MEASURING THE VIBRATION TRANSMISSIBILITY OF GLOVES USING DIFFERENT EXCITATION CONDITIONS

Takafumi Asaki, Donald R. Peterson*

Biodynamics Laboratory
University of Connecticut Health Center, Farmington, CT 06030-2017, USA

Introduction

The current approach to evaluating vibration-reducing (VR) gloves for vibration attenuation characteristics involves the strict following of the protocols defined in ISO 10819[1], which seeks to test gloves according to a criteria of total transmissibility values in the M (25 – 200 Hz, $\mathbf{T_{(M)}} \leq 0.9$) and H (200 – 1,250 Hz, $\mathbf{T_{(H)}} \leq 0.6$) spectrums. Even when following the protocols of the standard, previous studies[2,3] have shown that glove evaluation results can vary between testing laboratories and that results often conflict with the VR claims made by glove manufacturers. Variations in evaluation outcomes could result from testing factors, such as palm adapter misalignment, improper push/pull and grip force loadings, and/or an inadequate feedback control system for the electro-dynamic exciter; however, the experimental control of these factors are fairly simple and variations can be easily minimized. For the case of vibration excitation, if the frequency response of the glove is assumed to be governed by the Linear Time-Invariant (LTI) System theory, then the transmissibility results of the ISO test should hypothetically be the same as the results obtained under any excitation condition. In order to test this hypothesis, VR glove transmissibility assessments were conducted using three different Power Spectrum Density Spectrums (PSDS): 1) the ISO 10819 PSDS, 2) a flat PSDS, and 3) a PSDS obtained from actual power tool use in the field. In addition to the palm assessment defined in the standard, transmissibility was also simultaneously measured at the finger using a novel finger adapter, especially since recent findings demonstrated inhomogeneity between finger and palm transmissibilities[4].

Method

VR glove assessments were conducted using an ISO 10819-based hand-arm excitation system for each of the three PSDSs shown in Fig 1 and the frequency range and total unweighted (UW) and weighted (W) acceleration values for each of the PSDSs are presented in Table 1. A 1/3-octave tool PSDS was determined from ISO 5349 and ISO 8041 vibration measurements of four riveting operations in a helicopter manufacturing facility and contains 12 vibration waveforms in total, where the PSD for a low, middle, and high vibration signatures were determined for each of the four operations.

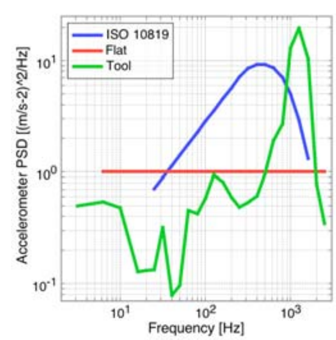


Figure 1. Three different PSDSs used

Table 1. Frequency range and total accelerations of the three PSDSs

PSDS	Freq. Range [Hz]	Total UW [m/s^2]	Total W [m/s^2]
ISO 10819	25 – 1,600	90.19	4.82
Flat	6.3 – 2,500	53.19	4.93
Tool	3.15 – 2,500	119.33	2.98

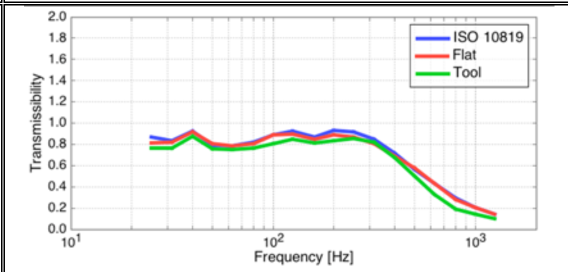
All measurement conditions were maintained following ISO 10819, including a 30 N grip force, 50 N push force, and a 30-second averaging window to calculate the mean transmissibility values for the M and H spectrums. Two gloves were used in this experiment: a leather glove with an internal air-bladder layer (Glove 1) and a nylon/cotton knitted glove with a chloroprene rubber coating (Glove 2). For this preliminary investigation, only one subject was used.

