Heavy/soft Impact Sound Measurement in Small Room

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Introduction

Floor impact sound measurement method in field condition is standardizing in ISO (ISO/DIS 16283-2). In ISO 16283-2, low frequency measurement method in small rooms on tapping sound was regulated. As a heavy/soft impact sound source, rubber ball was standardized. Also, receiving sound field correction method for heavy/soft impact sound was included in ISO 16283-2. Heavy/soft impact sound using rubber ball was measured in the living room of the apartment unit in Korea. The volume of the living room is usually larger than 25 m^3. Nowadays, small apartment with small bedroom is preferred by residents in Korea. In this paper, heavy/soft impact sound using rubber ball in small rooms were conducted and receiving sound field condition was changed intentionally for comparison of receiving sound field correction method.

Heavy/soft impact sound measurement

Heavy/soft impact sound source, such as rubber ball and bang machine is used in Korea, Japan and Canada. Rubber ball was regulated in ISO 10140-5 and ISO 16283-2. Heavy/soft impact sound was being measured in various sound field conditions from a reverberation chamber for a development stage to in-situ condition in apartment buildings. Figure 1 shows various sound field conditions where heavy/soft impact sound pressure level was measured.

Figure 1: Sound field condition where heavy/soft impact sound pressure level measured

Maximum sound pressure level($L_{i,Fmax}$) is regulated as a measurand for heavy/soft impact sound. In the past, it was known that maximum sound pressure level was changed by receiving sound field properties such as reverberation time and sound absoprtion power. However, it was reported that heavy/soft impact sound pressure level($L_{i,Fmax}$) was changed by the change of receiving sound field in reverberation chamber and standard test facility. NRC also investigated that heavy/soft impact sound pressure level was changed by the change of receiving room volume. In this study, heavy/soft impact sound pressure level in small wooden structured room with rubber ball was measured. Receiving sound field condition was changed by the placement of furniture, such as table, bed and sofas. Figure 2 shows the variation of receiving sound field with furniture.

Figure 2: Variation of receiving sound field with furniture

Heavy/soft impact sound was measured in a wooden structured house with concrete topping. Floor plan of source and receiving room was the same. Dimension of the room was 3 m ×3.3 m × 2.4 m. Receiving sound field changed as 6 stage from an empty room to fully furnised condition with table(T), bed(B) and 3sofas(S). At each stage, reverberation time and heavy/soft impact sound pressure level was measured. For the comparison of receiving sound field correction method, standardized, normalized maximum sound pressure level and receiving sound field condition which is newly regulated in ISO 16283-2 were applied.

Heavy/soft impact sound results

Figure 3 shows reverberation time at each receiving sound field conditions. In 80 Hz and higher frequency bands, reverberation time was decreased by the addition of furniture. However, in 50 Hz and 63 Hz bands, reverberation time was not decreased in proportion to the addition of furniture. Reverberation time in low frequency band below 63 Hz band was affected by the level distribution change.

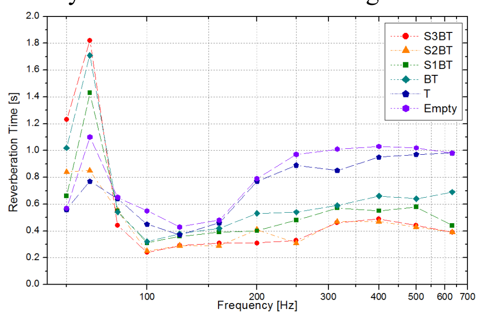

Figure 3: Measurement results of reverberation time

Rubber ball impact sound pressure level was measured with each receiving sound field condition. Figure 4 shows the results. By the addition of furniture, rubber ball impact sound pressure level was decreased in all frequency bands. In the case of 160 Hz band, rubber ball impact sound was changed more than 5 dB. 63 Hz band rubber ball impact sound also changed about 3 dB by the addition of furniture in receiving room. In order to minimize the rubber ball impact sound level change, induced by receiving sound field property, 3 kinds of receiving sound field correction methods were applied and compared. At first, standardized maximum sound pressure level was applied and shown in Figure 5. Rubber ball impact sound level difference in 100 Hz and higher frequency band became smaller.

