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ANTIVIBRATION GLOVES - PROPOSAL FOR THEIR SELECTION FOR VIBRATORY TOOLS

J. Koton, J. Szopa

Central Institute for Labour Protection, Czerniakowska 16, 00-701, Warsaw, Poland

Tel.: (+4822) 623 32 89 / Fax: (+4822) 623 36 95 / Email: jokot@ciop.pl

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ABSTRACT
Occupational exposure to hand-transmitted vibration can cause many kinds of disorders in the human body. Some reduction of the risk of vibration damage can be achieved by using gloves providing attenuation of vibration. The international standard ISO 10819 published in 1996 defines the procedure for determining the vibration transmissibility of gloves and specifies the requirements for gloves, which must be met in order to classify gloves as AV ones. But the results of the ISO 10819 standard test are not useful enough for potential buyers and users of gloves because on the basis of the values of TR_M and TR_H determined according to this standard, it is impossible to evaluate the effectiveness of a glove in reducing vibration when it is worn by a user of a particular vibratory tool. In order to select a proper glove for a tool, it is necessary to develop a special procedure. The proposal for such a procedure is presented in this paper.

1 - INTRODUCTION

Independently of some critical remarks concerning resolutions in the ISO 10819 standard, publication of this standard enabled the testing and evaluating of gloves intended for protection against vibration in like manner at various laboratories. However, a positive evaluation of a glove as a result of the standard tests, i.e. classification of a glove as an antivibration (AV) one, does not mean that this glove will be equally efficient when used by workers handling various vibratory tools. The efficiency of the same glove in reducing the risk of vibration damage may be different, depending on the frequency spectrum of vibration on the handles of particular tools. It is possible that a glove, classified as an AV glove, will not reduce vibration hazard at all in a specific practical situation or that the reduction of hazard by this glove will be unsatisfactory.
In order to achieve as maximum degree of protection against vibration as possible, it is necessary to select antivibration gloves for particular vibratory tools, like it is necessary to select hearing protectors for particular noisy workplaces. Various methods for selecting hearing protectors have been established and specified in an objective European standard. However, so far there is no established method for selecting AV gloves for tools. Thus, a conception of the method is submitted and discussed below.

2 - PROPOSAL FOR SELECTING AV GLOVES FOR VIBRATORY TOOLS

According to the methods advocated in current standards, the evaluation of human exposure to vibration is made on the basis of the two determined quantities:

- the magnitude of the vibration, which is expressed by the root-mean square (RMS) value of the frequency-weighted acceleration;
- the duration (per day) of vibration exposure.

Therefore, vibration exposure can be minimized by reducing daily exposure duration and by decreasing the frequency-weighted acceleration. The reduction of daily exposure time can cause a decrease in work productivity, thus it seems to be better to minimize vibration exposure by reducing the root-mean-square frequency-weighted acceleration.

In the case of evaluating exposure to hand-transmitted vibration, the frequency-weighted acceleration is measured on the handle of a tool.
It is assumed that when the operator holds a tool with a bare hand (without any glove), the value of acceleration at the palm of the operator's hand is the same as the value measured on the handle of a tool. When the tool operator uses an antivibration glove, the vibration signal (its spectral characteristic) on the palm of the hand changes in relation to the vibration signal on the handle of a tool held with a bare hand. As a result of this, the value of the frequency-weighted acceleration on the palm of a gloved hand is different than the value of the frequency-weighted acceleration on the palm of an ungloved hand, i.e. on the handle of a tool handled without a glove. The lower the weighted acceleration on the palm of a gloved hand in relation to the weighted acceleration measured on the handle (i.e. at the palm of the bare hand), the greater the efficiency of a glove.
Therefore, it is proposed to describe glove efficiency by the protection efficiency index (PEI) expressed as a ratio of the values of the frequency-weighted acceleration: measured on the handle of a tool ($a_{w,RMS,H}$) and determined on the palm of the operator's gloved hand ($a_{w,RMS,GP}$)

