Bergen, Norway

BNAM 2010

May 10-12

Simplified measurement of the reduction of transmitted impact noise by floor coverings

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Laboratory measurement of the reduction of transmitted impact noise by floor coverings on heavyweight and lightweight standard floors are specified in the International standards ISO 140-8 and ISO140-11, respectively. The laboratory arrangement consists of two rooms of about 50 m3 each, one on top of the other, separated by a standardized floor. Based on research from Physicalisch Techniches Bundesanstalt (PTB), a simplified method for heavyweight floors is now proposed for International standardization by ISO. The floor covering to be measured is placed on a slab of concrete of size 1,2 m x 0,8 m, and 0,2 m thick. A normal tapping machine is used for the excitation and the vibration level is measured with and without the floor covering. The paper describes the method and the instruments needed.

1 Introduction

The amount of reduction of transmitted impact noise is an important acoustical characterization of a floor covering. The standard laboratory measurement method for floor coverings on a heavyweight and lightweight standard floor is specified in ISO 140-8 (1997) and ISO140-11(2005), respectively [2,3].

Physicalisch Techniches Bundesanstalt (PTB) in Germany has proposed a simplified test method for heavyweight floors based on the measurement of floor coverings on a small concrete slab [1]. The excitation is generated by a standard tapping machine as specified in Annex A of the referred standard. The result is obtained from the difference in vibration levels when the concrete slab is covered and not covered by the floor covering to be measured. The vibration levels are measured by accelerometers attached to the underside of the concrete slab.

The proposed method is currently considered for standardization by ISO.

2 Current method

The current laboratory tests for reduction of transmitted impact noise by floor coverings requires two measurements rooms of about 50 m^3 each, one placed on top of the other and separated by a standardized floor of either concrete or timber. The size of the floor shall be at least 10 m^2. A tapping machine is placed on the floor and the averaged impact sound pressure level is measured in the room below the floor by a sound level meter equipped with 1/3-octave filters. The sound shall be measured in 1/3-octave bands in at least in the range from 100 Hz to 5000 Hz. The sound pressure levels are measured without and with the floor covering and the result is obtained from the differences in levels. A single-number quantity may be calculated as given in ISO 717-2 [4]. The procedure for the current method is illustrated in Figure 1.

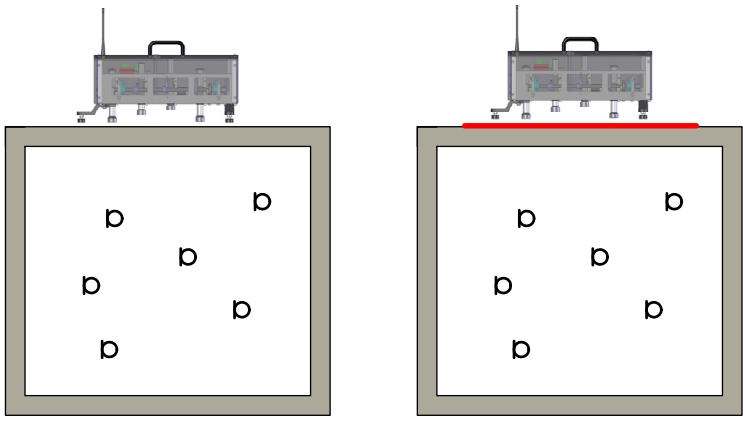


Figure 1. Illustration of the current method for the measurement of impact sound reduction. The sound pressure levels in the receiving room caused by the tapping machine above are measured without and with the floor covering.

3 Proposed method for heavyweight floors

3.1 Equipment and instrument

For the simplified method for measurement of the impact sound reduction for heavyweight floors, the two rooms are removed and the concrete floor is replaced by a small concrete plate or slab of similar thickness. The excitation is as before made with the standardized tapping machine. The size of the slab is 1,2 m times 0,8 m corresponding to an Euro-palette. The thickness is 20 cm. The concrete slab is resiliently mounted on elastic suspensions in each corner so the vertical resonance frequency is below 20 Hz.

