MAX NOISE LEVELS FROM HOCKEY PITCHES

Weigang Wei Apex Acoustics Limited, Gateshead, UK
J Harvie-Clark Apex Acoustics Limited, Gateshead, UK

1 ABSTRACT

A field measurement and a controlled measurement were carried out to quantify the maximum noise levels from hockey pitches. The main noise sources during a hockey match include hockey balls hitting perimeter boards, whistle blows, shouting, and hockey sticks striking the ball. The most significant noise source is the hockey balls hitting perimeter boards. Based on the measurements, it is found that 1) the typical sound power level for maximum sound, L_{AFmax}, is around 118 dB L_{AW} without mitigation, which can be reduced to 105 dB L_{AW} if three layers of turf materials are installed to the backboard; 2) the sound power levels for maximum sound, L_{AFmax}, of stick hitting hockey balls and players shouting are approximately 106 dB L_{AW} and 98 dB L_{AW} respectively; 3) the typical sound power level for maximum sound, L_{AFmax}, of whistles is around 100 dB L_{AW}, however, it can reach as high as 121 dB L_{AW}.

2 INTRODUCTION

The main noise sources during an outdoor hockey match include hockey balls hitting back boards, whistles, players shouting, and hockey sticks striking the ball. Research of such noise sources are mainly focused on the occupational noise impact on officials, mainly the potential risk of hearing loss. A study of the sport officials indicates that the major noise source causing the hearing loss was identified as the whistles with the sound levels ranging between 104 dB(A) and 116 dB(A)[1]. However, this study does not clearly specify if these numbers are sound levels at the ear position of the sport officials. The author further refers to the sound level of whistles may be over 80 dB(A) at 15m (equivalent to 112 dB L_{wA}). In a World Health Organisation report, the noise level from spectators at a sport event can range between 85 dB and 100 dB[2]. This range refers to the noise in large indoor arenas rather than open field sports facilities. A study of indoor hockey matches show that the average noise level is around 90 dB (SD=2) with peak noise level around 133 dB (SD=5) varying slightly at different arenas[3]. A detailed whistle noise level measurement was also carried out in this study and the measured whistle noise is 115 dB (SD=1) at 1.2 m above a hard surface within an arena, equivalent to 125 dB L_w. Other measurements of noise from spectators inside an arena indicate an average noise level around 85 dB(A) with the maximum noise level of 135 dB(A)[4]. An Australian measurement indicates the event's maximum noise level is above 100 dB(A) (SD=5)[5]. This data is mainly for assessing occupational noise impact on participants and all the measurements were carried out in an indoor environment. It is also not possible to accurately predict the sound power levels of these noise sources as the internal acoustic parameters are unknown.

For the noise impact assessment on other noise sensitive receptors rather than the sport officials, the maximum sound power levels from sources on an outdoor pitch need to be quantified. Based on our previous measurements5, the most significant noise source is the hockey balls hitting perimeter boards. This noise level can be reduced by more than 13 dB by wrapping the perimeter boards with a few layers of the synthetic turf. With this mitigation, the most significant noise source is not known. Although the current field measurement studies indicate a typical maximum noise level of 79 dB L_{AFmax} at 10 m[6], the most significant sound source has not been identified and the sound power level is not able to be calculated as the distance between the sound source and microphone is unknown. To address these two outstanding issues, two measurements have been conducted: 1) a field measurement during a normal match while the events (ball impact, whistle etc) and their location were recorded; 2) a controlled measurement at fixed locations when a professional player strikes a hockey ball and lets it hit the fence. With these two sets of measurements, the most significant sound source of a hockey match is identified, and the sound power level for maximum sound is calculated. These data can be used for more consistent and accurate assessments of noise impact.

3 MEASUREMENTS

3.1 Field Measurements during a Hockey Match

The maximum noise levels were measured for 40 minutes during a whole session of an adult / senior hockey game. The arrangement of the measurements is shown in Figure 1. The microphone was 10 m from the edge and 1.5 m above the ground level. The pitch was divided into 4 areas. When a noise event such as a whistle blow or stick hitting the ball occurred in the "near" area, they were noted for the calculation of their sound power levels. The identified number of events are shown in Figure 2. When an event is identified at the "near" area, it is considered that the event occurred at the centre of the "near" area. Therefore, the distance from the source (where the event happened) to the microphone is approximately 25 m.

