

Survey method for rubber ball impact sound

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ABSTRACT

Rubber ball impact sound was standardized in ISO standard as for precision and engineering method in ISO 10140 series and ISO 16283-2. Also, a single number quantities for rubber ball impact sound is standardizing. In order to improve low-frequency impact sound isolation performance, quality control in a construction site is one of a necessary point to get reliable isolation performance. A survey method for airborne and light-weight impact sound was regulated in ISO 10052. However, a survey method for rubber ball impact needs to be proposed. To proposed survey method for rubber ball impact sound, the proposed method should be correlated well with measurement results which were measured with precision or engineering method. In this study, field measurements were conducted using KS F 2810-2 with five impact positions and five receiving points in Korean apartment buildings and the results were compared with survey method results which are extracted from the field measurement results.

Keywords: Rubber ball, Floor impact sound, Survey method, Quality Control

1. INTRODUCTION

Rubber ball impact sound isolation performance can be measured in laboratory and field conditions according to ISO 10140-3 or KS F 2810-2, ISO 16283-2 respectively. In order to measure the rubber impact sound isolation performance the centre point and 3 ~ 4 boundary points of the upper unit are used for impact points. Also spatially averaged from measurement results at centre points and 3 ~ 4 receiving points of the lower unit of apartment buildings. In Korea, the height of the receiving point is from 1.2 m to 1.5 m from the floor (see Figure 1. (a)). Floor impact sound isolation performance measurement method for the floor system of the apartment buildings or resilient material using rubber ball is a method for precision or engineering methods and requires a lot of time and high-quality measurement equipment. A study (Ming Li, 2014) was carried out to simplify the measurement method with time and equipment in case of light-weight impact sound.

In general, noise or sound measurement methods are classified into Accuracy Grade 1, 2, and 3 according to the level of accuracy. Survey measurement methods are based on precision or engineering measurement methods and are defined as methods to be used for product screening and quality control by deriving simple measurement methods. Many studies have been carried out to improve the floor impact sound isolation performance and various floor impact sound isolation system have been developed, however, it has been reported that there is a large variation in performance between each apartment unit and quality control of construction stage and after the installation of finishing materials. In recent years, there has been an increasing interest in the quality control of floor impact sound isolation system to minimize such construction variations.

The survey method of light impact sound using a tapping machine was standardized in ISO 10052. Survey method of light-weight impact sound standardized to generate a light-weight impact sound at two or three points and a sound level meter in a lower receiving room to hold a space average of the arm length for about 30 s. Test results by ISO 10052 are reported to be similar to those measured by engineering measures (ISO 140-7) (Chiara M. Pontarollo, Antonino Di Bella, 2013). However, there is no study on the survey method of the rubber ball impact sound.

In this study, the results from survey methods that can be used for the quality control of floor impact sound isolation system in the field condition were compared with the results measured according to KS F 2810-2. As a simple measurement method for the quality control of the rubber ball impact sound, the measurement was made at the center of the lower receiver room, and the case of having the center point in the upper room was compared with the case of having the center point and one boundary point.

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2. SET UP FOR SURVEY METHOD OF RUBBER BALL IMPACT SOUND

In order to compare the measurement method of rubber ball impact sound, the impact sound of the rubber ball was measured according to KS F 2810-2 for the apartment buildings where the finishing was completed and the floor finishing material was not applied; where resilient material for reducing rubber ball impact sound and mortar only. The measured buildings were all about 270 m² wide and from three to nine units were measured for each floor plans. For comparison of the survey method, the rubber ball impact sound level was compared between the impact point and the receiving point for the unit of the upper and lower generations (see Figure 12). In Figure 1, I1 is the centre point, I2, I5 are the two points located inside the apartment house, and I3 and I4 are the points located on the window side. In the case of the receiving point, R3 is the centre point, R1 and R5 are the indoor sides, and R2 and R4 are the outer window side.

