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ACOUSTIC CHARACTERISTICS OF GUGAK(KOREAN MUSIC) PRACTICE ROOMS

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ABSTRACT

The acoustic quality criteria for music practice rooms was standardized as ISO 23591. This standard can be useful in constructing and utilizing music education facilities to train excellent musical instrument players. “Gugak,” Korean music, is taught and Gugak performers are trained at major national educational institutions. Recently, a variety of Korean music content has been introduced internationally. However, the acoustic characteristics of traditional houses where Gugak is played do not have a long reverberation time and are flat across frequency bands. This study investigated the acoustic characteristics of Gugak practice rooms in Gugak education institutions. Most of these rooms were found to have short reverberation times and high clarity. The measured reverberation times were also compared with the recommended values specified in ISO 23591. Previous studies have shown that Gugak performers generally prefer practice rooms with shorter reverberation times. Therefore, in the planning and design of Gugak practice spaces, maintaining a short reverberation time is essential. Additionally, the acoustic characteristics of Hanok architecture may serve as a useful reference in designing such spaces.

Keywords: *Gugak, Hanok, Practice room, Room acoustics, Reverberation time*

1. INTRODUCTION

The sound power of Gugak instruments was found to be relatively lower than classical instruments [1]. To establish the optimal acoustic conditions for Gugak practice rooms, it

is need to compare the measurement results of the room's acoustic characteristics with the preferences of the performers. In this study, the results of the indoor acoustic measurements of Gugak practice rooms were analyzed in detail and compared with the recommended reverberation time specified in ISO 23591[2].

2. ROOM ACOUSTIC MEASUREENT OF GUGAK PRACTICE ROOMS

To investigate the room acoustic characteristics of Gugak practice rooms, measurements were taken in eight practice rooms across two Gugak education institutions. The acoustic parameters of reverberation time (RT), clarity indices C50, C80, D50, and Centre Time (Ts), as specified in ISO 3382-1[3], were measured for each room. Acoustic measurements were conducted by generating a swept sine signal using an omnidirectional loudspeaker, with the sound produced by the source recorded at multiple points within the Gugak practice rooms using an omnidirectional microphone. The recorded spatial responses were subsequently post-processed to derive the impulse response for each measurement point. Based on this data, the room acoustic parameters were calculated.

Table 1. Details of the Korean Traditional Music Practice Rooms Measured

Practice room	Volume	RT _{500 Hz}
Private Practice Room 1	16 m ³	0.15 s
Private Practice Room 2	19 m ³	0.31 s
Small Ensemble Room	45 m ³	0.32 s
Daegeum Practice Room	59 m ³	0.34 s
Geomungo Practice Room	111 m ³	0.32 s
Gayageum Practice Room	192 m ³	0.41 s
Ensemble Room	309 m ³	0.51 s
Gugak Orchestra Room	464 m ³	1.02 s

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The practice rooms measured varied in size, from small individual spaces to large orchestral practice rooms, with volumes of up to approximately 464 cubic metres, capable of accommodating the full Korean traditional music orchestra. The volumes and mid-frequency reverberation times for the practice rooms measured are presented in Table 1.

The measurement results of the room acoustic parameters revealed that the reverberation time (RT30) at 500 Hz in most of the Gugak practice rooms was less than 0.5 seconds. Among the eight Gugak practice rooms, five had reverberation times in the range of approximately 0.3 to 0.4 seconds, which was similar to the reverberation time measured in Hanok [4].

3. RESULTS OF THE MEASUREMENT OF ROOM ACOUSTIC CHARACTERISTICS IN GUGAK PRACTICE ROOMS

The room acoustic measurement results of the Gugak practice rooms were analyzed across the octave bands from 63 Hz to 8 kHz. Based on these results and the volume of the Gugak practice room, the upper and lower limits for the appropriate reverberation time for quiet music, as specified in ISO 23591, were calculated, and the recommended frequency characteristic range was applied. These values were then compared with the measurement results, represented by a green dotted line in the reverberation time graph. Furthermore, the recommended ratios for each reverberation time frequency band, as standardized in ISO 23591, were applied to the measurement results and added as a grey dotted line for comparison.

