inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 3.0

EVALUATION OF IMPACT NOISE ISOLATION BY CEILING STRUCTURE IN APARTMENT BUILDINGS

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Keywords:
CEILING STRUCTURE, FLOOR IMPACT NOISE, NOISE REDUCTION

ABSTRACT
In apartment buildings, the floor-impact noise has been regarded as the major source to induce complaints from residents. Due to the life style of the heating floor structure (so-called "On-dol") in Korea, a heavy-impact noise as well as light-weight impact noise has become an issue. In this study, the propagation characteristics and the impact of noise reduction effects of air thickness and plasterboard in the existing ceiling structure were evaluated in the Mock-up laboratory. To improve the isolation performance, two different ceiling structures were designed and put into the ceiling space. One was made of porous material and the other was made of foaming polyurethane.

1 - INTRODUCTION
Ceiling space between the concrete slab and ceiling panel is mainly used for space of electric wiring. In the floor impact noise aspect, it is possible to make good use of the ceiling space as an isolation layer that prevent radiating noise toward down-stairs through the floor. As a result, the proper air thickness was found to avoid resonance. The impact noise radiation characteristics of the newly designed ceiling structures as well as the existing ceiling structure were analyzed.

2 - EXPERIMENT

2.1 - Ceiling structure
Table 1 is a result of 8 experiments on ceiling structure that was divided into 4 structure types by the existing structures and evaluated structures.

Type of Ceiling		Floor Structure including ceiling
Existing (building site)	Type 1	Mortar 30mm + Gravel layer 30mm + Lightweight foaming concrete 50mm + Concrete slab 150mm
	Type 2	Mortar 40mm + Lightweight foaming concrete 60mm + Concrete slab 120mm
	Type 3	Mortar 30mm + Gravel layer 30mm + Lightweight foaming concrete 50mm + Concrete slab 150mm + Plasterboard 7mm
	Type 4	Mortar 40mm + Lightweight foaming concrete 60mm + Concrete slab 120mm + Glass wool 30mm + Plasterboard 9mm
Evaluating (Mockup laboratory)	Type 5	Mortar 30mm + Concrete slab 140mm
	Type 6	Mortar 30mm + Concrete slab 140mm + Air-gap 50mm + Plasterboard 9mm
	Type 7	Mortar 30 + Concrete slab 140mm + Poly-urethane foaming 50mm + Plasterboard 9mm
	Type 8	Mortar 30 + Concrete slab 140mm + Air-gap 50mm + Glass fiber 2mm + PVC felt 5mm + Plasterboard 9mm

Table 1: Outlines of 8 experiments on ceiling structure.

2.2 - Experiment specification

Table 2 shows the specification for mock up test room. Ceiling's finishing material, air gap's thickness within the ceiling, and porous material can be varied to measure.
Measurement of light-weight impact was done at each measuring point for 10 seconds followed by measuring the linear average onto using 50 Hz − 5 kHz frequency range's 1/3 level, then calculating with 1/1. At the same time, heavyweight impact measurement was done using the trigger for 3 times on each measurement point for total of 8 seconds on 25 spectrum (0.4sec/spec). Measuring the peak level, which is the result of averaging the final 3 measurements, then followed it.

Item	Specification of test room
Size	3,000mm (W) × 3,900mm (D) × 3,000mm (H)
Volume	31.2m^3
Structure	RC
Thickness of slab	150mm
Thickness of wall	200mm
Mean absorption (m^2)	10.9

Table 2: Outlines of Mock-up laboratory.

3 - RESULT & ANALYSIS

3.1 - Existing ceiling structure's floor impact noise radiation characteristic

Test room experiment Figure 1 is the measurement outcome conducted at the mock-up test room by 1/3 octave band centered frequency within the frequency range of 50 − 10,000 Hz of floor impact noise performance of Type 5 which is a non-ceiling structure and Type 6 which contains 50 mm air-gap and 9 mm plasterboard. In case of lightweight impact noise, noise reduction of 8 − 15dB was measured when the frequency was over 315 Hz. It was also proved that the heavyweight impact noise showed the noise reduction of 3 − 8 dB within the range of 125 Hz − 2,000 Hz frequency.
Field Experiment
Figure 2 is the field experiment results of comparison for floor impact noise level based on the installation of double-layered ceiling. Type 3 is the case with 7 mm plasterboard finished underneath the slab. Type 4 is the case with installing a glass within the air-gap of double layered ceiling. In case of Type 3 the impact noise level shows an increase within the low frequency range of 63Hz on ceiling installation while a decrease of impact noise level is measured at the frequency of 250 Hz or higher. Type 4 indicates an overall decrease of floor impact noise level by adding the glass layer within the provided space.