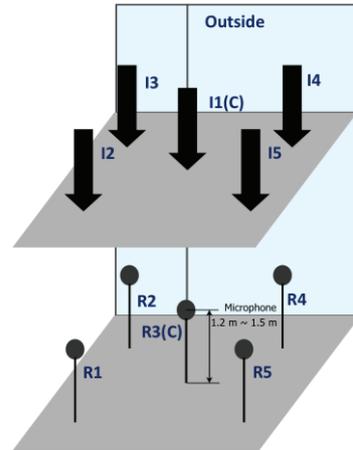
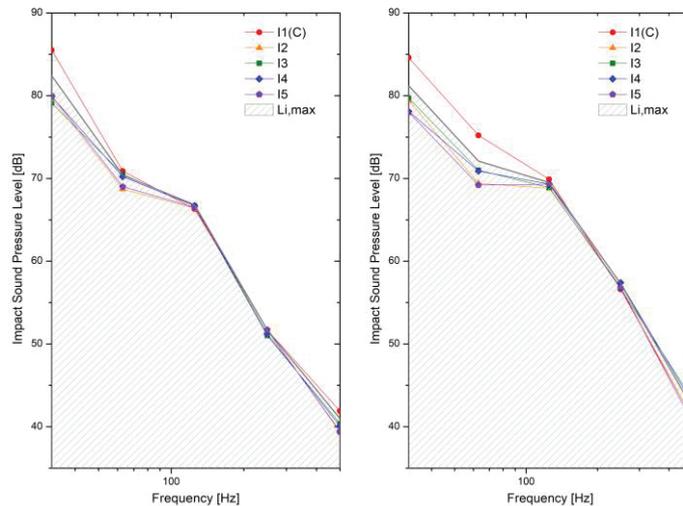


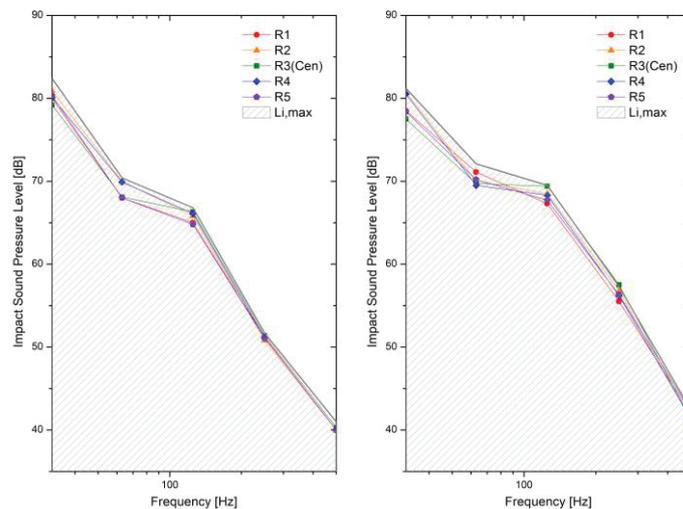
Figure 1 Measurement setup for rubber ball impact sound according to KS F 2810-2

As shown in Figure. 2, the difference between the average frequency characteristics and each impact points was small in the case of the impact point on the window side (I4) in both cases where finishing materials were applied and not applied.



(a) With finishing materials (b) Without finishing materials

Figure 2 Averaged rubber ball impact sound pressure level at 5 impact positions in upper units



(a) With finishing materials (b) Without finishing materials

Figure 3 Averaged rubber ball impact sound pressure level at 5 receiving positions in lower units

Previous studies on the survey method of light-weight impact sound have shown that the I2 position is suitable for survey method. Figure 3 compares the measurement results of the receiving points with the average spectrum, and the centre point (R1) and R4 point have the most similar characteristics. The impact point location for the survey method of rubber ball impact sound was compared and analyzed with the centre point (I1), I2, I4 position. In the case of receiving points, the centre point (R1), and R4 point was used. The combination of the impact point and the receiving point is composed of six cases and was shown in Figure 4

