DOI: 10.61782/fa.2025.0618

FORUM ACUSTICUM EURONOISE 2025

NOISE REDUCTION MAT PERFORMANCE OF APARTMENT HOUSES ACCORDING TO SLAB CONDITIONS

Jinyun Chung[1*] **Gokgon Song**[1]
Ahhyun Cho[2] **Seojin Jeong**[2]
[1] Korea Conformity Laboratories, Cheongju-Si, Republic of Korea
[2] Yonsei University, Seoul-Si, Republic of Korea

ABSTRACT

The floor impact sound problem, which is a living noise that can easily occur in apartment houses, is serious. In particular, Korea has a unique panel heating system called 'Ondol', which installs heating pipes on concrete slabs. Because of this heating system, Korea has a culture of taking off shoes in the living room, and this is the cause of floor impact sound problems. Reduction mats, which are widely used to solve floor impact sound in Korea, are made of various thicknesses and materials. Requirements for confirming the noise performance of the floor impact sound reduction mat are presented in the relevant standard (ISO 10140-5). The base floor is presented as a homogeneous reinforced concrete slab with a thickness of 100 to 160 mm. But, there is a big difference in floor mat noise performance between slabs including ondol structure and single slabs. Most floor in Korea are structures in which an ondol layer is installed on 210mm slab. In this study, the mat reduction performance according to the presence or absence of an ondol layer and the slab thickness was compared. However, the evaluation method used ISO 16283-2's general single number quality (SNQ) to confirm the light & heavy-weight impact sound reduction performance. Through this, it is intended to provide noise performance that can be referred to when consumers select floor mats.

Keywords: *floor impact sound, resilient layer, slab thickness, finishing material, floor mat*

[*] ***Corresponding author***: *jinyun97@kcl.re.kr.*

1. INTRODUCTION

Korea is a world-class country with a population density of 516 people per square kilometer. It ranks first among OECD countries. For that reason, there are many apartments where many people can live together in a narrow area. However, in co-living apartments, living noise between neighbors, especially floor impact sound problems, occurs very seriously. In addition, since Korea uses a panel heating method called ondol on concrete slabs, they live without shoes indoors. Since there are no shoes or slippers that can buffer, the floor impact sound problem becomes more serious. In Korea, it is mandatory to install a resilient material between slab ondol heating to reduce floor impact sound. Even with these efforts, the floor impact sound is the most serious cause of civil complaints in Korea.

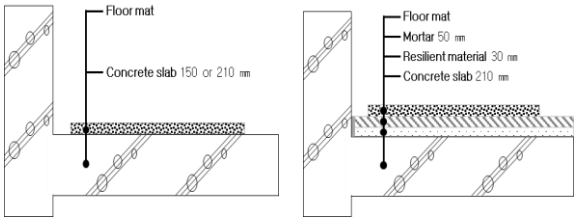
Houses with children use floor mats of various thicknesses and materials to reduce floor impact sounds. Noise performance measurement conditions for floor mats are provided in ISO 10140-5. The test slab is presented in homogeneous reinforced concrete with a thickness of 100 to 160 mm. However, the floor structure in Korea is different from the slab conditions and composition suggested by ISO because the minimum thickness is 210mm and a resilient layer must be installed to reduce floor impact sound.

The purpose of this study is to examine how these differences in floor structure affect the performance of floor mats, and to provide noise reduction performance according to conditions that consumers can refer to when choosing a floor mat

2. MEASUREMENT OVERVIEW

For the floor mat used in the experiment, 12 mats currently used in the market in Korea were selected. There are a total of 12 mats used, 6 inexpensive polyethylene-based products, 3 ethylene vinyl acetate products with excellent stability, and 3 polyurethane products with excellent eco-friendliness. In addition, in order to compare the noise reduction performance of the mat according to the thickness, an experiment was conducted on mats with different thicknesses for each material.

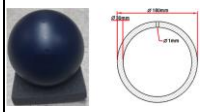
The section of the floor structure used in the experiment is shown in Figure 1. It is a floor structure without a Resilient layer with a thickness of 150 and 210 mm of concrete slab and a slab with a Resilient layer of 210 mm. The Resilient layer is a 'Ondol' structure on the slab, consisting of 'Concrete slab 210 mm + Resilient material (Expanded poly-styrene) 30 mm + Mortar 50 mm'. The measurement equipment used is shown in **Table 1**.



(a) Without resilient layer (b) With resilient layer

Figure 1. Section of test structures.

Table 1. Measurement system.