The volume of the Gugak private practice room 1 is 15 m³, as shown in Table 1, which falls outside the scope of ISO 23591. However, the criteria specified in ISO 23591 were applied and compared for reference. The reverberation time in private practice room 1 was found to be less than 0.2 seconds across most frequency bands (see Figure 1). The clarity measurements were also found to exceed 10 dB in most bands, starting from 125 Hz. The D50 values were found to be greater than 0.9 in all bands above 250 Hz, indicating that clear communication was achievable. The RT30 for the 63 Hz band was found to be relatively long, at 0.50 seconds, suggesting the presence of low-frequency resonance.

Figure 2 presents the measurement results for Private Gugak Practice Room 2. The volume of Private Practice Room 2 was 19 m³, which is smaller than the minimum volume of 35 m³ specified in ISO 23591, similar to Private Practice Room 1. The results of the room acoustic measurement results indicated that the room had a short

reverberation time, as well as very high clarity and D50. In the case of Private Practice Room 2, the RT30 for the 63 Hz band was also relatively long, at 0.85 seconds, which is thought to be due to the narrow and elongated shape of the practice room.

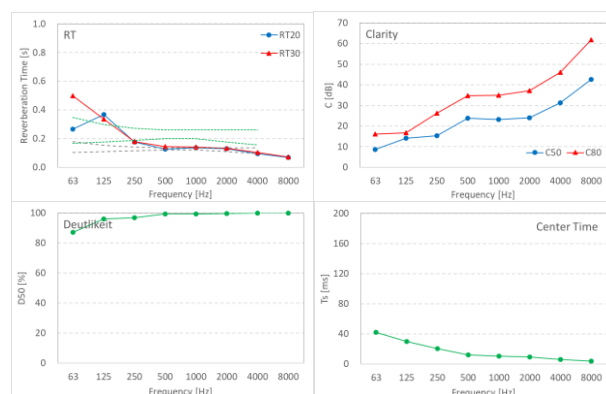


Figure 1. Room acoustic measurement results of private Gugak practice room 1

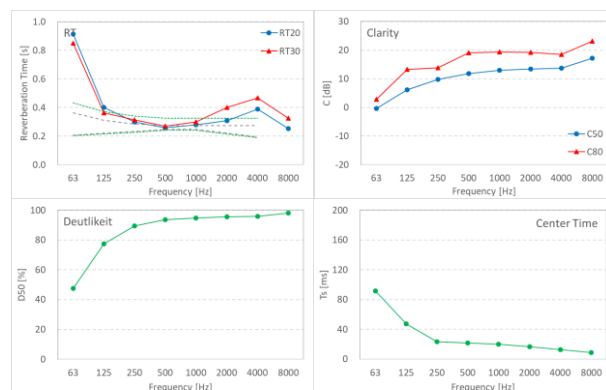


Figure 2. Room acoustic measurement results of individual Gugak practice room 2

Figure 3 shows the measurement results of a small ensemble room with a volume of 45 m³. The RT30 of the mid-frequency band was approximately 0.3 s, but the RT of the band below 125 Hz was relatively long. Compared to the measurement results applying the recommended frequency ratio of ISO 23591 (gray dotted line), the reverberation time of the band below 125 Hz is long. Compared to the recommended reverberation time of ISO 2359 (green dotted line) based on the volume of the space, the reverberation time of the band above 250 Hz was very short, although the band below 125 Hz was included. The



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Clarity, D50, and Ts results also show a space with low reverberation and high clarity overall.

