IMPULSE NOISE ATTENUATION WHEN EARMUFFS ARE WORN WITH SAFETY SPECTACLES

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Impulse noise is especially hazardous to hearing and in many situations the use of earmuffs is only one possibility to protect hearing against this kind of noise. Sometimes it is necessary to use also other personal protective equipment. For example, on the shooting ranges, simultaneous use of earmuffs and safety spectacles is often practiced. While earmuffs protect hearing, safety spectacles protect eyes from the potential impact of the bullet shells. Unfortunately, the simultaneous use of safety spectacles and earmuffs is associated with a possible decrease of impulse noise attenuation compared to the use of earmuffs without the spectacles. The aim of this study was to measure the changes in impulse noise attenuation in the case of simultaneous use of safety spectacles and earmuffs with respect to the situation of the use of hearing protection only. MIRE method (Microphone in Real Ear) was used. Measurements were performed while the person shots from the starting gun. Eight different earmuffs and three kinds of spectacles were tested. The least influence on the decrease of attenuation of LCpeak (0.7 - 8.1 dB) was associated with using spectacles with the temples of the smallest width (2 mm) and the greatest influence (8.1 - 16.1 dB) – using spectacles with the widest temples (5 mm). Knowledge of the effects of the use of other personal protective equipment when earmuffs are worn is important in the selection of the proper hearing protection for a specific impulse noise.

1. Introduction

Hearing protection with the use of hearing protection devices is the last possibility, when other methods (organizational methods, technical means) of noise reduction are ineffective or inapplicable [1]. According to EN 458 standard [2], if hearing protection devices are necessary and are not worn, even for short periods of time, then the effective attenuation of used protectors is highly reduced. The reduction of effective attenuation may also be the effect of simultaneous use of other types of personal protective equipment. This problem is even more serious in the case of exposure to impulsive noise. Effects of exposure to acoustic impulse may be immediate [3].

Reported reduction in sound attenuation that was a result of using other protection equipment with earmuffs reached up to 9 dB [4]. The aim of the present study was to show the changes not in continuous noise attenuation but in impulse noise attenuation. That changes were calculated as dif-
ference between attenuation measured in the situation of the use of hearing protection only and attenuation measured in the case of simultaneous use of safety spectacles and earmuffs.

Many users of hearing protection devices must use spectacles, too. Moreover, sometimes simultaneous use of earmuffs and safety spectacles is necessary, e.g. on the shooting ranges. Safety spectacles are used to protect eyes from the potential impact of the bullet shells. Thus, in this work, it was examined the attenuation of acoustic impulses generated during the starting gun shots when spectacles was used simultaneously with earmuffs.

2. Subject of testing

The changes in impulse noise attenuation in the case of simultaneous use of spectacles and earmuffs were carried out using eight popular earmuff models that differ in sound attenuation values, design of the cushion and the headband. Tested earmuffs were: EAR 5000, 3M Peltor H510A, 3M Peltor H540A, 3M Peltor H510P3 (with helmet), HL Bilsom Viking V1, HL Bilsom Viking V3, MSA Sordin EXC and 3M Peltor X4A.

Impulse noise attenuation for each of eight tested earmuffs was measured when earmuffs were worn without spectacles and when earmuffs were used simultaneously with one model of spectacles (prescription reading glasses) and two models of safety spectacles. Three tested spectacles differed in the dimensions of the temples. The width and height of temples in the case of prescription reading glasses, denoted in this article as “S” were 2.5x10 mm. In the case of safety spectacles it was: 2x20 mm (denotation “SSR”), 5x6 mm (denotation “SSS”).

3. Method

In order to obtain the impulse noise attenuation with earmuffs only and during simultaneous use of earmuffs and spectacles, a MIRE method (Microphone in Real Ear) was used. This method was already used to measure the attenuation of peak sound pressure level of shooting noise by earmuffs [5]. In this paper, measurements were performed while the person shots from the starting gun. This person carried out its tasks using earplugs. Thus, used Brüel & Kjær 4182 probe microphone was placed near the entrance to the external ear canal and at distance of a few millimetres from the earplug. This situation was illustrated in Fig. 1.