$$PEI = \frac{a_{w,RMS,H}}{a_{w,RMS,GP}}$$

The PEI would be determined for a defined tool-glove system. For the same tool and various gloves the values of PEI will be different. They will also be different for various tools and the same glove. The PEI equal to 1 would mean that the glove does not reduce at all the weighted acceleration occurring on the handle of the tool. A PEI value lower than 1 would mean that the glove causes an increase in the value of weighted acceleration considered as an essential one from the point of view of vibration exposure evaluation. A value of PEI greater than 1 indicates that the glove reduces vibration transmission from the tool to the operator's hand, i.e. reduces the risk of vibration damage.
Taking into account the submitted above proposal, selecting antivibration gloves for a vibratory tool would mean choosing a glove with the greatest value of PEI from the available selection of gloves classified as antivibration ones.
When embracing the proposed conception it is necessary to emphasize that the protection efficiency of a glove is dependent on the glove vibration transmissibility values determined in particular frequency bands and on the vibration spectrum on the handle of a tool. So, in order to determine the index of the vibration protection efficiency attached to the tool-glove system the process described schematically in Figure 1 should take place.

3 - VERIFICATION OF THE PROPOSED PROCEDURE

The proposed procedure of selecting gloves for tools was verified in practical situations. Vibration measurements were made for different vibratory tools in order to collect data on their vibration spectra and the vibration transmissibility of various gloves (as a function of frequency) was determined. On the basis of the gathered information the values of the protection efficiency index (PEI) were calculated for many tool-glove combinations.
Figure 2 shows an example of applying the procedure for choosing the most suitable AV glove, among the three available, for users of a pneumatic hammer. In this case glove number 3 turned out to be the best.

4 - CONCLUSIONS

- Taking into account the values of PEI determined for the various tool-glove combinations, it can be said that in many cases antivibration gloves do not provide significant attenuation of vibration. However, there are situations when using a glove reduces the transmission of vibration, i.e. reduces the risk of vibration damage.
- Possibilities for choosing a suitable glove for a defined tool are strongly limited because of the narrow selection of gloves fulfilling the requirements specified in the ISO 10819 standard. So, it seems to be justified to seek new solutions for gloves which will meet the criteria stated in ISO 10819.

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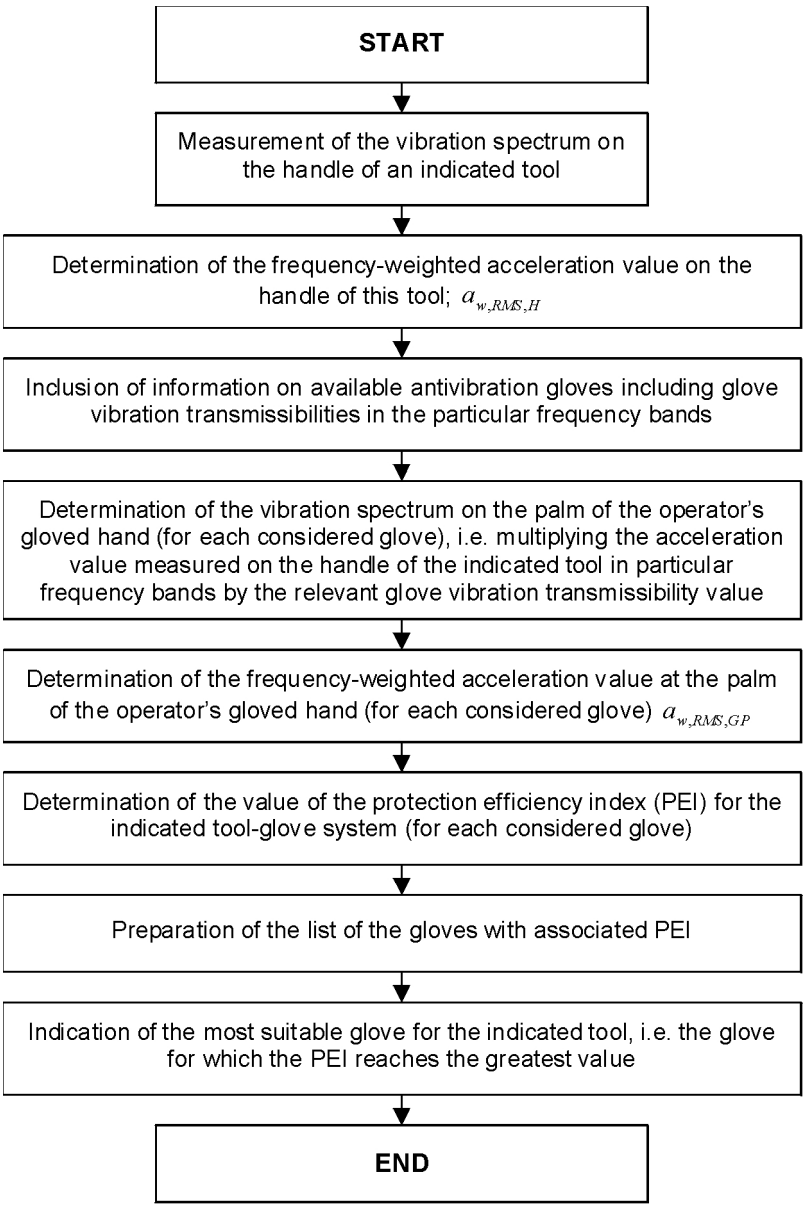

