FIELD ATTENUATION OF INDIVIDUAL ORCHESTRA SHIELDS

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Résumé

Un test a été effectué pour mesurer l'atténuation de deux écrans acoustiques commerciaux utilisés par musiciens d'orchestres symphoniques. Trois instruments différents ont été utilisés comme sources de son. Les écrans étaient équipés de deux dosimètres, un situé en avant et l'autre derrière chaque écran. L'atténuation a été trouvée en calculant la différence entre la lecture des deux dosimètres. Les atténuations calculées étaient entre 5,8 et 10,7 dBA.

Mots clefs : boucliers acoustiques, orchestre symphonique, contrôle du bruit, protection de l'ouïe

Abstract

A test was conducted to assess the field attenuation of two commercial acoustic shields used by symphonic orchestra musicians. Three different musical instruments, were used as sound sources. The shields were equipped with two noise dosimeters each, located one in front and the other behind the shield. The attenuation was calculated as the difference between the readings of both dosimeters. Attenuations were found to be between 5.8 and 10.7 dBA.

Keywords: acoustic shields, symphonic orchestra, noise control, hearing conservation

1 Introduction

Acoustic shields are devices used in symphonic orchestras to protect musicians' hearing from high sound levels originated by players located behind them. A field attenuation study aimed to determine if shields are beneficial to orchestra players was conducted by some of the present authors[1]. The attenuation was obtained as the difference between the readings of two noise dosimeters: one installed on the shield, exposed to the direct sound of the instrument generating the sound, and the second one was attached to the shoulder of the protected player. Results of the study showed that in most cases, the attenuation was negligible.

The results from the study didn't actually measure the attenuation of the shield, but only the difference between the measured sound levels. As a matter of fact, noise levels reaching any of the dosimeters are the result of sounds from several sources including musicians seated on the sides and in front of the protected musicians, reflections from lateral walls and/or ceiling, and finally those generated by the protected musician. No distinction can be made between signals from all these sources and the one generated by the musician seated behind the individual intended to be protected short of using acoustic intensity techniques.

Musicians, however, claim that they do perceive significant attenuation of sounds generated by loud instruments (e.g., brass and percussion) located on the other side of the shields. The present study was intended to evaluate the attenuation of the shield in the same location, but only with instruments being played by the musician into the shield.

2 Attenuation measurement

2.1 Location

The testing was performed in the orchestra pit of the Four Seasons Centre for the Performing Arts, in Toronto, same location where the study of the reference was conducted.

2.2 Shields under test

The two types of acoustic shields used in the previous study, Wenger and Manhasset model 2000, were evaluated. Both shields consist of an acrylic plate mounted on a pole that allows for varying its height from the floor. The Wenger's plate dimensions are 57 cm by 43 cm. The Manhasset's plate is larger: 65 cm by 55 cm. Both plates are made of Lexan polycarbonate with a thickness of 6 mm. The density of the material is 1,200 kg/m^3, the resulting surface density is 7.2 kg/m^2. As per the acoustic Mass Law, the transmission loss should be in the order of 20 dB at 500 Hz in absence of diffraction.

2.3 Sound sources

Three musical instruments were used as sound sources. They were chosen as being among the loudest in the orchestra and also to cover the low, middle and high portion of the sound spectrum. The instruments were a trombone, a trumpet and a flute.

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Only one instrument was used at a time. Musicians were requested to perform a loud piece of their choice, playing for roughly one minute duration. All musical segments were extracts from Tchaikovsky - Swan Lake.

Measurement instruments and set-up

Measurements were performed simultaneously on two shields (See Figure 1): one Wenger and one Manhasset. They were located at an angle of 45° in front of the player, at a distance of around 1 m between the end of the instrument and the player. Each shield was equipped with two dosimeters B&K Type 4448, one on each side of the shield. The dosimeters were located on stands at a distance of 10 cm from the center of the shield.

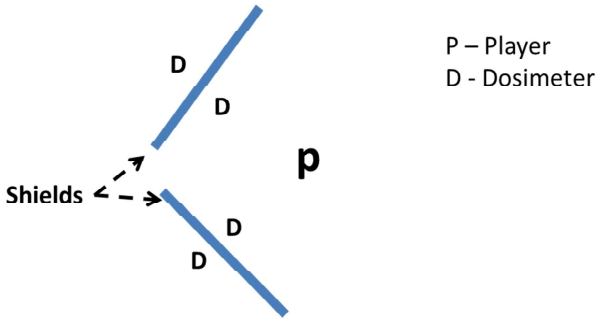

Figure 1: Measurement setup.

2.4 Procedure

Before the start of each measurement the batteries of the four dosimeters were tested and the instruments calibrated per the manufacturer's instructions.

