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Comparison of Resiliently Suspended Floating Slab Constructions

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ABSTRACT

Floating floor systems are commonly used in mechanical rooms, music practice rooms and other areas where rotating machinery and/or heavy impact sources create a need for airborne and structure borne sound isolation. There are numerous technologies and construction methods used to create a decoupled or floating concrete slab condition. Through laboratory testing, a head-to-head analysis was completed to compare various systems including lift-slab, point isolation, and continuous compressible elastomeric technologies. All floor systems were tested on a 150mm (6”) concrete slab, with a 100mm (4”) topping slab. While the overall airborne (STC) and impact (IIC) ratings of the different isolation systems were similar, there are some significant variations at low and high frequencies. The effects of differing material properties between two generations of recycled rubber underlayment are also examined.

Keywords: Sound, Insulation, Transmission I-INCE Classification of Subjects Number(s): 35.4.4

1. INTRODUCTION

A floating floor is a term that refers to a concrete topping slab that is applied to an intermediate resilient support layer. This study will compare data collected on four different types of floating floor interlayer technologies. Two of these aforementioned floating floor resilient support layers represent similar products with different formulations. When the structural floor, topping mass and composition remains the same, the quality of isolation resulting from the components selected is dependant largely upon three factors:

1. The height of the space between the structural and topping concrete layers
2. The dynamic characterization of the isolation material
3. The effect of resonance in the intermediate air space due to mass-spring-mass effect

The results of both impact and airborne vibration source isolation of four different compositions of the intermediate layers will be compared. These four different intermediate layers are described below:

Point Isolation – This particular product is an isolator manufactured by Kinetics Noise Control as Kinetics KIP (KR). This type of floor utilizes 50mm (2") high neoprene coated fiberglass squares spaced 400mm OC. These point isolators are topped by plywood. Concrete is then applied on top of the plywood creating the topping 100mm (4") slab. Insulated point isolation is a second point isolation floor system that was studied. This system is similar to the KR system, but contains insulation between the isolators. This system will be referred to as the insulated Kinetics RIM (KRi) system.

Encased Mount – The Kinetics Encased Mount (KEM) floor system, also manufactured by Kinetics Noise Control, is similar to the point isolation floor, but utilizes steel mounts encased in the concrete. The mounts have threaded bolts, which are used to lift the topping slab to create a 50mm air gap. The mounts are seated on neoprene pads.

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Pliteq GenieMat FF25 Generation 1 (FF25G1) - FF25G1 is used as an intermediate layer between the topping slab and the base structure. It is comprised of a 25mm thick layer of recycled rubber. The FF25G1 is manufactured with a profile on one side to minimize surface area contact. The FF25G1 represents the first generation of this product. A two-layer system of the mat (50mm thick) is also tested. This product is called GenieMat FF50 and will be referred to as FF50G1. No plywood or insulation is required between the product and the topping slab.

Pliteq GenieMat FF25 Generation 2 (FF25G2)- Is the similar to FF25G1, but with a formulation incorporating different particle tortuosity of recycled rubber within the material and therefore different dynamic characteristics. This is discussed further in Section 3.5.The FF25G2 still has the same profile as the FF25G1. A two-layer system of 50mm thickness is also tested (FF50G2). Again, no plywood or insulation is required between the product and the topping slab.

2. ACOUSTICAL TESTING

2.1 Test Procedures

The test data presented in this paper was collected at the National Research Council of Canada in Ottawa, Ontario, Canada. Airborne sound transmission loss testing was completed in accordance with ASTM E90, and the impact sound pressure level data was completed in accordance with ASTM E492.

2.2 Test Assemblies

In all assemblies examined, the structural slab is a 150mm (6") concrete slab cured for greater than 28 days as per ASTM test requirements. The topping slab is a 100mm (4") concrete slab in all assemblies.

The KR and KRi assemblies have 50mm (2”) high fiberglass pads compressed to 35mm under the topping slab loading. 13mm plywood sits above these isolators. The KRi assembly has 65mm insulation is placed in the cavity.

