Akustikverkstan AB, Kinnegatan 23, 531 33 Lidköping, tel: +46 510 – 911 44

pontus.thorsson@akustikverkstan.se
Direct: +46 706 – 59 37 99

AIRBORNE SOUND INSULATION IMPROVEMENT FOR VIBRATEC CEILING SYSTEMS VT-SFC AND VT-CBC

ABSTRACT

The airborne sound insulation improvement for two different suspended ceiling systems have been estimated; VT-SFC and VT-CBC from Vibratec Akustikprodukter AB. The estimations are based on the measured impact sound improvements in Akustikverkstan Report 18-718-R1.

From acoustical theory, sound insulation calculations, and comparisons with laboratory measurements for airborne sound insulation improvement and impact sound level improvements made on the same floor sample it can be concluded that the best estimation of the airborne sound insulation improvement is the impact sound level improvement in each one-third octave band separately. This conclusion holds for all situations where the original floor can be considered as an isotropic heavyweight floor.

Both ceiling systems were mounted below a reference heavyweight floor made of 160 mm concrete. Both systems were mounted with 250 mm suspension and 95 mm mineral wool, and with 2, 3 and 4 layers of normal gypsum boards (12.5 mm thickness) respectively.

The resulting airborne sound insulation efficiency has been evaluated according to SS-EN ISO 10140-5:2010 and SS-EN ISO 717-1:2013. Single number values for the measurement samples can be found in the table below. Values in one-third octave bands that can be used for the airborne sound insulation improvement, i.e. the corresponding impact sound level improvement, can be found in Akustikverkstan Report 18-718-R1.

Test sample	$\Delta R_{w,heavy}$ (dB)	$\Delta(R_{w,heavy}+C_{50\text{-}3150})$ (dB)
1. Vibratec VT-SFC, 250 mm suspension with 95 mm mineral wool, 2 layers of 12.5 mm normal gypsum board	23	16
2. Vibratec VT-SFC, 250 mm suspension with 95 mm mineral wool, 3 layers of 12.5 mm normal gypsum board	26	18
3. Vibratec VT-SFC, 250 mm suspension with 95 mm mineral wool, 4 layers of 12.5 mm normal gypsum board	28	20
4. Vibratec VT-CBC-RF50, 250 mm suspension with 95 mm mineral wool, 2 layers of 12.5 mm normal gypsum board	23	15
5. Vibratec VT-CBC-RF50, 250 mm suspension with 95 mm mineral wool, 3 layers of 12.5 mm normal gypsum board	25	17
6. Vibratec VT-CBC-RF50, 250 mm suspension with 95 mm mineral wool, 4 layers of 12.5 mm normal gypsum board	27	20

1. CLIENT

Vibratec Akustikprodukter AB, Fagernäsvägen 1, 760 17 Blidö, Sweden
Contact: Svante Hägerstrand, 0176 – 20 78 84, svante.hagerstrand@vibratec.se

2. ASSIGNMENT

To estimate the airborne sound insulation improvement for the two suspended ceiling systems sold by Vibratec from the measured impact sound level and the impact sound improvement of the same systems, as reported in Akustikverkstan Report 18-718-R1. The evaluations shall be made according to SS-EN ISO 10140-5:2010 and SS-EN ISO 717-1:2013.

3. TEST SAMPLES

The constructions of the test samples are described in Table 1. The test samples were mounted below Akustikverkstan's 160 mm heavyweight reference concrete floor. The whole surface was covered, and elastic strips were mounted between test sample and surrounding laboratory structure.

Figure 1: The VT-SFC system contains only primary profiles. Tested with 25 mm elastic pads. In the tests the hangers were mounted with c/c 900 mm and the profiles were mounted with c/c 450 mm.