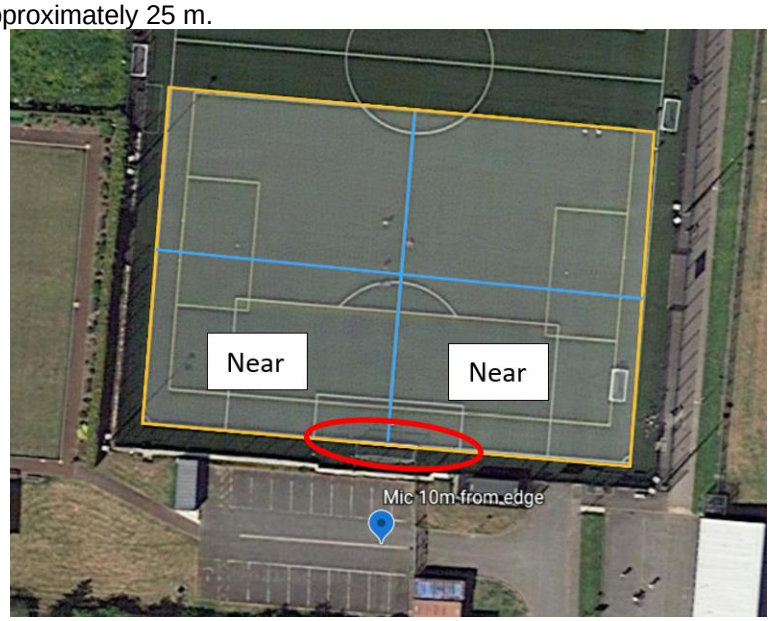

Figure 1: Maximum noise level measurement demonstration

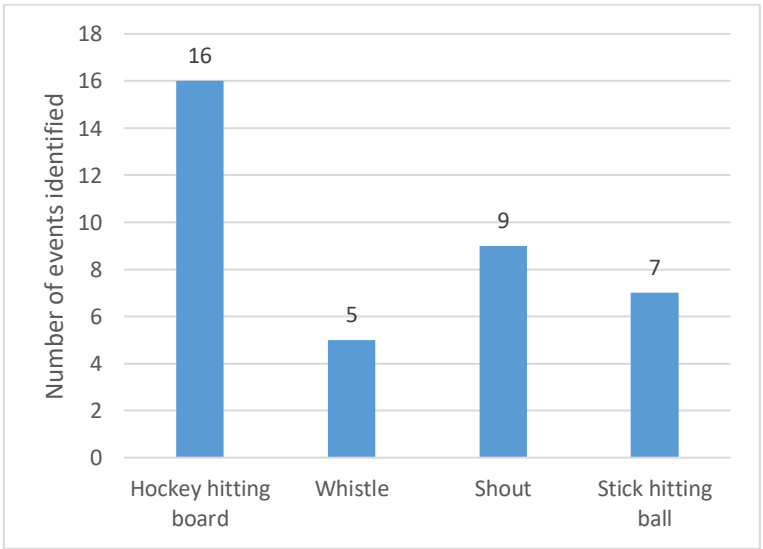

Figure 2: Identified events occurring within the "near" area

3.1.1 Measured noise levels of different events

The highest noise levels of hockey balls hitting back boards were around the area close to the microphone, as indicated in red in Figure 1. These noise levels were used to calculate the sound power levels of the ball hitting perimeter boards. The 10 highest measurements of balls hitting the perimeter board range from 83 dB L_{AFmax} to 91 dB L_{AFmax} at around a measurement distance of 10 m. The logarithmic average of these highest 10 events is 88 dB L_{AFmax}. The measured logarithmic average whistle noise level when it occurred in the "near" area is 64 dB L_{AFmax} with the lowest and highest maximum noise level of 57 dB and 67 dB L_{AFmax}. The measured logarithmic average shouting noise level when it occurred in the "near" area is 62 dB $L_{AFmax,}$ with the lowest and highest maximum noise levels of 55 dB and 66 dB L_{AFmax}.

The sound power levels of these noise events are calculated based on a source-receiver distance of 25 m as shown in Table 1.

Table 1: Sound power level of the maximum noise events during a hockey match

Noise event in a real hockey match	Maximum sound power level, dB L_{AFmax}		
	Highest	Logarithmic average	Lowest
Hockey ball hitting perimeter board without mitigation	119	116	111
Stick hitting hockey ball	105	103	86
Whistle	102	100	92
Shouting	102	98	83

3.2 Measurements under Controlled Conditions

The hockey ball hitting the boards is the most significant source generating the highest noise peaks. It is an efficient mitigation measure to wrap the perimeter board with a few layers of the synthetic turf material. A study was carried out by Apex Acoustics and Nottsports based on 13 no. different turf materials. It is found that by installing three layers of turf on the backboard, a sound level reduction of 13 dB and 20 dB can be achieved for perimeter board and goal board respectively[6].

Once the perimeter board is wrapped with three no. turf layers, the maximum sound levels are reduced to the similar values as other noise events, such as a stick hitting a hockey ball, shouting, and a whistle blow. Another field measurement was carried out to quantify the maximum sound power level of a stick hitting hockey balls. This measurement was undertaken by recording ball striking events at a fixed distance of 10 m. In total 104 strikes on hockey balls were recorded. The measured average maximum noise level is 78 dB L_{AFmax} (SD=2.5), with the lowest and highest maximum noise levels of 70 dB and 84 dB L_{AFmax} respectively. The measured density function is shown in Figure 3.