Figure 1: Algorithm for selecting antivibration gloves for a tool.

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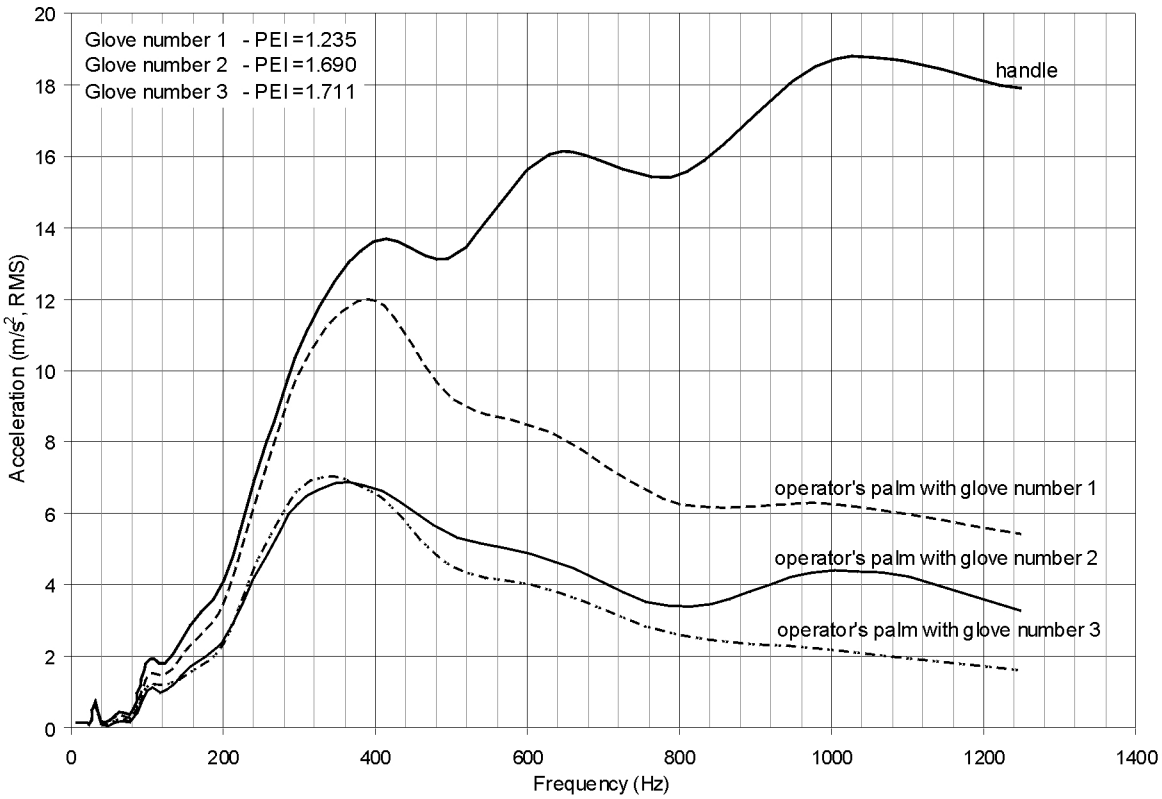

Figure 2: Vibration spectrum on the handle of a pneumatic hammer and the vibration spectra determined on the palm of the operator's hand with glove number 1, 2 and 3.