Application of Sound Insulation Technology in Floating Floor

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Abstract. In this paper, the sound insulation performance of the floating floor is studied from the perspective of its structural application. The field test shows that the sound insulation improvement value of the dry laying method is higher than that of the wet sticking method. At the same time, the influence of the construction technology of the floating floor on the load and net height of the building structure is summarized and compared. Finally, the weighted standardized impact sound pressure level of the field test is higher than the normalized impact sound pressure level measured in the laboratory. This universal phenomenon is analyzed. This paper puts forward the construction technology of dry laying method of floating floor with sound insulation mat, which can provide reference for the construction of sound insulation mat laying on reinforced concrete floor and the design of building structure.

1. Introduction

The research shows that the normalized reinforced concrete floor slab standardization impact sound pressure level is 78 dB~85 dB [1-2]. Even if a thick material such as 50 mm cement coke and floor tile stone is added on the floor [3], the impact sound pressure level cannot be satisfied with standard requirements. Floating slabs are a good sound insulation measure, and paving does not change the building structure, which has attracted the attention of many researchers. Buratti and Moretti [4] believe that the effect of floating slab construction on sound insulation performance is extremely significant. Vinokur [5] passed various floor test tests, and also believed that in actual slab construction, the sound bridge caused by construction has a significant impact on sound insulation performance. There are few studies on the effect of sound insulation on the construction of floating slabs in China, especially in the case that the wet-laid method is mature and widely used, it is generally only explored from the perspective of sound insulation materials. Xiaoli Xie [6] tested the sound insulation effect of floating floor slabs from the thickness of the sound insulation mat, the material and the angle of the baseboard. However, the influence of other paving processes on the sound insulation effect is not known. Therefore, five floating floor slab tests and analysis were carried out for the two floating slab construction techniques of wet and dry slabs, in order to optimize the impact of reinforced concrete slabs. Acoustic performance provides an effective method.

2. Experiment

2.1. Experimental Method

In this study, five sets of houses in a residential project community were selected as experimental sites, and the size and room area of each house were consistent. Select A and B two different brands of sound insulation mat products for multi-party verification, both products are extruded polyethylene foam material, thickness of 3 mm and 5 mm, using dry and wet stickers for four sets of housing
performing sound insulation mat floating slab structure, comparing and analyzing the sound insulation effect of the reference slab without sound insulation measures, and then standardizing the impact sound pressure level of the four floating slabs measured on site and the laboratory measured. The normalized impact sound pressure level is explored, and the reasons for the large difference in the impact sound pressure level of the weighted standardization are analyzed. The detailed construction of the process using the dry-laid method and the wet-laid method is shown in figures 1 and 2.

![Figure 1. Structure of the sound insulation mat (dry paving).](image1.png)

![Figure 2. Structure of the sound insulation mat (wet paving).](image2.png)

### 2.2. Theoretical Research

Field test is the main way to study the sound insulation technology of floating floor slabs. Because the field test is more complicated than the laboratory test, it includes various lateral sounds in addition to the up and down direction [7-8]. Therefore, the field test should consider the reverberation time of the receiving chamber, and calculate the standardized impact sound pressure level $L_{nT}$ [9].

$$L_{nT} = L_i - 10 \log \frac{T}{T_0}$$

(1)

Here $L_i$ represents impact sound pressure level. $T$ is reverberation time of the receiving room. $T_0$ is reference reverberation time, for residential $T_0=0.5$ s. According to the Chinese standard GB-50118-2010 code for design of sound insulation of civil buildings, the impact sound insulation of 16 1/3 octave frequency ranges from 100 Hz to 3150 Hz is measured, the impact sound pressure level curve is obtained, and the weighted standardized impact sound pressure level $L_{nT}$ is obtained by referring to the impact sound evaluation standard curve.