The KEM assembly was built into the concrete topping slab (102mm thick) and the slab was reinforced with bars of unknown diameter. The 16 mounts were measured as 130mm x 130mm x 64mm.

The FF25G1, FF25G2, FF50G1 and FF50G2 were placed profiled side down on the structural slab. No plywood or insulation is used. The seams of the mat, in all cases, were taped and topping slab was directly applied.

3. PERFORMANCE ANALYSIS

Table 1 shows a summary of all of the Airborne and Impact ratings of the tested assemblies.

Table 1 - Overall Airborne and Impact Ratings

Isolation Type	Overall Airborne (dB)	Overall Impact (dB)	STC Controlling Frequency (Hz)	IIC Controlling Frequency (Hz)
KR	68	60	250	200
KRi	72	62	160-315	100-250
KEM	69	61	200	200
FF25G1	69	62	125-315	100-250
FF50G1	72	64	125-315	100-250
FF25G2	68	63	200	160
FF50G2	69	66	200	160

The following figures show comparative airborne and impact rating curves that will be referenced later in this document.

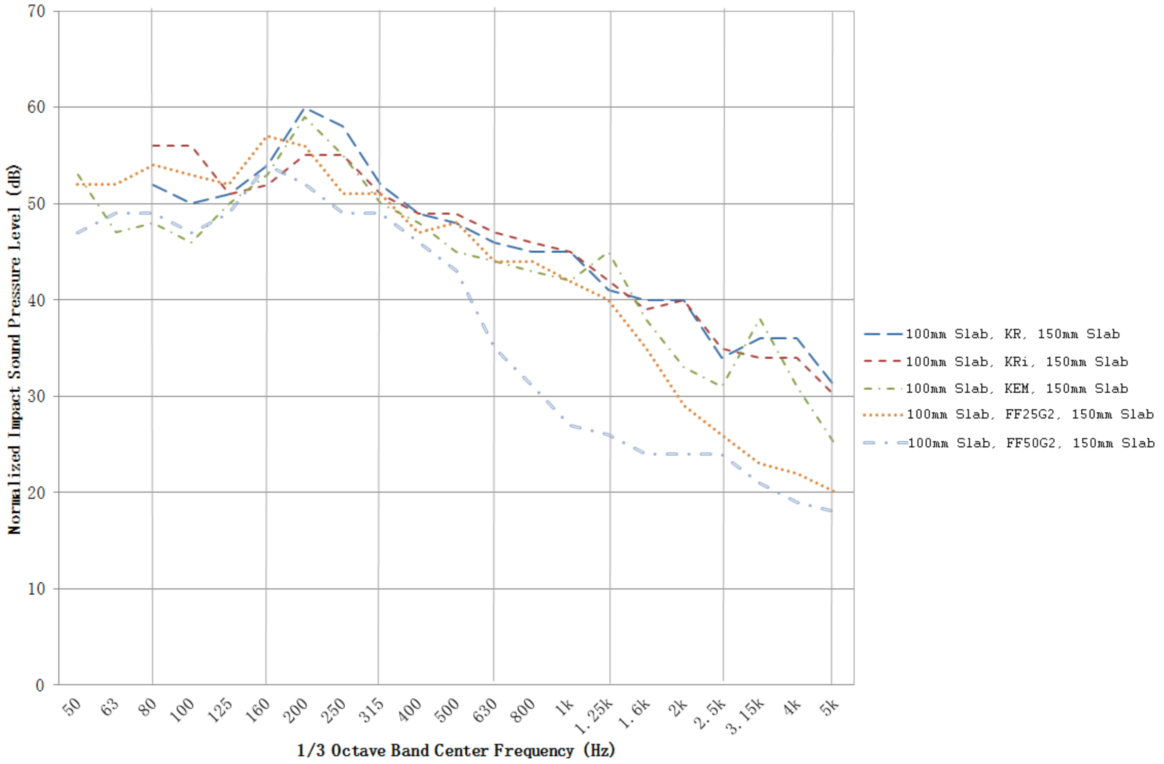

Figure 1 - Impact sound data from a tapping machine source on selected assemblies