Results

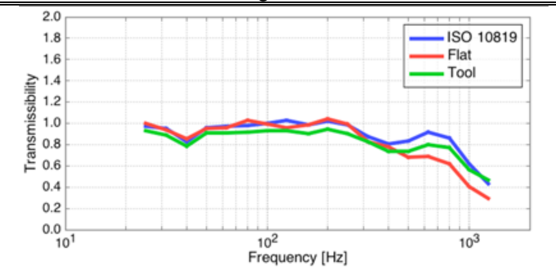
Table 2. 1/3 octave vibration transmissibilities including M and H mean transmissibility values

GLOVE 1

Palmer Side



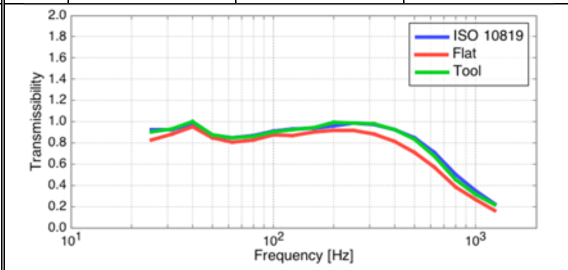
Finger Side



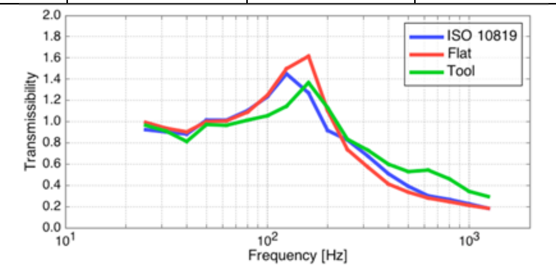
Palmer Side	ISO 10819	Flat	Tool	Finger Side	ISO 10819	Flat	Tool
M	0.864	0.837	0.794	M	0.971	0.960	0.910
H	0.767	0.742	0.453	H	0.908	0.864	0.698

GLOVE 2

Palmer Side



Finger Side



Palmer Side	ISO 10819	Flat	Tool	Finger Side	ISO 10819	Flat	Tool
M	0.914	0.868	0.915	M	1.093	1.062	1.046
H	0.899	0.811	0.629	H	0.668	0.713	0.578

Discussion

Following the ISO 10819 testing conditions, but changing the excitation spectrum, did not seem to influence results as the transmissibility characteristics of the gloves showed very similar responses with only slight differences observed between spectrums. These results suggest that consistent operation of an ISO 10819-based hand-arm excitation system, including the data acquisition system, should yield similar transmissibility measurements regardless of the excitation PSDS. In addition, if the transmissibility measurements were observed to be dramatically different in a multi-subject study, then variations in subjects (e.g., gender, anthropometry, etc.) and/or applied forces (i.e., grip and push/pull) might be the major influences on transmissibility results rather then changes in the vibration excitation.

References

1. ISO/DIS 10819 (2011). 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.
2. Griffin, M.J. (1998). Evaluating the effectiveness of gloves in reducing the hazards of hand- transmitted vibration. Occup. Environ. Med. 55, 340–348.
3. Welcome, D.E., Dong, R.G., Xu, X.S., Warren, C. and McDowell, T.W. (2012). An evaluation of the proposed revision of the anti-vibration glove test method defined in ISO 10819 (1996). Int. J. Ind. Ergon. 42, 143–155.
4. Asaki, T. and Peterson, D.R. (2014). Incorporating a finger adapter into ISO 10819 to measure the vibration transmissibility of gloves at the fingers. Proceedings of 5th ACHV, Guelph, Ontario, Canada. (submitted)

[Work supported by the National Institute for Occupational Safety and Health research grant 5R01 OH008997]

5th American Conference on Human Vibration

June 10 - 13, 2014 - University of Guelph, Ontario, Canada

Proceedings of the Fifth American Conference on Human Vibration

University of Guelph
Guelph, Ontario, Canada

Edited by Michele Oliver, Ph.D., P.Eng.
School of Engineering, University of Guelph
Guelph, Ontario

This activity is an Accredited Group Learning Activity (Section 1) as defined by the Maintenance of Certification program of The Royal College of Physicians and Surgeons of Canada and approved by Occupational Medicine Specialists of Canada (OMSOC). The activity has been approved for up to 13 hours for the 3 day course (1 credit per hour).

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