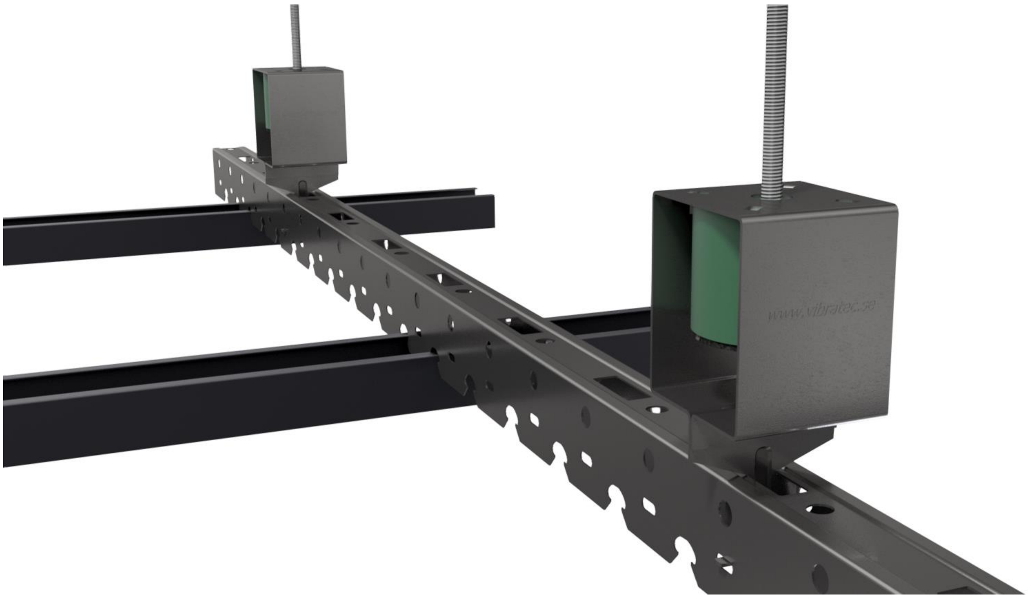

Figure 2: The VT-CBC system contains both primary and a secondary profiles. Tested with 50 mm elastic pads. In the tests the hangers were mounted with c/c 600 mm, the primary profiles were mounted with c/c 750 mm, and the secondary profiles were mounted with c/c 400 mm.

Sample	Sample description
1	VT-SFC with 2 layers of 12.5 mm normal gypsum boards. P: 450 mm, G: 900 mm. 250 mm suspension with 95 mm mineral wool. 25 mm elastic pads
2	VT-SFC with 3 layers of 12.5 mm normal gypsum boards. P: 450 mm, G: 900 mm. 250 mm suspension with 95 mm mineral wool. 25 mm elastic pads
3	VT-SFC with 4 layers of 12.5 mm normal gypsum boards. P: 450 mm, G: 900 mm. 250 mm suspension with 95 mm mineral wool. 25 mm elastic pads
4	VT-CBC-RF50 with 2 layers of 12.5 mm normal gypsum boards. P: 750 mm, S: 400 mm, G: 600 mm. 250 mm suspension with 95 mm mineral wool. 50 mm elastic pads
5	VT-CBC-RF50 with 3 layers of 12.5 mm normal gypsum boards. P: 750 mm, S: 400 mm, G: 600 mm. 250 mm suspension with 95 mm mineral wool. 50 mm elastic pads
6	VT-CBC-RF50 with 4 layers of 12.5 mm normal gypsum boards. P: 750 mm, S: 400 mm, G: 600 mm. 250 mm suspension with 95 mm mineral wool. 50 mm elastic pads

Table 1: Description of test samples. P describes the c/c distance between primary profiles, S the c/c distance between secondary profiles, and G the c/c distance between hangers.

4. EVALUATION PROCEDURE

From a theoretical standpoint, the radiated sound power from a ceiling surface (e g the reference floor in the laboratory) is radiated from the vibrations of the surface. A suspended ceiling reduces the radiation of these vibrations by covering the surface. For a floor construction with low internal damping and that can be considered as an isotropic plate, it is not important if the source of the vibration is a force or an airborne sound wave. This means that the airborne sound improvement for a suspended ceiling is equal to the impact sound level improvement in the same frequency band, since sound is radiated from the whole surface irrespective if it comes from a tapping machine or from a loudspeaker. This statement holds for the reference floor in the laboratory.