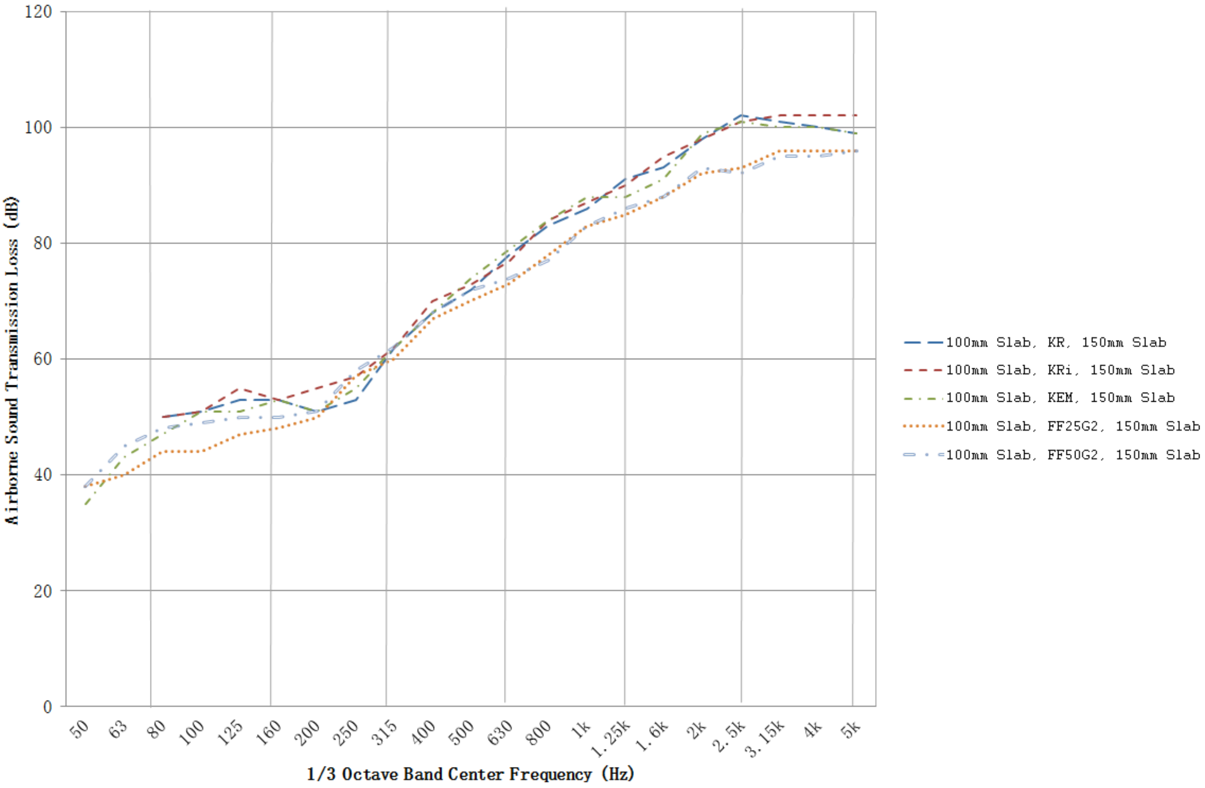

Figure 2 - Airborne sound transmission loss data from selected assemblies