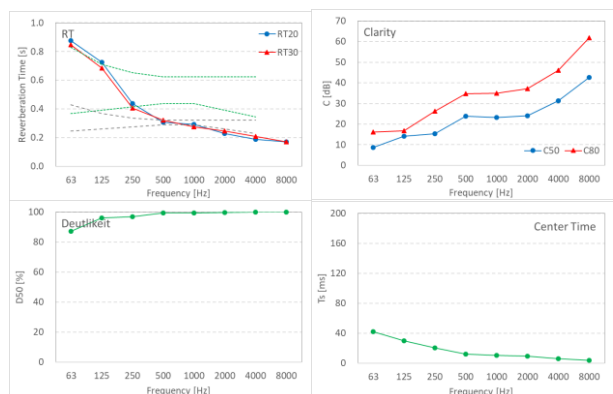


Figure 3. Room acoustic measurement results of Gugak ensemble room

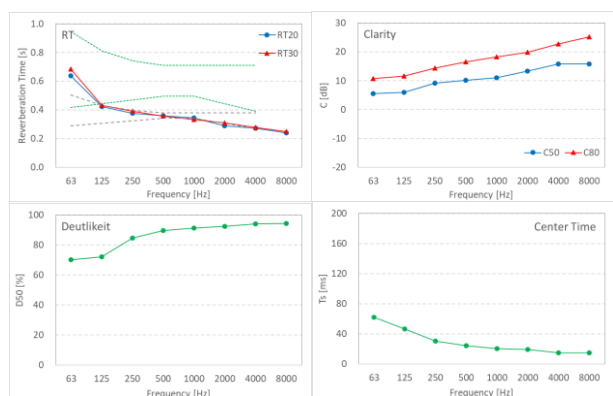


Figure 4. Room acoustic measurement results of Deageum practice room

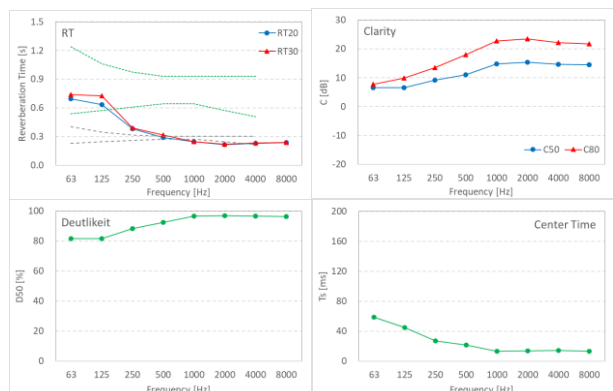


Figure 5. Room acoustic measurement results of Geomungo practice room

Figure 4 presents the measurement results for the Daegeum practice room. With the exception of the 63 Hz band, the RT30 was shorter than 0.4 seconds across all frequency bands. When applying the recommended frequency ratio from ISO 23591, based on the measured reverberation time (grey dotted line), the results were within the recommended frequency range for most bands, except for the 63 Hz band. However, when comparing the measured reverberation time to the recommended values of ISO 23591 (green dotted line), based on the room volume, it was found to be shorter than the recommended reverberation time in most bands. As indicated by the Clarity, D50, and Ts measurements, it can be observed that this is a space where sound is transmitted clearly.

Figure 5 presents the measurement results for the Geomungo practice room, which is approximately twice the size of the Daegeum practice room. Despite the larger volume, the RT30 in the mid-frequency bands was actually shorter than that of the Daegeum practice room. The RT30 in the mid-frequency band was considerably shorter than the recommended reverberation time specified in ISO 23591. Figure 6 presents the measurement results for the Gayageum practice room. The RT30 measurements across frequency bands indicate that the reverberation time in the 125 Hz and 250 Hz bands is longer than in the mid-frequency bands, in comparison to the other Gugak practice rooms. The measured reverberation times were mostly outside both the calculated reverberation time range (grey dotted line), based on the measured RT30, and the recommended reverberation time range (green dotted line), based on the room volume. The D50 and Ts measurement results indicate that the reverberation time in the low-frequency band is longer, and the clarity is somewhat lower, compared to the other Gugak practice rooms.