To measure airborne sound insulation improvement in a laboratory is difficult, since flanking transmission in the structure surrounding the test floor is usually strong. This holds in particular for the heavyweight reference floor, which have a high airborne sound insulation as it is. To measure the airborne sound insulation improvement for linings attached to the heavyweight reference floor is normally not possible with acceptable accuracy.

The hypothesis above has been tested on one floor that has a comparatively low airborne sound insulation. That floor did however have higher internal damping. At frequencies up to around 500 Hz, the impact sound level improvement and the airborne sound level improvement were close to one another. At frequencies higher than 500 Hz the impact sound level improvement increased more with frequency than the airborne sound insulation improvement. That difference corresponds well to that the radiation from the floor's bottom surface becomes more and more localized with increasing frequency (decreasing wavelength).

The conclusion for the actual measurements is thus that we can estimate that the airborne sound level improvement is equal to the impact sound level improvement in each one-third octave band. These improvements can then be used to evaluate the one-figure airborne sound insulation improvements that are defined in SS-EN ISO 10140-5:2010 together with SS-EN ISO 717-1:2013.

The tested suspended ceiling systems incorporate efficient vibration isolation, and the validity of the hypothesis above can be tested through comparisons with theoretical calculations of the airborne sound insulation improvement by using the specialized sound insulation software *Insul*. Here, calculations of the airborne sound insulation of the reference floor were used together with calculations for each of the measured ceiling constructions. In the calculations, the efficient vibration isolation in the hangers was implemented in the software by using the "separate studs" frame option. Comparisons of the results can be seen in Figure 3 and 4.

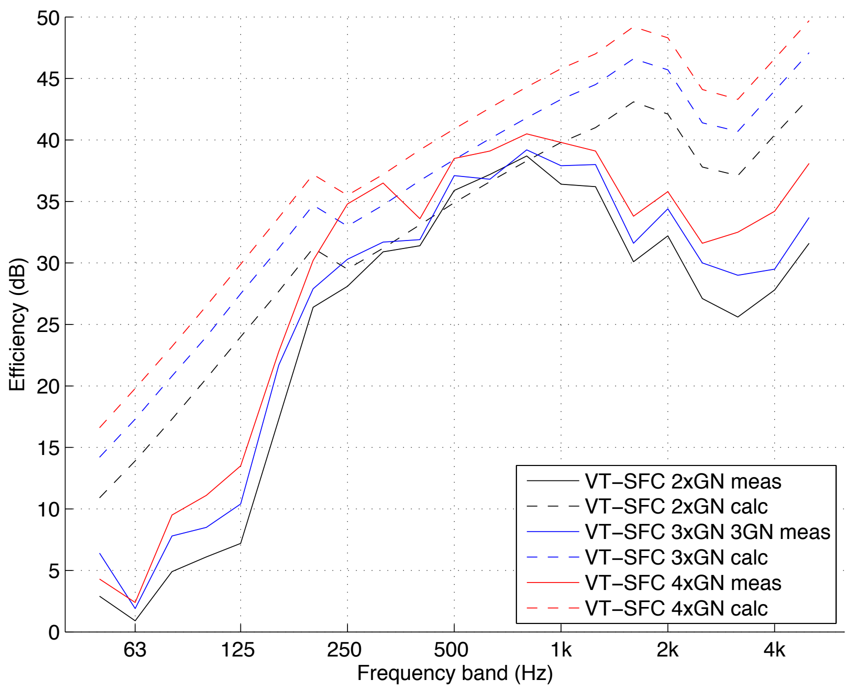

Figure 3: Comparison between Insul calculations and measurements for the VT-SFC system.

