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FLOOR IMPACT NOISE REDUCTION EFFECT OF POLYESTER FELT

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Abstract

In Korea usually walking barefoot in the room unlike Western ways, the noise from children running barefoot in apartment houses has caused perpetual frictions between neighbors. For this reason the government established a regulation to reduce the floor impact noise, as a result almost all apartment houses have been enforced to use the floor structure with 210mm thickness concrete slab and 120mm thickness of floor heating system since July 2005. If do not want to apply this kind of system, they should have to use the system which obtain the certification from the institution appointed by government. In this reason a lot of construction material companies and construction companies have been trying to develop the system with 180mm thickness concrete slab which could reduce the cost. To develop the optimized floor system, actual size test building were constructed and the materials related with reducing floor impact noise were composited and tested in the test building. Through this procedure the most effective system were found.

INTRODUCTION

As society has become more dynamic and its problem more complex, privacies are required to be more important. To satisfy these requirements the room should be isolated completely from the noise in the spacial and acoustical aspect.

However the sound insulation performance grows smaller as the means of aggregating densely as like multistory houses. In multistory house which share the floor and wall with neighbors a lot of complains were issued, above all complain from the floor impact noise has been occurred frequently. Such complain comes to the front

as a social issue and connected to amend the law on demand of citizens' group.

At 2004 the law to regulate floor impact noise was made and enforced at July 2005. As a result the multistory houses tried to get construction approval have to design the floor concrete slab with thickness of more than 210mm and standard floor heating system designated by government. If do not want to apply this kind of system, they should have to use the system which obtain the certification from the institution appointed by government.

When comparing the cost before and after the enactment of regulation, the cost of constructing structure shows a rise of about 20dollars/㎡ over the 150mm thickness of concrete slab. According to the housing supply of 400,000 per year the rise of cost will be about 0.8billion dollars. In this reason a lot of construction material companies and construction companies have been trying to develop the system with 180mm thickness concrete slab to reduce the cost.

So this study aims to develop the impact noise insulation floor structure with 180mm thickness of concrete slab satisfying the regulation.

METHOD

The floor impact noise level depends on the type of impact source, vibration properties of the floor slab structure, and the acoustic characteristic of receiving room. To minimize these kinds of variables which can give effects to the test result, the test was done in the building which was constructed exactly the same as that of government appointed institution.

Presently the institutions which issue the certification are KICT(Korea Institute of Construction Technology) and KNHC(Korea National Housing Corporation). In this study the test building of KICT was selected as an example for construction of a new test building, all variables were controlled as same as possible with KICT test building except substituting the cement mortar with precast concrete plate which can reduce the time for testing

The floor structures for testing were classified by its role, spring part, spring supporting part, mass part, thermal insulation part. According to this classification all materials were serveyed to make the best composition. After testing the each composition, the floor impact insulation performance was compared each by each and made compact the composition cases.

NATURAL FREQUENCY AND VIBRATION TRANSMISSION RATIO

The floor impact noise is structure-borne noise. To reduce this kind of noise the solution should be found in the vibration control and that is regarded as a general opinion.

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \cong \frac{4.98}{\sqrt{\delta}}$$

$f_n : natural\ frequency(Hz)$
$k : spring\ \ constant(N/cm, kgf/cm)$
$m : mass(kg)$
$\delta : displacement(cm)$

The natural frequency of vibrating object is decided by its mass and spring constant. After the natural frequency decided the object responds differently for the impact and produce an effect on the vibration transmission ratio.

If the natural frequency maintained below the 1/3 of forced frequency, the vibration transmission ratio will be about 12.5%.

$$T = \frac{1}{\left|1-\left(\frac{f}{f_n}\right)^2\right|}$$

$T : Transmission\ ratio$
$f : Forced\ \ frequency(Hz)$
$f_n : Natural\ \ frequency(Hz)$

When analyzing the floor impact noise level the peak level is formed around the natural frequency of floor. Basically any floating floor which has the natural frequency over the 10Hz could not be expected the reduction effect. In the relation with natural frequency and vibration transmission ratio, the basic way to reduce the floor impact noise is to develop the mass-spring system which can maintain the natural frequency below the 10Hz.

The way to lower the natural frequency is to increase the mass or decrease the spring constant. Reducing the spring constant by half shows same effect with increasing the mass by double. In the floor structure of apartment houses the cement mortar with thickness 40~50mm plays a initial role of mass about 100~110kgf/㎡. The various floor impact noise reduction systems developed previously are mainly consisted with vibration absorbers that act as thermal insulators simultaneously.

This is an attempt to reduce the natural frequency by lower the spring constant without control the mass. But in the most insulators achieving the desired natural frequency was proved not easy, as a result improving the floor impact noise insulation performance showed a limit.

TEST BUILDING

To reduce overall time for testing the cement mortar which takes usually 7 or 10 days for curing was substituted with the precast concrete plate, and made it possible to be installed and removed by using the hoist.