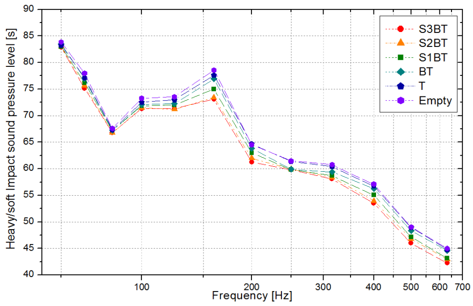

Figure 4: Measurement results of rubber ball impact sound with diffirent receiving sound field condition

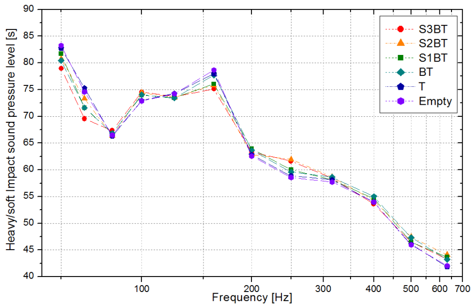

Figure 5: Standardized maximum sound pressure level of rubber ball impact sound with diffirent receiving sound field

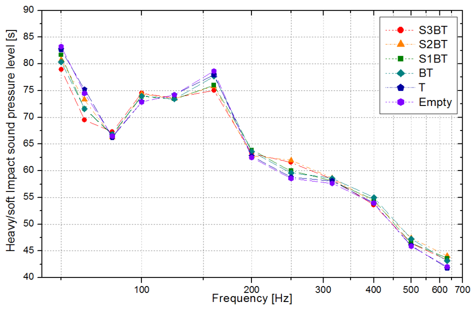

Figure 6: Normalized maximum sound pressure level of rubber ball impact sound with diffirent receiving sound field

Normalized maximum sound pressure level was applied to measurement results and shown in Figure 6. Normalized maximum sound pressure level showed similar results with standardized maximum sound pressure level. In both case level difference in low frequency band below 63 Hz became larger. In ISO 16283-2 and ISO 10140-3 Amd 2, sound field correction method for heavy/soft impact sound pressure level measurement was regulated. Equation below is the receiving sound field correction method.

$$L'_{i,Fmax,V,T} = L_{i,Fmax} + 10\lg\frac{V}{V_0} - 10\lg\left[\frac{1-C_0^{-1}}{1-C^{-1}}\left(\frac{C^{(1-C)^{-1}} - C^{-(1-C^{-1})^{-1}}}{C_0^{(1-C_0)^{-1}} - C_0^{(1-C_0^{-1})^{-1}}}\right)\right]$$

$$C_0 = \frac{T_0}{1.7275} \qquad C = \frac{T}{1.7275} \qquad \text{(A.5)}$$

where

T is the reverberation time for the octave or one-third octave frequency band in the receiving room;

T_0 is the reference reverberation time; for dwellings, $T_0 = 0{,}5$ s;

V is the receiving room volume, in cubic metres;

V_0 is the reference receiving room volume, for dwellings, $V_0 = 50$ m^3

Figure 7 shows the receiving sound field corrected results with ISO 16283-2 and ISO 10140-3 Amd 2 method. Most of the rubber ball impact sound pressure level difference, induced by receiving sound field condition were disappeared except fot 160 Hz band. In the case of 50 Hz and 63 Hz band, rubber ball impact sound level difference did not become smaller.

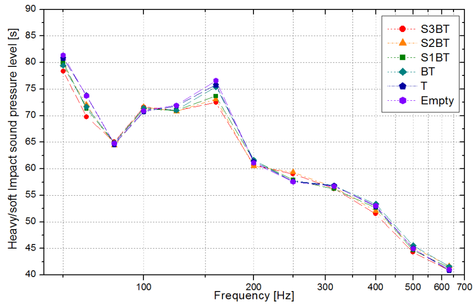

Figure 7 : Rubber ball impact sound level with ISO 10140-3 Amd 2 and ISO 16283-2 with diffirent receiving sound field

Remark

In this study, heavy/soft impact sound with different receiving sound field condition in small room was conducted. Heavy/soft impact sound level was differed by the change of receiving sound field condition. 3 kinds of receiving sound field correction method was applied and compared to measurement results. During the 3 kinds of receiving sound field correction methods, ISO 10140-3 Amd 2 and ISO 16283-2 method showed the best receiving sound field correction performance. However, in low frequency below 63 Hz and 160 Hz band, the heavy/soft impact sound level difference still remained after application of ISO method. The remained level difference may come from the reverberation time measurement method and heavy/soft impact sound measurement position etc.. To improve sound field correction performance of ISO method, measurement and analysis setting of reverberation time will be checked in the near furture. In addition, receiving point for low frequency heavy/soft impact sound in small room should be checked.

Reference

[1] ISO 10140-3 Amd 2 Acoustics - Laboratory measurement of sound insulation of building elements - Part 3: Measurement of impact sound insulation.

[2] ISO 16283-2 Acoustics - Field measurement of sound insulation in buildings and of building elements - Part 2: Impact sound insulation

[3] J.H. Jeong, J.U. Kim and J.G. Jeong, "The effect of receiving room sound field on the heavy-weight impact sound pressure level," Proc. Inter-noise 2012(2012).

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