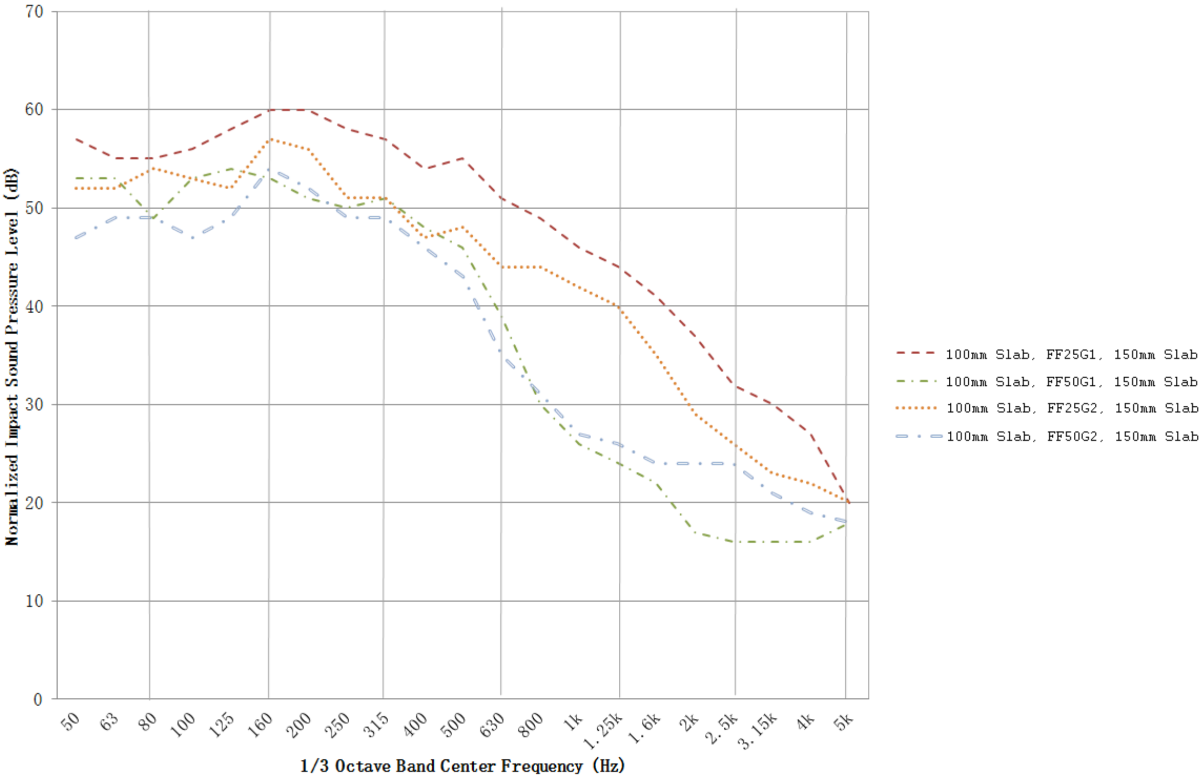

Figure 3 - Impact sound data from a tapping machine sources from both generations of Pliteq GenieMat FF25 and FF50