The vibratory acceleration levels on the slab are measured by one or more acceleration sensors on the underside of the slab. The signal is fed to a sound level meter with 1/3-octave filters as in the current standard. At least four accelerometer positions shall be used. The positions shall be selected randomly in a way that avoids symmetry about the main axes. If only one transducer is used, this has to be moved around for spatial averaging. The tapping machine shall be used in at least two positions – again avoiding symmetry and not placed parallel to the edges of the slab. Figure 2 illustrated the setup in the proposed method.

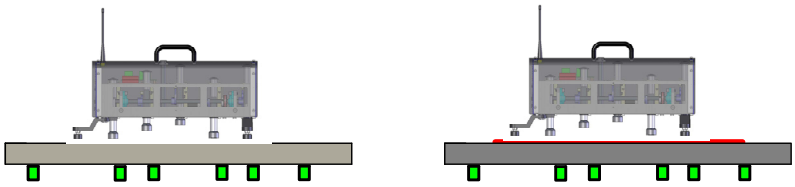


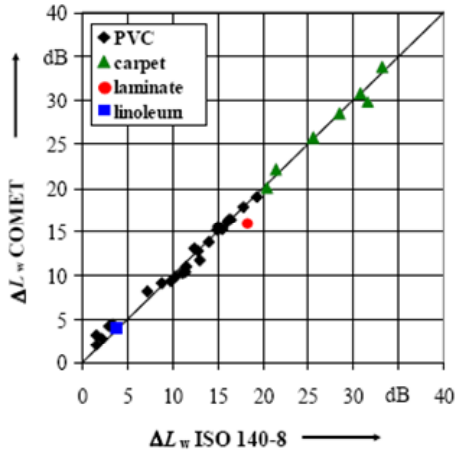
Figure 2. Illustration of the proposed method. The vibration level is measured without and with the floor covering.

A picture of a concrete slab according to the proposal is shown on Figure 3. Mounting studs for the accelerometers are glued to the lower side of the slab.

Figure 3. Concrete slab for the measurement of impact noise reduction.

3.2 Comparison with current method

As described in the paper by Sommerfeld [1], the results from measurement by the proposed simplified method corresponds well with the current method described in ISO 140-8 [2]. For floor coverings of PVC, linoleum and carpets, the maximum difference in the single-number impact noise reduction, ΔL_w, between the methods were below 2 dB. For laminate, the differences were somewhat higher but still within an acceptable range. Figure 4 shows some of the results.



Floor Covering	Δmax
PVC	1.6
Carpet	1.8
Laminate	2.4
Linoleum	0.1

Figure 4. Heavyweight floor: Comparison between full and simplified method for measurement of impact sound reduction (Reproduced from [1]).

4 Proposed method for lightweight floors

As reported by Sommerfeld [1], there have also been done substantial research on a simplified method for lightweight floors. However, the results so far do not match as well as for the heavyweight floors. It is therefore assumed that this method is currently not mature for standardization. Figure 5 shows a comparison between the simplified and the full method as given in ISO 140-11[3]. The results are obtained by PTB [1].

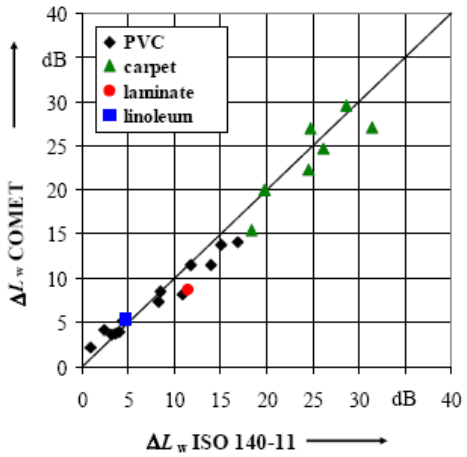


Figure 5. Lightweight floor: Comparison between full and simplified method for measurement of impact sound reduction (Reproduced from [1]).