Measurement system	Products	
Real Time Analyzer	PAK MK Ⅱ (12 channel), Müller-BBM, Germany	
Microphone	46AE(1/2“), GRAS, Denmark	
Light-weight Impact Sound Source	Tapping Machine, 01dB, France	
Heavy-weight Impact Sound Source	Rubber Ball, RION, Japan	

3. MEASUREMENT AND EVALUATION METHOD OF FINISHING MATERIAL

Currently, an evaluation method for evaluating the performance of the floor finishing material is presented in ISO 717-2. However, only the light-weight impact sound single number index (ΔL_w) for the reduction performance of the upper floor coverings is defined, and there is no separate method for evaluating the weight impact sound. In the case of the existing light-weight impact sound reduction evaluation method that can evaluate finishing materials, it is difficult for users to judge performance by looking at figures because the calculation results are difficult for ordinary residents to feel. In this study, we evaluated the insertion loss by confirming the light & heavy-weight impact sound reduction performance and comparing the common single number quality (SNQ) of ISO 16283-2, which is easy to understand when users install floor mat. This method is already widely used as a method of evaluating the floor impact sound of foam mat products. Equations (1) and (2) show how to reduce light-weight and heavy-weight impact sound insertion losses.

$$\Delta L_{Lw}(dB) = L_{without\ covering} - L_{with\ covering} \quad (1)$$

Where, $\Delta L_{Lw}(dB)$: Light-weight impact sound insertion loss due to finishing materials

$L_{without\ covering}$: Floor impact sound level before finishing installation, standardized impact sound pressure level ($L'_{nT,W}$)

$L_{with\ covering}$: Floor impact sound level after finishing installation, standardized impact sound pressure level ($L'_{nT,W}$)

$$\Delta L_{Hw}(dB) = L_{without\ covering} - L_{with\ covering} \quad (2)$$

Where, $\Delta L_{Hw}(dB)$: Heavy-weight impact sound insertion loss due to finishing materials

$L_{without\ covering}$: Floor impact sound level before finishing installation, standardized impact sound pressure level ($L'_{iA,Fmax}$)

$L_{with\ covering}$: Floor impact sound level after finishing installation, standardized impact sound pressure level ($L'_{iA,Fmax}$)

4. RESULTS OF MAT REDUCTION PERFORMANCE

4.1 Acoustic characteristic of floor mat

Figure 2 shows the noise reduction performance of floor mat. As a result of comparing the floor mat by material, the reduction performance of PE products is the best, followed by PU and EVA. In all materials, as the thickness increases, the reduction performance is also excellent. In particular, in the case of heavy-weight floor impact sound, the effect of thickness appears significantly.

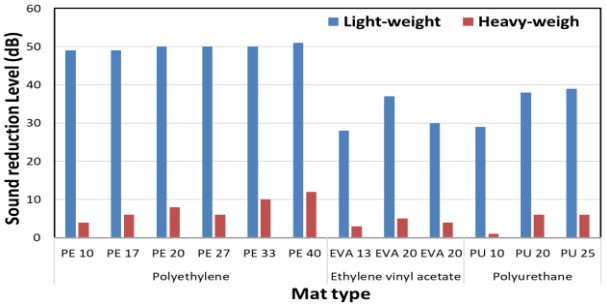
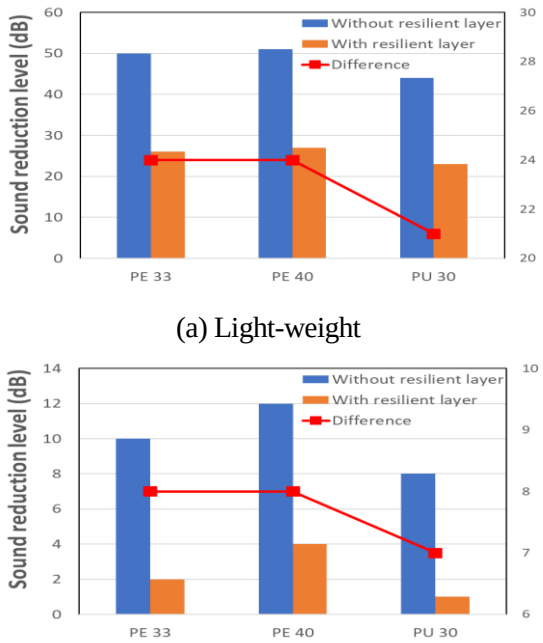


Figure 2. Sound reduction level of floor mat.

4.2 Installation of resilient layer on slab

Korea uses 'Ondol', a panel heating system, on the top of the slab in apartment houses. However, the current International Standard (ISO 10140-5) evaluates the floor impact sound reduction performance under the condition that the installation of a resilient layer on the top of the slab is not considered. Therefore, when floor mat is installed to reduce floor impact sound, on-site reduction performance in Korea may differ from results measured by international standards. Among the 12 types of mats reviewed in 4.1, three representative mats with excellent performance and high use (33 mm PE, 40 mm PE, and 30 mm PU) mat were selected. The floor impact sound reduction performance was compared according to the presence or absence of a resilient layer considering the 'ondol' structure in Korea. As shown in Figure 3, depending on the presence or absence of a resilient layer, there is a difference between 21 and 24 dB for the lightweight impact sound and 7-8 dB for the weight impact sound. Through this, if mat reduction performance is measured on the slab before installing the resilient layer as an ISO international standard measurement method, the noise performance of mat may be overestimated compared to the actual living performance in Korea. A separate evaluation method different from the ISO standard is required for floors where additional layers are installed on the slab, as in Korea.