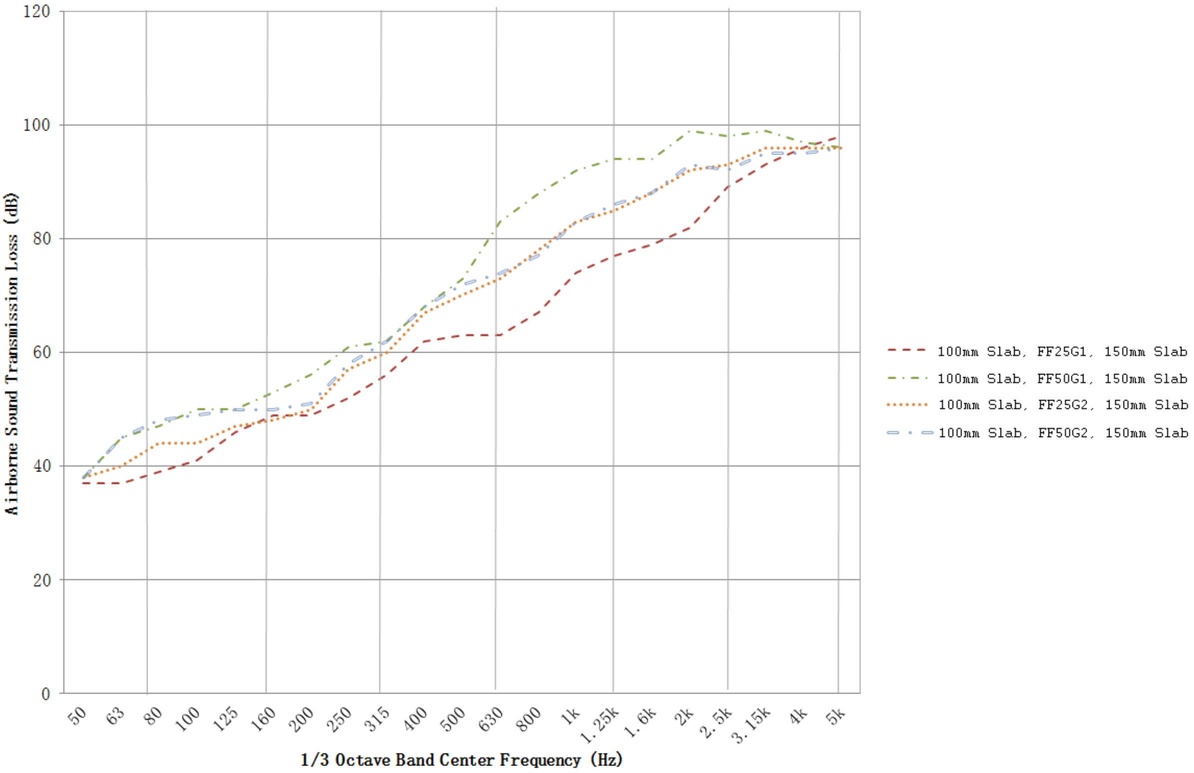

Figure 4 - Airborne sound transmission loss test data from both generations of Pliteq GenieMat FF25 and FF50

3.1 Overall Airborne Sound Ratings

By examining Table 1, it can be seen that all of the floors tested had similar single number airborne sound results between STC 68 and 72. For the point isolation assemblies, the effect of adding insulation to the intermediate air space was 4 dB (KR vs. KRi). This effect is due to reducing the mass-spring-mass resonance in the air cavity. The effect of doubling the air gap from 25mm to 50mm added 3 dB (FF25G1 vs. FF50G1). An increase of 1 dB was observed between FF25G2 and FF50G2. The decreased difference between the two generations is most likely due the lower dynamic stiffness of the G2 material.

The resulting test data curves of the floors are very similar. All curves are within 5 dB of each other at most frequencies. All of the floors tested were controlled by deficiencies between 125 and 315 Hz.

3.2 Overall Impact Sound Ratings

While the overall impact ratings of the floors were all similar, the test data curves show some very significant variations at low and high frequency. FF50G2 yielded the highest overall single number impact sound rating of IIC 66. The KR floor was the lowest at 60. This is likely limited by the lack of insulation in the cavity resulting in resonance. This can be seen at 200 Hz (Figure 1) where there is a spike most predominately seen with the KR floor. The same 200 Hz deficiency is observed in the EM floor where the cavity is not insulated.

The KR and KEM floors are controlled by an 8 dB deficiency at 200 Hz. The KRi and FF25G1 assemblies are controlled by sum 32 deficiencies from 100 to 250 Hz. The FF25G2 assemblies are controlled by an 8 dB deficiency at 160 Hz.

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3.3 Airborne Sound Pressure Level Variation

The airborne sound transmission loss curves in Fig. 2 show similar performance from all of the products that were plotted. At low frequency, the FF25G2 floor influenced up to 5 dB of transmission loss less than the other floors. The FF25G1 & FF25G2 are the only floor assemblies with a 25mm gap height, which can explain this deficiency. By examining Fig. 2, it can be seen that by having the increased air gap of the double layer of FF50G2, the low-frequency losses are similar with all systems. In the mid-range frequency bands, the different assemblies seems to have very similar performance as the curve become very close. The KR, KRi and KEM assemblies start to deviate away from the FF assemblies at higher frequencies.