In addition, the impact sound improvement value $\Delta L$ is used to compare the sound insulation effect of various floating floors more intuitively.

$$\Delta L = 40 \log \frac{f}{f_0}$$

(2)

Here $f$ is noise frequency, while $f_0$ means resonant frequency of the sound insulation mat, where $f_0$ is determined by $E$, $m$ and $d$:

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{2E}{md}}$$

(3)

where $E$ is the elastic modulus of the sound insulation mat, $d$ represents the thickness of the sound insulation mat.
3. Influence of Sound Insulation Mat Paving Process on Sound Insulation Performance of Impact Sound

The sound insulation mat paving method has a significant impact on the sound insulation performance of the floor and the safety performance of the building structure. In this study, the paving methods of figures 1 and 2 were used to lay out the type A and B sound insulation mat products. The reinforced concrete floor slab is 120 mm thick and smeared with the original slurry. The dry-laid process uses dry cement mortar and wire mesh with total thickness of 35 mm. The wet-paste process uses fine stone concrete with a bi-directional steel bar thickness of 40 mm and a floor tile thickness of 8 mm. The sound insulation mats are respectively made of extruded polyethylene foam insulation mats of 3 mm and 5 mm thick, and each has a baseboard sound insulation structure [10]. The effect of the sound insulation mat dry and wet paving process on the sound insulation performance of the floor impact sound is shown in figures 3 and 4.

Figure 3. Effect of different paving technology of sound insulation mats on impact sound insulation of floor.

Figure 4. Analysis of the impact sound improvement value of each floor.

It can be seen from figures 3 and 4 that the sound insulation improvement values of the four floating slabs is basically consistent with the frequency distribution law, and the curves of the impact sound improvement values at different noise frequencies are the same. Studies have shown that the sound absorption capacity of floating floor slabs mainly acts in the middle and high frequency bands of 250 Hz to 4 kHz. The thicker the sound insulation mat, the better the sound insulation effect. Among them, the impact sound improvement value of the 3 mm dry process floor slab using B product is 6 dB. According to the data of the sound pressure level measurement of the standardization floor slab, the sound insulation improvement value is higher than that of the similar product 5 mm wet process. The value is more than 2 dB. Under the same sound pressure level, the dry process requires less thickness of the sound insulation mat than the wet process. Therefore, the sound insulation
performance of the sound insulation mat with equal thickness can be significantly improved after adopting the dry process. In addition, the thickness of the floating slabs using the wet and dry methods of the 5 mm sound insulation mat is 45 mm and 40 mm, respectively, and the loads are 1 kN/m² and 0.8 kN/m², respectively. When paving tiles or stone indoors, 20 mm fine stone concrete cushions need to be laid, and materials such as fine stone concrete in floating floor slabs can also be used as cushions for vitrified bricks or stone. Therefore, in the case of indoor paving of vitrified tiles or stone, the floor load generated by the 5 mm sound insulation mat floating floor slab is 0.5 kN/m², and the resulting thickness is 25 mm, and the impact is relatively small. In addition, the dry-laid method does not need to pre-wet the block or the wall surface with water before construction. After the surface dust removal, the special masonry mortar or the plastering mortar is used for the block masonry or the wall flour brush to realize the dry brick masonry. Dry wall plastering effectively avoids the phenomenon that the traditional wet-laid construction is likely to cause cavity cracking, hollowing, and leakage.

In summary, in the actual engineering application of floating slabs, the dry-laid method can be used to further improve the sound insulation performance of floating slabs. In the process of building structure design, the construction thickness of 7 cm to 10 cm should be reserved and the design value of 1 kN/m² load should be increased based on the original load.

4. Comparison of Single Value Evaluation of Impact Sound
Comparing the weighted standardization of the impact sound and the weighted normalized impact sound is the main way to explore the reasons for the difference between the sound insulation results of the floating floor slab impact sound field test and laboratory test. In this study, 3 mm thickness of sound insulation mat was selected for floating floor slab laying. The construction practices and results of floating slabs using weighted normalized impact sounds and weighted normalized impact sounds are shown in table 1, figures 5 and 6.

| Structural practice | Weighted standardized impact sound pressure level | Weighted normalized impact sound pressure level |
|---------------------|--------------------------------------------------|-----------------------------------------------|
| Floor impact sound pressure level without sound insulation | (1) 120 mm reinforced concrete slab | (1) 120 mm reinforced concrete slab |
|                     | (2) 3 mm sound insulation mat | (2) 3 mm sound insulation mat |
|                     | (3) Sound insulation mat protective film with reinforcement | (3) Sound insulation mat protective film |
|                     | (4) 35 mm dry cement mortar with reinforcement | |
|                     | (5) 8 mm vitrified brick | |
| Weighted impact sound pressure level | 79 dB | 78 dB |
| Reduction of sound pressure level | 73 dB | 63 dB |
| Reduction of sound pressure level | 6 dB | 15 dB |

It can be seen from table 1 that the improvement of the weighted normalized impact sound insulation of the sound insulation mat with a thickness of 3 mm is 15 dB, and the improvement of the weighted normalized impact sound insulation is 6 dB, and the sound insulation improvement value is quite different.

