

Effect of strength (G) on listener envelopment of concert hall 공연장에서의 공간감지표에 대한 음의 세기의 영향

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1. Introduction

Concept of spatial impression has been crucially considered as one of the most influential factors of subjective evaluation of a concert hall. Spatial impression is defined by several acoustical parameters such as listener envelopment (LEV) and apparent source width (ASW). Among these parameters of subjective attributes, LEV has served as a pivotal factor that affects the overall spatial impression. For this reason, LEV has been studied in relations with other parameters like sound pressure level (SPL) and interaural cross-correlation coefficient (IACC). However, in terms of threshold of sound level, it has not been fully investigated though SPL seems to have significant influence.

Therefore, in this study, the effects of SPL on LEV perception were clarified. Also, influences of IACC and RT on LEV were investigated. Then, the minimum level of SPL was determined as a threshold for LEV perception.

2. Acoustical measurements in concert hall

2.1 Measurements

An omni-directional loudspeaker was installed on the stage and 38 points of receivers were located in the audience area, as show in Fig. 1. In order to obtain binaural impulse responses, Head and Torso Simulator (B&K Type 4100) was introduced. Sound pressure level was calibrated so that the equivalent level (L_{eq}) was 75 dBA at the nearest recording position.

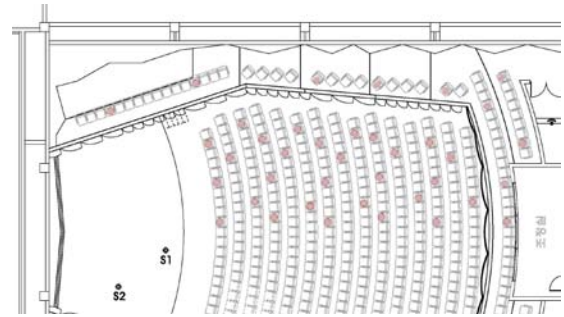


Figure 1 Source and receiver positions

2.2 Acoustical parameter analysis

Measured value of the acoustical parameter in the hall is as follows. The total average value of RT, EDT, C80 and D50, were 1.29 s, 1.25 s, 1.2 dB and 37.7%. And LF, G and IACC were 0.30 s, 4.0 dB and 0.29 respectively.

Among the 38 recording positions, 3 points (A-C) were chosen for the LEV experiments, as shown in Table 1. The 3 points were selected based on SPL and IACC distribution, as shown in Fig. 2.

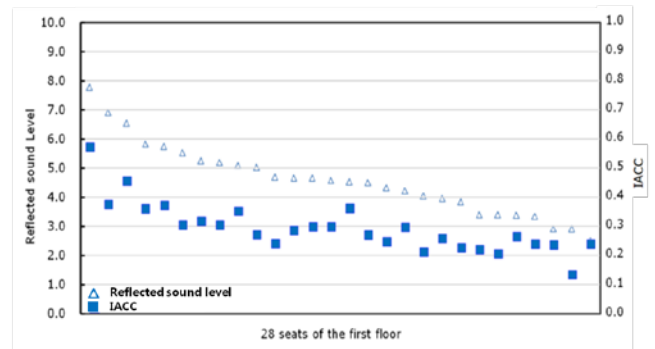


Figure 2 Sound level and IACC of measured positions

Table 1 Acoustical parameters of selected positions

Seat	C80 [dB]	D50 [%]	EDT [s]	RT [s]	LF	IACC	G [dB]
A	3.3	56.2	1.19	1.24	0.25	0.57	7.8
B	3.1	56.7	1.17	1.26	0.30	0.37	7.0
C	0.6	32.4	1.27	1.31	0.33	0.13	2.9