At the beginning of the test the four dosimeters were switched on. One of the players executed the selected piece. Then the dosimeters were switched off and their readings were recorded. The second player took the place of the first; dosimeters were again switched on at the beginning and off at the end of the playing and their readings were recorded. Same procedures were conducted for the third player.

To assess the repeatability of the results, the entire procedure with the three players was repeated. In such the attenuation of both shields was recorded twice with each instrument.

At the end of the tests, the readings from the dosimeters were extracted electronically and compared with those read directly from the dosimeters to confirm the measurement results accuracy.

3 Results of the measurements

The results of the measurements are shown in Table 1, The first column shows the test trials (1 and 2). As mentioned above, each of the three players played twice. The fifth column "Attenuations" shows the differences between the readings from the front and the back dosimeters. The last column shows the differences between the attenuations between the first and second trials of measurements.

Table 1: Results from the measurements (Leq, dBA).

Trials #	Instruments	Shield		Attenuation*	diff. trials 1 and 2
		Front	Back		
		Manhasset			
1	Trumpet	103.5	92.8	10.7	0.6
	Flute	91.9	82.8	9.1	2.0
	Trombone	93.5	85.9	7.6	2.9
2	Trumpet	103.2	93.1	10.1	
	Flute	90.7	83.6	7.1	
	Trombone	96.1	85.6	10.5	
		Wenger			
1	Trumpet	101.2	95.0	6.2	0.6
	Flute	90.0	83.0	7.0	2.0
	Trombone	95.3	89.3	6.0	1.0
2	Trumpet	99.5	93.9	5.6	
	Flute	90.3	85.9	5.0	
	Trombone	96.2	89.2	7.0	

* Attenuation = Leq Front - Leq Back, dBA

Figure 2 shows graphically the values of the column 5 of Table 1.

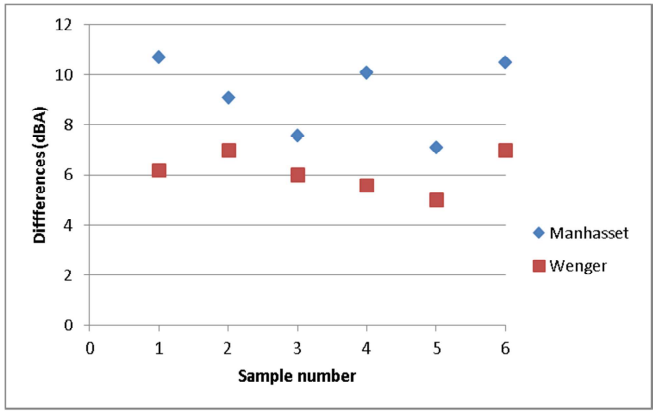

Figure 2: Scattergraph of the attenuations.

4 Discussion

4.1 Attenuation

With regard to the measured attenuations, results in Table 1 and Figure 2 show that the Manhasset shield has a larger attenuation than the Wenger. This can be explained by the Manhasset's larger surface that reduces the diffraction of the impinging sound. Interesting enough, the spread among the individual values is larger for the Manhasset than for the Wenger. No satisfactory explanation was found for this finding.

Table 2 summarizes the results from Table 1. It shows that the average attenuation of the Manhasset shield is

3.3 dBA larger than the Wenger. This is a statistically significant difference, shown by the result of the t-Test, also shown in Table 2.

The measured attenuation is much larger than that from the referenced study. This confirms that the real attenuation by the shields is greatly reduced because of the sound generated by the surrounding instruments and by the protected player. This is shown in Table 3. As stated in the previous study, the shield cannot reduce the noise generated by the protected player as well the generated by the players surrounding him.

The present study performed using real orchestra instruments shows that the average attenuation of acrylic acoustic shields in ideal conditions (no background noise) is less than 10 dBA. Combined with the results from the reference study it questions the benefit of the shields as a means to protect musicians' hearing.

Table 2: Summary of the attenuations.

Shield Type	Mean Attenuation	Standard error
Manhasset	9.2	0.6
Wenger	5.9	0.3
t-Test	0.006	

Table 3: Attenuations measured in this study and by the reference.

	Manhasset	Wenger
This study	9.2	5.9
Reference	2.7	-2.1

4.2 Repeatability

Table 2 shows a reasonable repeatability between the sound levels of the two renditions by the players, something that helps validate the results. Those differences should be the same for both trials, something that didn't show, probably due to variations of the position of the instrument while playing and to directionality pattern of the same. That is quite visible in the case of the trombone, an instrument large enough in comparison to the distance between its bell and the shield.

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The final version was set up by Francesca Copelli from Ryerson University, Toronto.

References

[1] Y. Luo, A. Pham, A. Behar, S. Mosher, and M. Abdoli-Eramaki. Acoustic Shields - A Study of Field Attenuation. Accepted for publication, Canadian Acoustics.