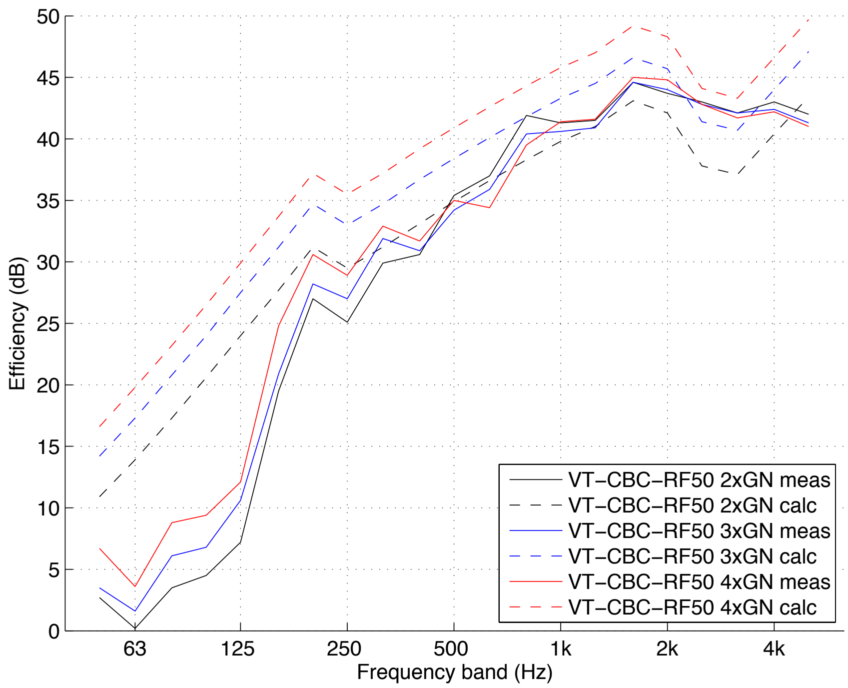

Figure 4: Comparison between Insul calculations and measurements for the VT-CBC system.

From the results in Figure 3 and 4 it can be seen that the measured impact sound level improvement follows in general the same trend as the calculation, but the measured values are always some dB:s lower than the calculations. The difference between calculations and measurement results correspond to differences commonly seen when doing a similar comparison for e.g. double gypsum walls.

The hypothesis used here does not always hold; it is not valid for e.g. lightweight wooden floors, which both have higher internal damping and are strongly orthotropic. In simpler words, the vibrations from the tapping machine do not spread as evenly over the ceiling surface as they do for the homogeneous concrete plate in the reference floor.

5. EVALUATION RESULTS

The estimated airborne sound insulation improvement results have been evaluated according to SS-EN ISO 10140-5:2010 and SS-EN ISO 717-1:2013. The weighted reduction index together with one selected correction term is presented in Table 2 for all constructions. Values for the airborne sound insulation improvements in one-third octave bands can be found in the measurement protocols 18-718-M1 to -M13 in the report 18-718-R1.

The estimated results are only valid for the tested samples.

Test sample	$\Delta R_{w,heavy}$ (dB)	$\Delta(R_{w,heavy}+C_{50\text{-}3150})$ (dB)
1. Vibratec VT-SFC, 250 mm suspension with 95 mm mineral wool, 2 layers of 12.5 mm normal gypsum board	23	16
2. Vibratec VT-SFC, 250 mm suspension with 95 mm mineral wool, 3 layers of 12.5 mm normal gypsum board	26	18
3. Vibratec VT-SFC, 250 mm suspension with 95 mm mineral wool, 4 layers of 12.5 mm normal gypsum board	28	20
4. Vibratec VT-CBC-RF50, 250 mm suspension with 95 mm mineral wool, 2 layers of 12.5 mm normal gypsum board	23	15
5. Vibratec VT-CBC-RF50, 250 mm suspension with 95 mm mineral wool, 3 layers of 12.5 mm normal gypsum board	25	17
6. Vibratec VT-CBC-RF50, 250 mm suspension with 95 mm mineral wool, 4 layers of 12.5 mm normal gypsum board	27	20

Table 2: Selected one-figure measurement results and corresponding measurement protocols.

7. ESTIMATION PRECISION

The precision of the estimations is difficult to state, since the estimations are based on physical reasoning and comparisons to other measurement data. The precision should be similar to that of a laboratory measurement, provided that the used hypothesis holds.

Pontus Thorsson
PhD in acoustics

Reviewed by Anders Grimmehed, 2019-06-27