5 Requirements for the instrumentation

When the slab is excited by the tapping machine without any floor covering, the acceleration is dominated by higher frequencies normally only limited of the applied vibration transducer. Further, most piezo-electric accelerometers have a pronounced resonance peek at the upper end of the frequency range for measurement. The short impacts for a floor without covering will often excite the self-resonance of the accelerometer where the sensitivity is many times the normal sensitivity. Although the resonance frequency (typically 30 kHz) is normally well above the upper frequency of interest, the high signal levels at this frequency may cause overload in the accelerometer or in the accompanying measurement system. Figure 6 shows a typical frequency response function for an accelerometer. The resonance may lead to significantly higher levels above 20 kHz than in the frequency range to be measured: 50 Hz – 5000 Hz. The high-frequency content may easily overload the measuring instrument or the accelerometer with integrated preamplifier like accelerometers of ICP®- or CCP-types. Sound level meters with a frequency range below 20 kHz may therefore not display the real level. Further, the frequency response required by the IEC standard for 1/3-octave filers will not guarantee sufficient rejection of frequencies outside the passband due to the large difference in levels between the various bands. As seen from Figure 6, the size of the resonance peek of 30 dB may reduce the effective stop-band attenuation of the 1/3-octave filters far below the nominal 70 dB for a class 1 filter.

In order to limit the high-frequency contents, Norsonic has developed a preamplifier with a low-pass filter for this application which effectively limits the frequency components above 7 kHz. The preamplifier has a charge-sensitive input and is powered by the sound level meter. The amplifier will greatly reduce the possibility for overloading the measuring instrument.

Since the measurement is based on the difference in vibration level with and without the floor covering, an absolute calibration of the sensitivity of the transducer is not needed. However, if more accelerometers and measurement channels are applied for simultaneous measurement of the spatial average, all transducers/measurement channels must have matching sensitivities and frequency responses. A vibration calibrator may therefore be needed.

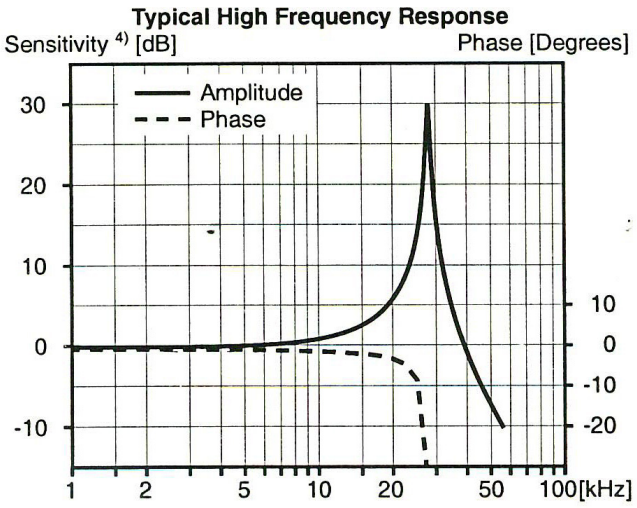


Figure 6. Typical frequency response for an accelerometer.

6 Summary

The proposed simplified method for measurement of the reduction of transmitted impact noise by floor coverings will be a valuable tool for a fast measurement of floor coverings. It will also significantly reduce the cost for measurement due to the elimination of the need for an acoustical laboratory with two large rooms on top of each other. The simplified method for heavyweight floors seems mature for standardization. However, the proposal for lightweight floors may still need more considerations.

References

[1] Marc Sommerfeld, A simplified measurement method for the determination of impact sound reduction, DAGA 2009 (Rotterdam).

[2] ISO 140-8(1997): Acoustics – Measurement of sound insulation in buildings and of building elements – Part 8: Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight standard floor.

[3] ISO 140-11(2005): Acoustics – Measurement of sound insulation in buildings and of building elements – Part 11: Laboratory measurements of the reduction of transmitted impact sound by floor coverings on lightweight reference floors.

[4] ISO 717-2(1996): Acoustics – Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation.

[5] IEC 61260 ed1.0 (1995): Electroacoustics - Octave-band and fractional-octave-band filters.