(a) Light-weight

(b) Heavy-weight

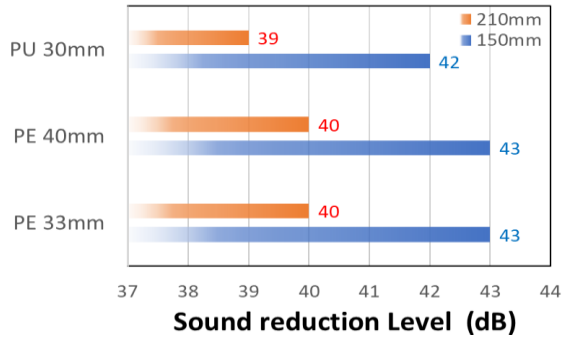
Figure 3. Reduction performance by resilient layer.

4.3 Slab thickness

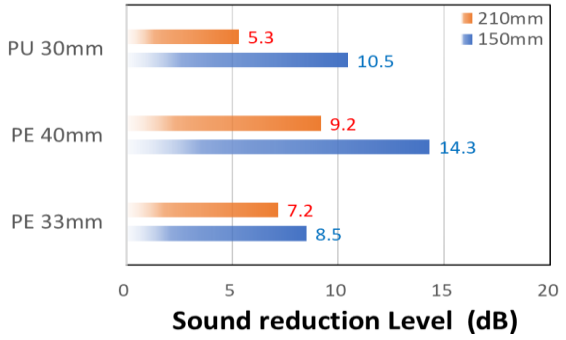
In ISO 10140-5, the reduction performance measurement condition of floor finishing material is 100-160mm in slab thickness, but the minimum slab thickness is 210mm in Korean apartments. This means that evaluating the performance of the finishing material according to ISO measurement conditions is different from the field conditions in Korea. Therefore, it is necessary to examine the possibility that the floor impact sound reduction performance of floor mat will vary according to the change in slab thickness.

The experiment was conducted on the floor mat used in 4.2. Two types of slabs, 150 and 210 mm, were compared, and the reduction performance of the mat was examined in slabs without a resilient layer.

As a result of the measurement, the reduction performance of the mat is evaluated higher by 150mm slab than 210mm. When the slab thickness increases from 150mm to 210mm, the light-weight impact sound decreases by 3dB in all three mats, and the heavy-weight impact sound decreases by 1.3dB to 5.1dB.

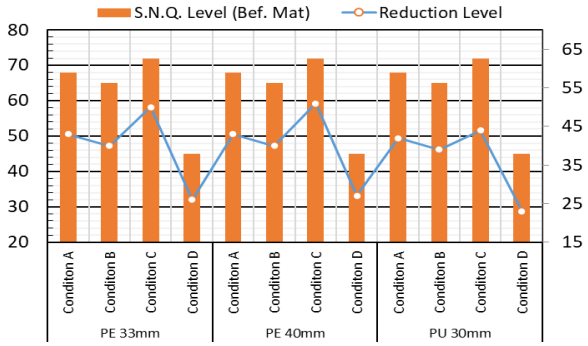


(a) Light-weight

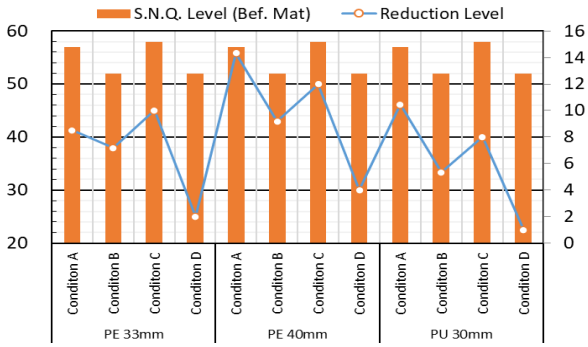


(b) Heavy-weight

Figure 4. Reduction performance with slab thickness.



(a) Light-weight



(b) Heavy-weight

Figure 4. Relationship between SNQ and reduction level.

5. RESULTS

The reduction performance of floor mat varies depending on the conditions of the slab. Slab conditions are not significantly affected by finishing materials such as fly-wood that do not have high sound insulation performance, but finishing materials with high sound insulation performance such as floor mat are affected by slab thickness and the presence or absence of a resilient layer. In the case of floor mats with excellent reduction performance, the reduction performance tends to decrease when the slab thickness becomes thicker or when a resilient layer is installed. Figure 5 is the result of comparing the reduction level of floor mat with the performance before mat installation (SNQ). It can be seen that the reduction performance of the finishing material tends to be excellent when the reduction performance is measured under poor performance conditions. Therefore, in evaluating the performance of the finishing material, it is necessary to clearly present conditions such as the thickness and composition of the slab.

6. ACKNOWLEDGMENTS

This work is supported by the Korea Agency for Infrastructure Technology Advancement (KAIA) grant funded by the Ministry of Land, Infrastructure and Transport (Grant RS-2022-00144050)

7. REFERENCES

[1] ISO 10140-5:2021, “Acoustic – Laboratory measurement of sound insulation of building elements – Part 5: Requirements for test facilities and equipment”.

[2] ISO 16283-2:2020, “Acoustic – Field measurement of sound insulation in buildings and of building elements – Part 2: Impact sound insulation”.

[3] ISO 717-2:2020, “Acoustic – Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation”.