It can be seen from figures 5 and 6 that under the condition of normalized impact sound detection, the sound insulation of the floating floor slab has obvious improvement effect in the middle and high frequency bands, and the sound insulation improvement ability increases with the increase of the frequency, and the middle frequency sound insulation improvement value for 10 dB to 20 dB, the high-band sound insulation improvement is greater than 25 dB. The application of the weighted
standardization impact sound has a lower sound insulation improvement value in the low frequency band, and the sound insulation improvement value in the middle and high frequency bands is about 5 to 10 dB, and the sound insulation improvement value is not obvious at different frequencies.

Through analysis, the reasons for the difference reduction of sound pressure level between the weighted standardized impact sound pressure level and the weighted normalized impact sound pressure level are mainly as follows:

1) The field test adds a lateral sound path to the sound transmission method compared to the laboratory test. The impact sound of the laboratory floor is basically transmitted through the vertical direction. In addition to the vertical sound transmission, the floor sound of the floor test will transmit the sound energy to the surrounding room through the lateral sound of the surrounding wall and frame structure, resulting in standardized impact. The sound is louder than the normalized impact sound.

2) The field test is close to the actual application and 8 mm vitrified bricks are added. According to the calculation formula of floor acoustic noise frequency \( f_0 = \frac{1}{2\pi} \sqrt{\frac{2E}{md}} \), the noise frequency is a function of the elastic modulus E of the material [8]. The elastic modulus of common vitrified bricks is higher than that of cast-in-place concrete, so laying The vibrating brick produces a larger impact sound than the unpaved cast-in-place concrete slab, resulting in a laboratory-tested slab impact sound pressure level improvement value that is less than the weighted standardized impact sound pressure level improvement value.

3) The sound bridge was laid on site. Floating slabs have high requirements on construction technology, and the influencing factors are numerous and complicated. During the on-site construction

**Figure 5.** Comparison of standardized impact sound pressure levels and normalized impact sound pressure level.

**Figure 6.** Comparison of reduction of sound pressure level between standardized impact sound pressure levels normalized impact sound pressure level.
process, the soundproof vibration damping mat is damaged, the water is accumulated, the lap joint is not properly handled, the slurry is leaked, and the pipeline is improperly laid, which will cause the ground and the base layer to be rigidly connected, so that the vibration is directly transmitted to the cast-in-place reinforced concrete floor through the surface layer. The sound bridge is generated, so that the sound of the impact sound of the floating floor slab fails to reach the normalized impact sound insulation.

5. Conclusion
In this paper, through the experimental research on the construction technology of floating floor slab wet deposition method and dry shop method, the conclusions are as follows:

1. Under the same sound pressure level, the dry-laid method of floating floor is lower than the thickness of the sound-insulating mat required by the wet-laid process, and the sound insulation improvement value of the 3 mm thickness sound insulation mat using the dry-laid process is higher than that of the wet paste. The process has a 5 mm thickness sound insulation mat of 2 dB or more. In practical engineering applications, dry-laid methods are recommended to further improve the sound insulation performance of floating floor slabs and avoid the empty drum probability caused by traditional construction methods.

2. In the case of indoor paving of vitrified bricks or stone, the load increment and thickness increment generated by the floating slab are 0.5 kN/m² and 25 mm, respectively, and the floating slab dry slab method is compared with the wet splicing process. The thickness is 0.2 kN/m² and 5 mm, respectively. The construction thickness of the floating slab of 7 cm to 10 cm should be reserved during the design of the building structure, and the design value of the load of 1 kN/m² should be added on the basis of the original load.

3. Compared with the wet-laid process, the floating floor slab dry process has a load value and thickness of 0.2 kN/m² and 5 mm, respectively. The load increments and thickness increments generated by the floating slabs are 0.5 kN/m² and 25 mm, respectively.

4. The reasons for the difference between the weighted standardized impact sound level and the weighted normalized impact sound level are different: (a) The indoor background noise is large when the scene is detected. (b) The lateral sound is added in the sound transmission mode. (c) Increase the vitrified bricks in the construction of the site. Corresponding improvements should be made during field testing to avoid background noise and other interference with the test.

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