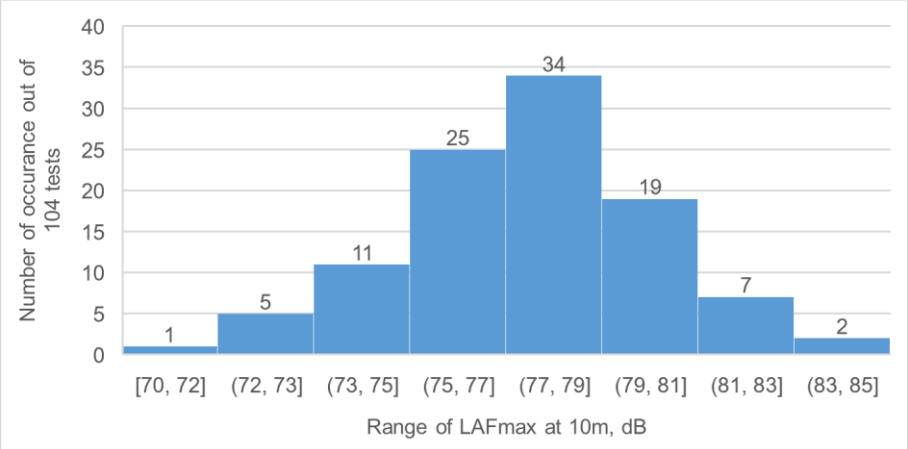

Figure 3: Distribution of the measured maximum noise levels of striking a hockey ball at 10 m

The noise levels of hockey ball hitting backboards were also measured under a test condition. An adult professional player was requested to strike the hockey ball and let it hit the testing backboard. No mitigating turf layers were installed to the testing board. For the goal board, the measured average maximum noise level is 96 dB L_{AFmax} at 5 m with the lowest and highest maximum noise levels of 95 and 97 dB L_{AFmax} respectively.

The noise level of whistle blowing was also measured under test conditions. The microphone was 2 m from the whistle in an outdoor playing field, and the referee blew the whistle really hard. The measured highest noise level of the whistle blowing is 107 dB L_{AFmax} at 2 m.

The sound power levels of these measurements were calculated and shown in Table 2.

Table 2: Sound power level of the maximum noise events in test condition

Noise event in test condition	Sound power level for maximum sound (L_{AFmax}), dB L_{AW}		
	Highest	Logarithmic average	Lowest
Hockey ball hitting goal board without mitigation	119	118	117
Stick hitting hockey ball	112	106	98
Whistle blow	121	121	121

4 DISCUSSION

The difference between the field and test measurements are within 3 dB for average noise levels for the hockey ball hitting backboards and the stick striking a hockey ball. However the highest and lowest maximum levels are more than 10 dB different between these two events. The maximum noise level range of the controlled test condition is smaller than the field measurement condition. It is therefore considered that the average values are more reliable than the highest values.

The measured whistle noise level under controlled test conditions is around 20 dB higher than the field measurement and similar to the value measured for big sporting events inside arenas. The field measurement of whistle noise is considered more reasonable for assessments of small and non-professional outdoor pitches. However, the whistle noise can vary significantly.

5 CONCLUSION

Maximum noise levels were measured during a hockey match and under controlled test conditions. The noise sources of an outdoor hockey match include hockey balls hitting perimeter boards, whistle blows, players shouting, and hockey stick striking. The most significant noise source is identified as the hockey ball hitting backboards. Based on comparison of these two sets of measurements, the average noise levels are considered more reliable and typical to be used in assessments.

The typical sound power level for maximum sound, L_{AFmax}, is around 118 dB L_{AW} without mitigation, which can be reduced to 105 dB L_{AW} if three layers of turf materials are installed to the backboard. The sound power levels for maximum sound, L_{AFmax}, of stick hitting hockey balls and players shouting are approximately 106 dB L_{AW} and 98 dB L_{AW} respectively. The typical sound power level for maximum sound, L_{AFmax}, of whistles is around 100 dB L_{AW}, however, it can reach as high as 121 dB L_{AW}.

6 REFERENCES

1. R. Ammon, K. Mahoney, G. B. Fried, K. Al Arkoubi and D. M. Finn, “Roar of the Crowd: Noise-Related Safety Concerns in,” Journal of Legal Aspects of Sport, vol. 25, no. 1, pp. 10-26, (2015).

2. WHO, “Hearing loss due to recreational exposure to loud sounds - a review,” (2015).
3. K. L. Adams, indoor hockey officials’ noise exposure, temporary hearing loss, and effect of helmet visor length on exposure to whistle noise, Fort Collins: Colorado State University, 2016.
4. B. England and J. B. Larsen, “Noise Levels Among Spectators at an Intercollegiate Sporting Event,” vol. 23, (2014).
5. E. Beach, W. Williams and M. Gilliver, “Estimating young Australian adults’ risk of hearing damage from selected leisure activities,” Ear and Hearing, vol. 34, no. 1, pp. 75-82, (2013).
5. W. Wei, A. Cooke and J. Harvie-Clark, “measurements of hockey ball hitting backboards covered by different materials,” in Proceedings of the Institute of Acoustics, (2018).
6. C. Vaughan, “The assessment of noise from all weather sports pitches,” IOA Acoustic Bulletin, vol. 43, no. 1, (2018).