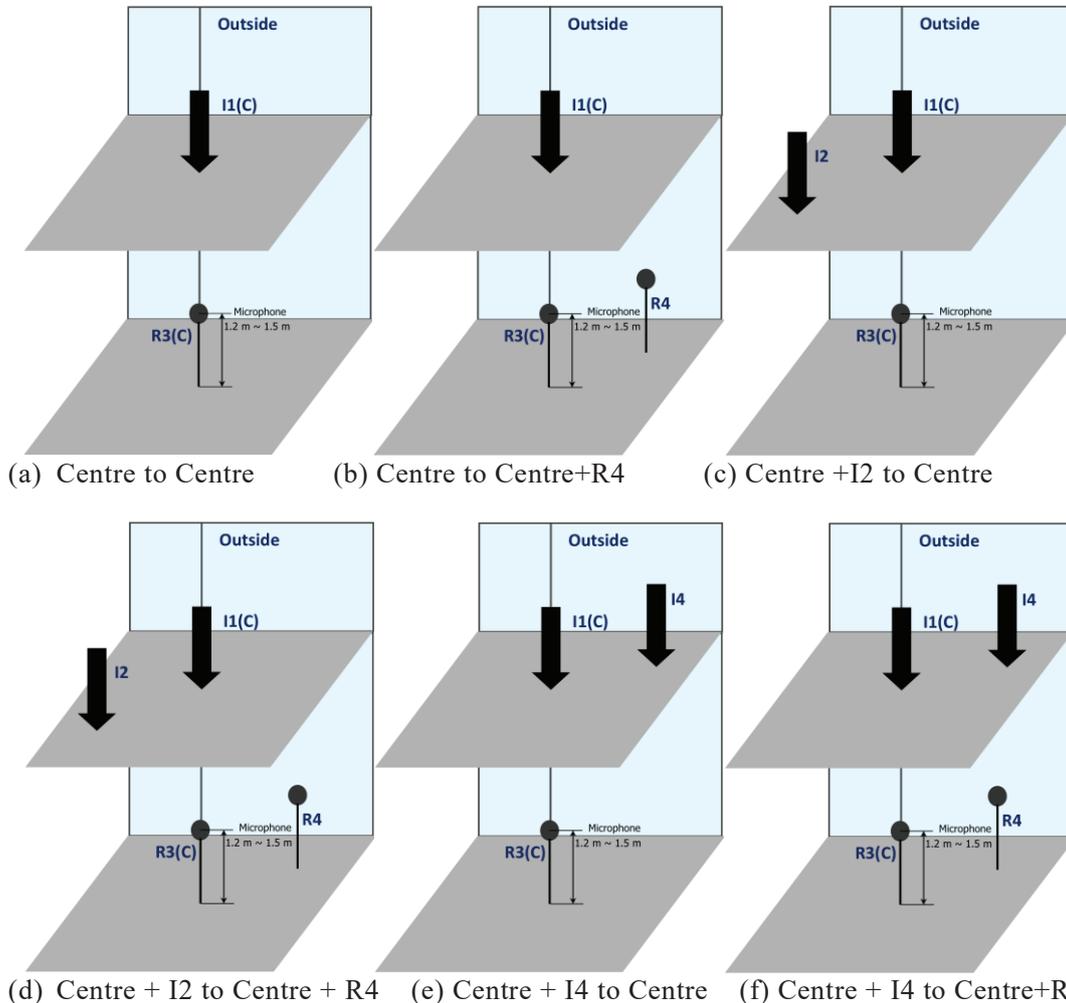
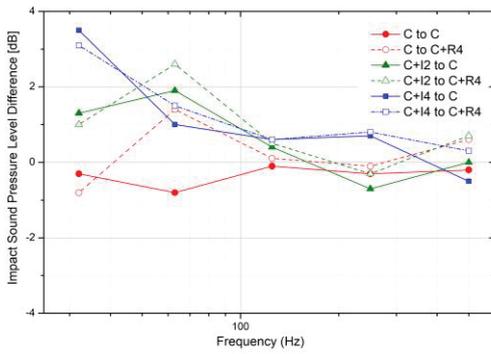


Figure 4 Impact and receiving point setups for the comparison of the survey method of rubber ball impact sound

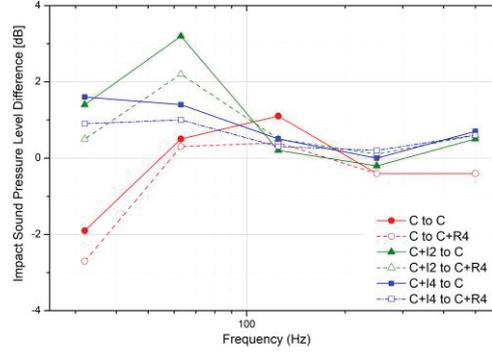
3. COMPARISON BETWEEN SURVEY METHODS

The results of the precision measurement and the survey method were shown in Figures 5 ~ 6, respectively. In ISO 10052, the difference in sound pressure level between the results measured by the survey method and those measured by the precision or engineering measurement method is shown to be within ± 2 dB. Therefore, the limit of the difference between the proposed method and the KS F 2810-2 was set to ± 2 dB.