Fig. 4 shows the differences in airborne sound pressure levels between the two generations of the FF products. The variation is interesting as it would appear that the two assemblies of Generation 2 with the lower dynamic stiffness seem to perform very similarly. The generation 1 assemblies with higher dynamic stiffness have a more variation in the mid to upper frequency bands.

3.4 Impact Sound Pressure Level Variation

By examining Figure 1, it can be seen that above 630 Hz the FF assemblies show significantly higher sound pressure level reductions than the KEM and KR floor assemblies. The KR floor shows 3-15 dB less isolation from 630 – 5000 Hz, while the KEM floor had the same deficiency but not until the 1250 Hz 1/3-octave band and up. When the FF50G2 floor was used, the high frequency impact isolation was significantly increased between 630 Hz and 2500 Hz one-third-octave bands when compared to the FF25G2 assembly. The FF50G2 floor was at least 10 dB improved when compared to either the KR or KEM from 800 Hz and up.

Fig. 3 shows that the FF25G1 performs with a pretty consistent deficiency along all tested frequency bands when compared to the FF25G2 with the lower dynamic stiffness. The double layer specimens have similar performance with the FF25G1 (higher dynamic stiffness) performing better at higher frequencies.

3.5 Dynamic Stiffness Comparison of Different Generations of GenieMat FF

Table 2 shows a comparison of the difference between the two different product generations of Pliteq GenieMat FF sound control underlayment. Specifically, the different dynamic stiffnesses are compared. In terms of the testing previously discussed in this paper, the most relevant loading would be 1 N/cm2 as this corresponds more closely with a 100mm topping slab that was presented in the acoustical test data. The natural frequency data of each product is also shown.

Table 2 - Dynamic Stiffness & Natural Frequency Comparison of GenieMat FF

	Dynamic Stiffness (MN/m^3)			
Loading (N/cm^2)	FF25G1	FF50G1	FF25G2	FF50G2
1	21.5	10.8	14	7
2	35	18.5	21	11
3	48.5	28.5	29	17
4	60	35	38	22

	Natural Frequency (Hz)			
Loading (N/cm^2)	FF25G1	FF50G1	FF25G2	FF50G2
1	25	18	12.5	13
2	20	14	16.5	12
3	20	14	15.5	12
4	20	14	15	12

4. CONCLUSIONS

When designing a floating floor it is important to understand the frequency range of the source vibration. It is also imperative to understand if it is an impact or airborne disturbance. Once these two parameters are understood, it is possible to optimize the floating slab intermediate layer design.

Increasing the height of the air gap between structural and topping slabs caused a step increase in performance across all one-third octave bands in impact sound testing. The overall airborne rating increased when the air gap was doubled. The impact rating also showed some increase with the larger air gap. This is evident by comparing the FF25 and FF50 (G1 and G2) test data.

The dynamic characterization of the isolators was not within the scope of this paper. Data was unavailable on the neoprene mounts and fiberglass point isolators.

When there was no rubber or insulation in the cavity, a spike at 200 Hz was observed in both airborne and impact tests. This is likely due to resonance in the 2” cavity. This would have to be considered when designing for machinery or other vibration sources with significant outputs around 200 Hz. An insulated or rubber filled cavity would be optimal in this condition.

The changes in dynamic stiffness between the two generations of the FF products show differences in the airborne transmission loss. The difference between the double layer and the single layer are much more evident with the first generation of the material. The second generation FF assemblies appear to perform better at higher frequencies in the impact tests.

Based on the data presented in this paper, the performance of the seven tested floors are comparable. Cost of overall installation and construction should also be considered an important variable. Due to ease of constructability, no requirement for a plywood sub-layer, insulation or rebar and given the surplus availability globally of recycled rubber from scrap tires and other sources, the recycled rubber is anticipated to offer significant cost savings per unit surface area and per decibel of sound isolation improvement.

ADDITIONS

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