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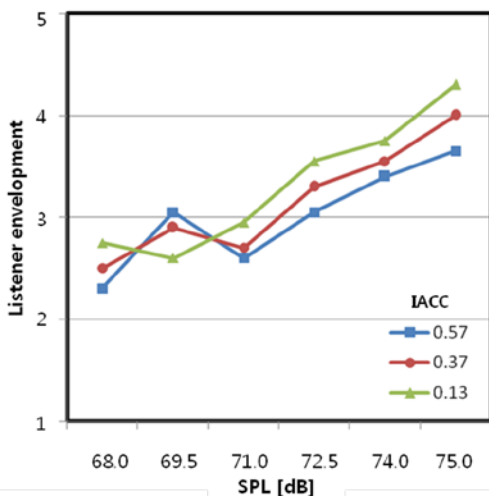
3. Evaluation of perceived LEV

3.1 Outline of the experiments

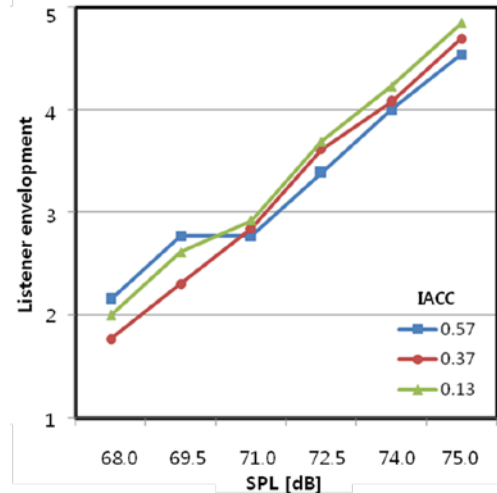
Impulse responses of the three selected points were convolved with an anechoic violin music. The SPL of the convolved sounds were varied from 68.0 to 75.5 dBA with a step of 1.5dB. Also RT of the sounds were manipulated to 1.7 and 2.0 s so that 3 groups of sounds were obtained including that of 1.2 s. The experimental sounds were presented to subjects through stereo dipole system in a semi-anechoic chamber. Nineteen subjects were asked to evaluate the sounds in terms of LEV perception using 5 point scale.

3.2 Result of the experiments

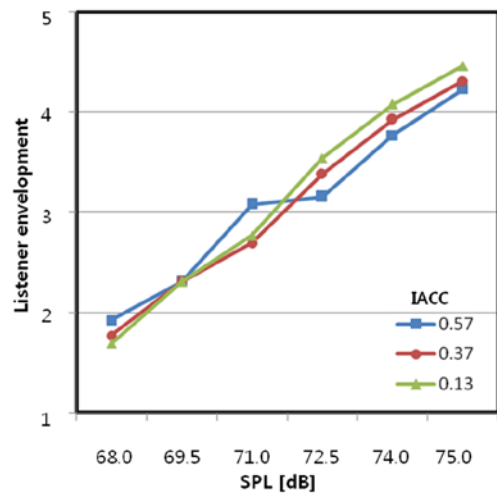
Figure 3 shows the results of LEV perception. In this experiment, level 3 was set to the acceptable level in terms of LEV. This means, level 1 or 2 explain that LEV perception is not acceptable or not desirable, whereas, levels above level 3 indicate satisfactory or good enough. The responses of larger than level 3 were found in the cases that SPL were larger than 70 dBA. Below this level, the effect of IACC on LEV became less. The preference of LEV was increased when the SPL was larger than 70 dBA. The tendency of the results from 3 groups of different RT cases were maintained as similar, as shown in Fig. 3



(a) RT, 1.2 s



(b) RT, 1.7 s



(c) RT, 2.0 s

Figure 3 LEV as a function of SPL

4. Conclusions

In this study, the threshold of SPL for LEV perception was investigated. According to the results, the effects of IACC on LEV were became less when SPL were below 70 dBA. When SPL was over 70 dBA, LEV was increased as a function of SPL. Therefore, the threshold of LEV perception could be assumed as around 70 dBA. The similar tendency was observed among the results of different RT cases. This means certain level of sound energy can be required for to realize LEV perception in concert halls.