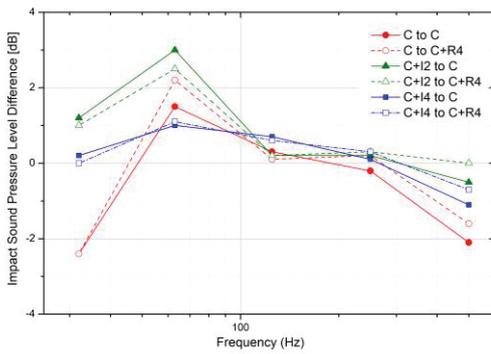
Figure 5 shows the analysis results for the 25 apartment units with 4 kinds of floor plan where installation of finishing material had been completed. In the combination of the six survey methods, it was found that there was a difference of less than 2 dB in the frequency range over 63 Hz bands. In the case of the impact point, the difference was small when the impact points were center point (I1), the center point (I1) and I4 point. In addition, it was found that the difference became smaller when boundary receiving point (R4) and center receiving point (R3) were included as receiving points. When the centre impact point (I1) and I4 point were set up as impact points and the center point (R3) and R4 were set up as receiving points, most of the differences are distributed within 1 dB range.



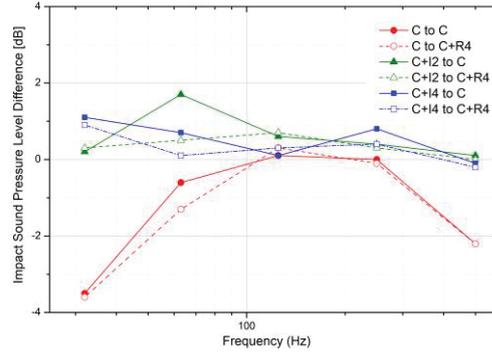
(a) Floor plan A



(b) Floor plan B

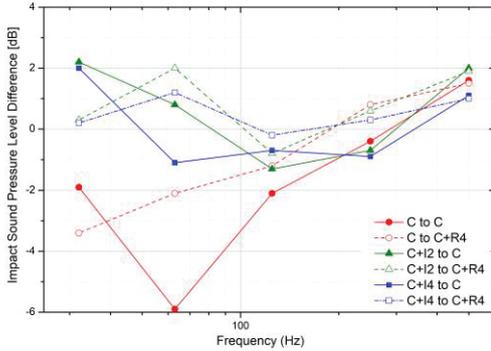


(c) Floor plan C

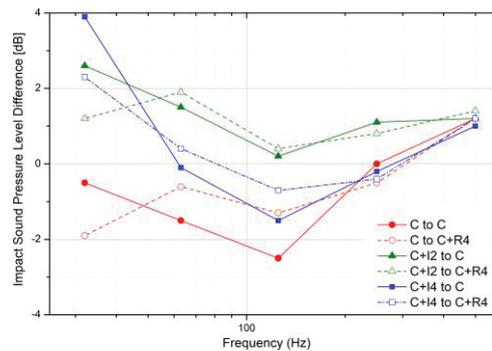


(d) Floor plan D

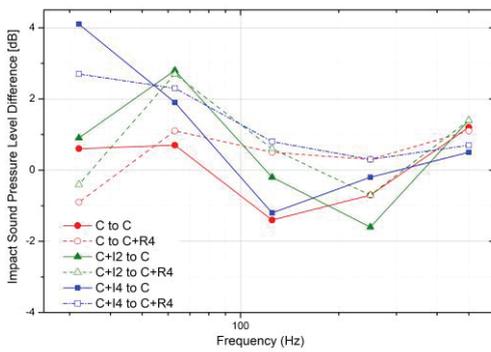
Figure 5 Comparison of rubber ball impact sound pressure level characteristics of the apartment units with finishing materials between the results of the engineering method (KS F 2810-2) and proposed survey methods



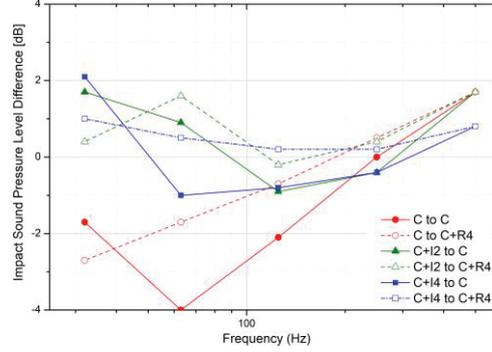
(a) Floor plan A



(b) Floor plan B



(c) Floor plan C



(d) Floor plan D

Figure 6 Comparison of rubber ball impact sound pressure level characteristics of the apartment units without finishing materials between the results of the engineering method (KS F 2810-2) and proposed survey methods

Figure 6 shows the results of analysis for 15 apartment unit without finishing material with 4 kinds of floor plans. In this cases of floor and wall cladding and some doors not installed, therefore the difference between engineering method and survey method was larger than in the case of the apartment house where the finishing materials were installed (see Figure 5). In the case of center impact point (I1) and receiving center point (R3), the differences were often larger than 2 dB. When the I2 point is added, the difference between the frequency bands was became larger. When the I4 is added, the level difference became smaller than that of I2. There was a tendency, as in the case of apartment unit where finishing materials were installed (see Figure 5), that the level difference in the measurement band was reduced when the central point (R3) and R4 are calculated together.