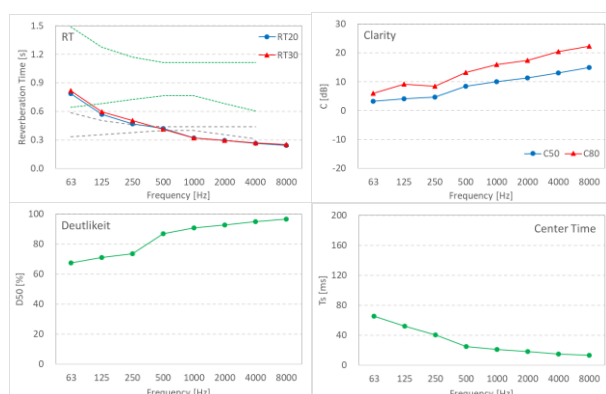


Figure 6. Room acoustic measurement results of Gayageum practice room



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Figure 7 presents the measurement results for the Gugak ensemble room. The RT30 ranged from approximately 0.5 to 0.7 seconds across all frequency bands. This room showed a distribution of reverberation times most similar to the recommended RT range (grey dotted line), calculated based on the measured RT30. However, when comparing the measured results with the recommended reverberation time (green dotted line) of ISO 23591, based on the room volume, it is evident that the measured RT30 is relatively short. The Clarity, D50, and Ts measurement results, by frequency band, showed relatively flat characteristics.

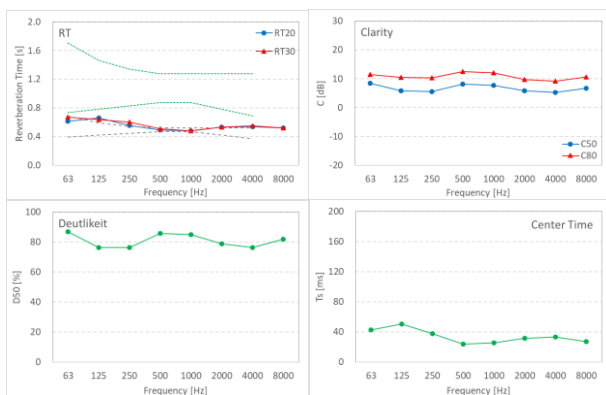


Figure 7. Room acoustic measurement results of Gugak ensemble room

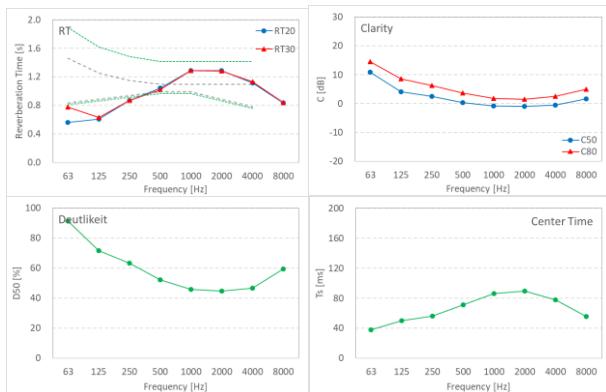


Figure 8. Room acoustic measurement results of Gugak orchestra room

Figure 8 also shows the measurement results for the Gugak orchestra room, the largest of the Gugak practice spaces. The RT30 measurements in the mid-frequency band ranged from approximately 1.0 to 1.3 seconds, which falls within the recommended reverberation time range (green dotted line) calculated according to the space volume, as specified

in ISO 23591. However, the reverberation time in the low-frequency band was found to be relatively short, with RT30 values of 0.87 seconds or less in the bands below 250 Hz. This is believed to be due to the application of perforated plates across the entire wall surface of the space.

4. DISCUSSION AND RESULTS

The results of the indoor acoustic measurements of Gugak practice rooms revealed that most of the rooms had a reverberation time of less than 0.5 seconds, with the exception of the Gugak orchestra room, which had the largest volume. The reverberation time measurements, coupled with the results of the performer survey, indicated that many respondents perceived the Gugak orchestra room as having a long reverberation time. In contrast, Gugak players generally preferred shorter reverberation times in the other practice rooms [5]. The reverberation times in the Gugak practice rooms were found to be shorter than the recommended reverberation time for practice rooms for quiet music, as specified in ISO 23591. This is considered appropriate, given the indoor acoustic characteristics of Hanok[4]. However, the frequency characteristics of the reverberation time in the Gugak practice rooms are thought to require further improvement.

5. ACKNOWLEDGMENTS

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