 specifies a frequency range from 25 to 1,250 Hz and is missing six low-frequency 1/3-octave band frequencies (6.3, 8, 10, 12.5, 16, and 20 Hz) that are considered to be extremely important for assessing and characterizing HTV exposures.

A previous study showed that the frequency response of a glove can be modeled as a Linear Time-Invariant (LTI) System and that transmissibility results do not differ when conducting ISO 10819 assessments using various vibration excitation spectrums[1]. Given this information, it is possible to simply characterize vibration exposures to a gloved hand by using the frequency signature of a tool and the transmissibility information of a glove or, more specifically, overlap ISO 5349 tool assessments with ISO 10819 glove evaluations. In this study, a simple protocol was developed as a practical method for glove selection that uses previously captured tool vibration and glove transmissibility spectrums to quickly estimate the effectiveness of a glove in reducing tool-specific vibration.

Methods

Tool spectrums were obtained from ISO 5349- and ISO 8041-based vibration measurements of several power tool operations. All glove transmissibility assessments were conducted using an ISO 10819-based hand-arm excitation system, where vibration at the handle, palm, and finger were measured. In order to directly overlap the frequency range between ISO 5349 and ISO 10819, the six low-frequency 1/3-octave band frequencies (from ISO 5349) in the tool spectrums were excluded. The tool spectrum was multiplied by the glove transmissibility spectrum, for both palm and finger, to yield an estimated vibration exposure spectrum to the hand-arm system while a glove is worn. In addition, the overall percent reduction in vibration exposure for each glove was calculated using the total unweighted (UW) and weighted (W) accelerations determined from the tool and estimated vibration exposure spectrums.

Results

Results for the case of a rivet gun and a leather air-bladder glove are presented in Figure 1 for both palm and finger, where column A is the measured spectrum of tool vibration, column B is the ISO 10819 spectrum of glove transmissibility (from palm and finger adapters), and column C is the calculated spectrums of vibration exposure. Table 1 provides the summary of the total UW and W accelerations for the tool vibration and vibration exposure, as well as the overall percent reduction in vibration exposure resulting from wearing a leather air-bladder glove while using a rivet gun.

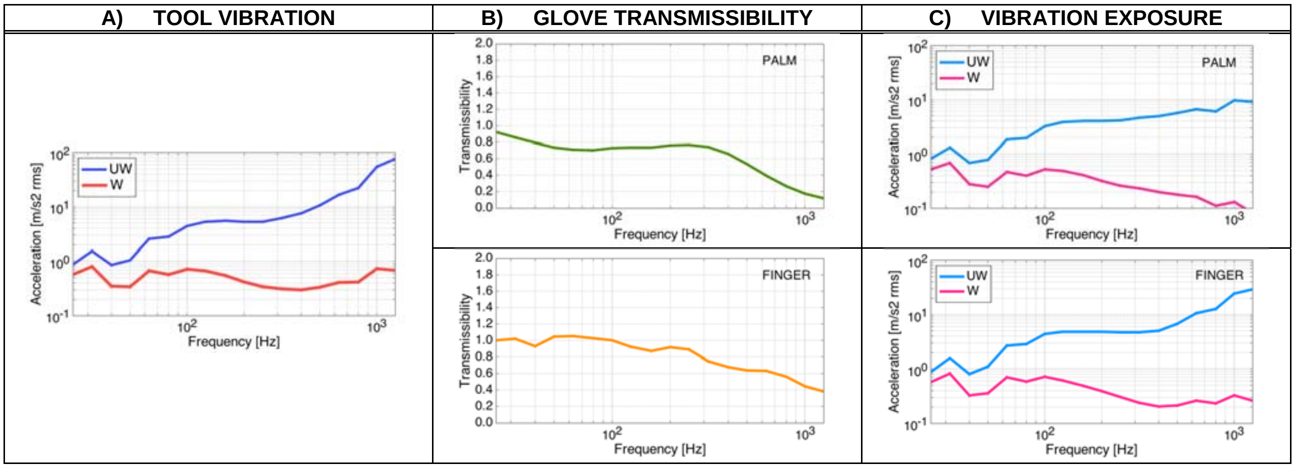

Figure 1. Estimate of the Effectiveness of a Glove in Reducing Tool-Specific Vibration Exposure

Table 1. Total UW and W Accelerations and Overall Percent Reductions of Tool Vibration and Vibration Exposure

	TOOL (25 to 1,250 Hz)	VIBRATION EXPOSURE (25 to 1,250 Hz)			
		PALM		FINGER	
	Acceleration [m/s^2]	Acceleration [m/s^2]	% Reduction	Acceleration [m/s^2]	% Reduction
UW	99.2	20.5	79.4 %	43.8	55.8 %
W	2.3	1.5	33.1 %	2.0	13.7 %

Discussion

With an adjustment in the frequency range, the LTI-based method can be used to simply estimate the vibration exposure of a gloved hand using ISO 5349-based power tool vibration spectrums and ISO 10819-based glove transmissibility spectrums. While the mean transmissibility values for the M and H spectrums are beneficial for categorizing VR gloves for manufactures, these values do not provide any simple practical use for glove users. Previously studies[2,3] introduced different glove evaluation methodologies but their results were limited to the M and H spectrum frequency ranges. In addition, most gloves do not pass the ISO 10819 M and H tests even though the gloves may still have some practical vibration attenuation capabilities as is evidenced in the calculation of the overall percent reduction in vibration exposure.

References

1. Asaki, T. and Peterson, D.R. (2014). Measuring the vibration transmissibility of gloves using different excitation conditions. Proceedings of 5th ACHV, Guelph, Ontario, Canada. (submitted)
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3. Griffin, M. J. (1998). Evaluating the effectiveness of gloves in reducing the hazards of hand- transmitted vibration. Occup. Environ. Med. 55, 340–348.

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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