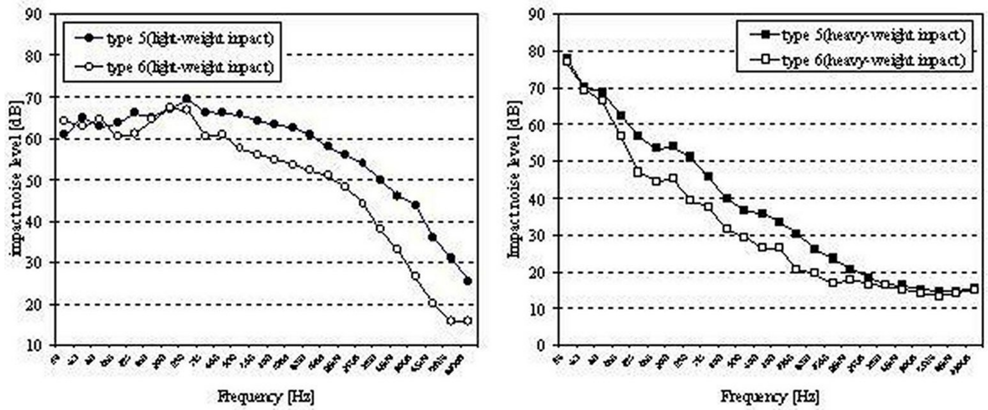

Figure 1: The measurement outcome conducted at the mock-up test room.

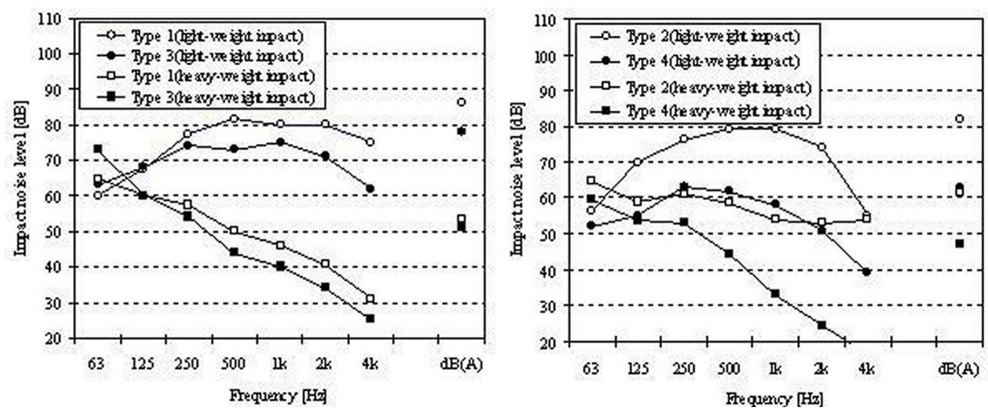

Figure 2: The field experiment of floor impact.

3.2 - Evaluated ceiling structure's floor impact noise & radiation characteristic

Figure 3 is the result of measurement given by 50 − 10,000Hz frequencies within 1/3 octave band center frequency on floor impact setup at the mock-up testroom on the following condition:
Type 6 which consists of 50 mm air-gap and 9 mm plasterboard beneath the concrete slab in ceiling structure; Type 7 which is the structure of 50 mm air-gap added with 50 mm Poly-urethane foaming; Type 8 which consists of 9 mm plasterboard with 2 mm glass fiber and 5 mm PVC felt.
Lightweight impact showed noise reduction within the 200 − 3,150 Hz, and the Type 7 showed the most noise reduction. In case of heavyweight impact noise, Type 8 showed a noise reduction within-125 − 800 Hz range and Type 7 within the frequency range of 125 Hz and above.

4 - CONCLUSION

- It has been proved that in case of the lightweight impact noise, over 315 Hz-frequency range and in case of heavyweight impact noise with the range of 125 Hz − 2,000 Hz showed the effectiveness of noise reduction.
- Double-layered ceiling proved to be more effective towards lightweight impact noise, and in case of heavyweight impact noise, it showed less noise reduction, however with the insulation of Poly-urethane foam in Type 7, it proved to be more reduction effective towards middle frequency range.
- Therefore, an additional check up on material's density and thickness is planned to improve the effectiveness of Poly-urethane foam on frequency range below 125 Hz.

REFERENCES

1. **Kajima express**, *Noise and Vibration Control of Buildings*, pp. 126-127, 1988
2. **Cyril M. Harris**, *Handbook of Noise Control*, pp. 23.17-23.18, 1979

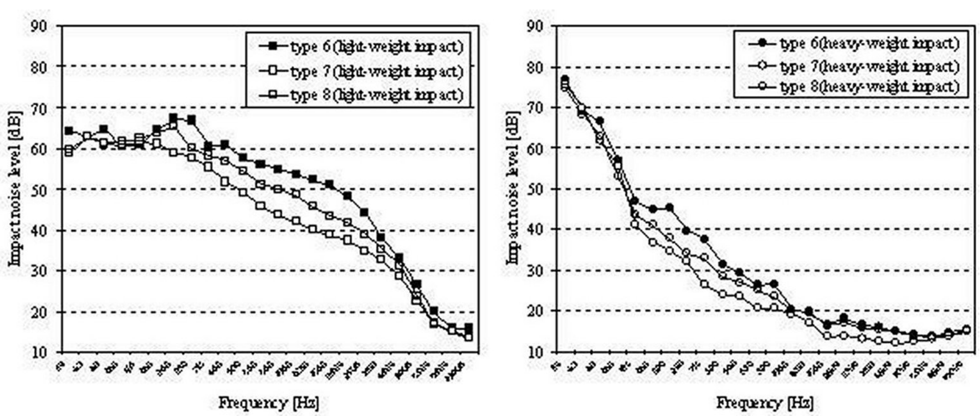

Figure 3: Evaluated ceiling structure's floor impact noise & radiation characteristic.