![Figure 1. The probe microphone placed in the test person's external ear.](image)

In order to determine impulse noise attenuation with earmuffs, C-weighted peak sound pressure level ($L_{Cpeak}$) was measured. Impulse noise attenuation with earmuffs (without and with simultaneous use of spectacles) was measured as a transmission loss. Measurements outside earmuffs were conducted with the use of Brüel & Kjær 4135 microphone. This microphone was placed beside the head of the person at a distance of 10 cm from the end of probe microphone. However, it also was measured how the value of the $L_{Cpeak}$ measured next to the head of the person differs from value measured with probe microphone. C-weighted peak sound pressure level near to the entrance to ear...
canal in average is 0.5 dB greater than 10 cm from the end of probe microphone. This difference may be used to recalculate transmission loss to insertion loss values.

As mentioned above, measurements of impulse noise attenuation were conducted when the external ear canals of person were blocked by earplugs. Each measurement was repeated three times, and each presented number was obtained on the basis of three measurements.

4. Results

Figure 2 shows the average attenuation of $L_{Cpeak}$ measured when earmuffs were worn without spectacles and in the case of simultaneous use of spectacles and earmuffs. It may be seen that in the case of each of tested earmuffs simultaneous use of earmuffs and spectacles reduces impulse noise attenuation.

![Figure 2. Attenuation of $L_{Cpeak}$ measured when earmuffs were worn without spectacles (“E”) and in the case of simultaneous use of earmuffs and three kinds of safety spectacles: “E+SSR” – earmuffs with SSR safety spectacles, “E+S” – earmuffs with S prescription reading glasses, “E+SSS” – earmuffs with SSS safety spectacles.](image)

Changes in attenuation of $L_{Cpeak}$ associated with the use of three tested spectacles are shown in Fig. 3. The smallest changes, from 0.7 to 8.1 dB were observed for earmuffs used simultaneously with SSR safety spectacles - with the temples of the smallest width. Next, in the case of S spectacles the range of changes was from 2.3 to 12.1 dB. The biggest changes were observed in the case of SSS safety spectacles with the widest temples and the changes were in the range from 8.1 to 16.1 dB.
Figure 3. Decrease in attenuation of $L_{\text{Cpeak}}$ in the case of simultaneous use of earmuffs and three kinds of safety spectacles: “E+SSR” – earmuffs with SSR safety spectacles, “E+S” – earmuffs with S prescription reading glasses, “E+SSS” – earmuffs with SSS safety spectacles.

5. Summary and Conclusions

Measurements, carried out in the presence of impulses produced by shots from the starting gun, shows that simultaneous use of each of eight tested earmuffs and each of tested spectacles was associated with a decrease of impulse noise attenuation compared to the use of earmuffs without the spectacles. The smallest observed change in attenuation of $L_{\text{Cpeak}}$ was 0.7 dB and the biggest observed change was 16.1 dB.

In general, the least influence on the decrease of attenuation of $L_{\text{Cpeak}}$ was associated with using spectacles with the temples of the smallest width (0.7 - 8.1 dB) and the greatest influence – using spectacles with the widest temples (8.1 - 16.1 dB).

For given spectacle, changes in attenuation of $L_{\text{Cpeak}}$ varied considerably between earmuffs and had a value in range of 7.4 dB (spectacles with the temples of the smallest width), 8.0 dB (spectacles with the widest temples) and 9.8 dB (prescription reading glasses).

It should be noted that the effects of the simultaneous use of safety spectacles and earmuffs may be associated with a reduction in attenuation of $L_{\text{Cpeak}}$ such that in more than half of the cases will be higher than 8 dB and may be even as large as 16.1 dB. This means that the impulse noise may have an impact on hearing much stronger than the results of the selection of hearing protection devices (without consideration of using spectacles) show. Thus, the knowledge of the effects of the use of other personal protective equipment when earmuffs are worn is important in the selection of the proper hearing protection for a specific impulse noise.
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REFERENCES