Figure 1 Exterior view of test building

Figure 2 Interior view of test building

Figure 3 2nd floor – Source room

Figure 4 1st floor – Receiving room

Figure 5 Precast concrete plate

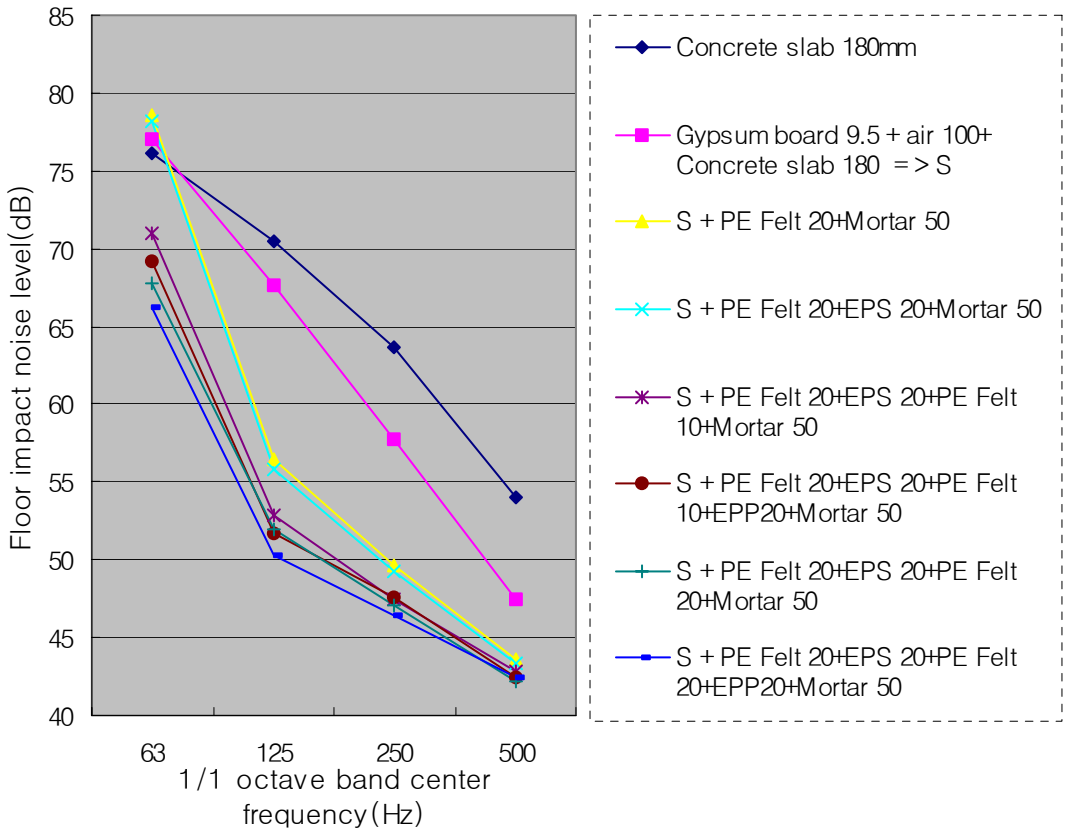
TEST RESULT

In Korea the floor impact noise that cause frictions between neighbors is mainly heavy weight impact noise such as children's running noise. So in this study the test was focused on the heavyweight impact noise. The heavyweight impact source, Bang machine, was used for test.

The number of impact points of source room and microphone points of receiving room are 4 include center point. The sound pressure level of receiving room was averaged based on the intensity averaging for each impact point, and then the intensity averaged sound pressure level for each impact point was averaged arithmetically.

The test was conducted on the 180mm thickness concrete slab and then the effects of adding gypsum board, adding floor structure were evaluated to check the influence of each composition.

The test items and results are as followed figure.



G/board : Gypsum Board, PE Felt : Poly Ester Felt, EPS : Expanded Poly Styrene, EPP : Expanded Poly Propylene

Figure 6 Floor impact noise level for each item

SUMMARY

Floor impact noise is structure borne noise generated by floor impact in upstairs, this impact transmitted through the building structure as vibration and then finally emitted at the surface of receiving room as airborne noise. To reduce this kind of noise the vibration absorbing method should be applied on the floor. For making the vibration absorbing system spring and mass theory should be applied.

Elastic materials such as metal spring, rubber mount, EVA chip etc., were used as a spring part, and mass materials such as concrete block, concrete plate, steel plate were used as a mass part. The attempt to find out best composition to reduce floor impact noise by composing these materials has been done.

As above in the relation of spring and mass, mass could be increased by double, spring constant could be reduced by 1/10, so the performance of floor impact noise insulation is decided by spring constant. As a result the floor structure with PET felt was revealed as the most competitive structure in the price and performance aspect.

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