In the case where the impact point and the receiving point are set as a centre point, the level difference from the overall measurement result was sometimes larger than 2 dB. The point where the impact point or the receiving point is selected most similar to the engineering measurement result is within 2 dB difference. In the case of two impact points including the centre point and two receiving points including the centre point, the level difference from the engineering measurement result is less than 1 dB. As a survey method for measuring the rubber ball impact sound, it was considered appropriate to impact and receive at two points including the centre point or the centre point. It is necessary to indicate that the level difference may deviate from 2 dB in case of the centre to centre case. It can be recommended that the method of receiving at two points including the centre point and impact at two points including the centre point because the level difference was smaller than other survey method setup.

4. RRESULTLS AND DISCUSSION

According to the measurement method of KS F 2810-2, there are five impact points including the centre point and five receiving points containing the centre point. The difference between the measurement results obtained by KS F 2810-2; engineering method, method and the results of the six survey methods were calculated and compared. It was found that there was a difference of less than 2dB between the centre impact point to the centre receiving point and engineering method. However, the difference between the centre impact point to the centre receiving point was larger than 2dB. In case of adding one impact or receiving point with the most similar characteristics to the engineering measurement results, the level difference from the engineering measurement result was less than 2 dB. It is analyzed that the level difference was about 1 dB in the entire frequency band when calculated with the setup with two impact points including the centre point and two receiving points including the centre point.

Table 1 – Single number quantity correlation coefficient and the level difference of rubber ball impact sound pressure level between engineering method and survey methods

Case	With finishing materials		Without finishing materials	
	Correlation coefficient	Average of level difference	Correlation coefficient	Average of level difference
Case 1	0.617	-0.04	0.789	-2.49
Case 2	0.679	0.03	0.817	-1.17
Case 3	0.718	0.44	0.904	-0.69
Case 4	0.868	0.56	0.959	-0.05
Case 5	0.694	0.41	0.853	-1.04
Case 6	0.800	0.44	0.840	-0.08

Along with the characteristics of each frequency band, the important measurement result is a single number quantities. Table 1 shows the correlation between the single number quantities calculated from the engineering measurement results and the single number quantities calculated by the six survey methods. Results of correlation analysis showed that increasing the number of impact points and the number of receiving points increased the correlation coefficient with the single number quantities of the measurement results with the engineering method.

In the case of the difference of single number quantities for the six survey methods for two apartments buildings by the presence of the finishing materials, the correlation analysis showed that the case where only the centre point was impacted and received; Case 1, the average single number quantity difference was the smallest, but the average difference was the largest in the apartment where

the finishing materials were not installed. The condition with the smallest average difference of the single number quantities by the presence or absence of finishing was Case 6, which was excluded from the central point and one additional point. Correlation analysis for single numerical quantities, average level difference and characteristic difference analysis by frequency band can be recommended as a survey method for the center point and the method of impact and receiving at one additional point.

REFERENCES

1. ISO 10140-3, Acoustics -- Laboratory measurement of sound insulation of building elements -- Part 3: Measurement of impact sound insulation; 2010.
2. KS F 2810-1, Field measurements of floor impact sound insulation of buildings — Part 2: Method using standard heavy impact sources; 2017.
3. ISO 16283-2, Acoustics -- Field measurement of sound insulation in buildings and of building elements - - Part 2: Impact sound insulation; 2018.
4. J. H. Jeong, S. C. Lee and J. Y. Hong. Survey method of light weight impact sound isolation performance for the quality control of floor impact sound isolation system. Journal of KIAEBS; Vol.13, No,1; 2019, p.1-15.
5. Ming Li. Simplified measurement method for impact sound insulation in buildings, Doctoral dissertation of The University of Auckland; 2014.
6. ISO 10052:2004 Acoustics - Field measurements of airborne and impact sound insulation and of service equipment sound - Survey method.
7. Chiara Martina Pontarollo, Antonino Di Bella. Comparison between field measurements methods of acoustic performances of buildings; 2013, proceeding of AIA-DAGA 2013 Merano.