Assessment of the impact sound insulation by light weight floors and floor coverings

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Introduction

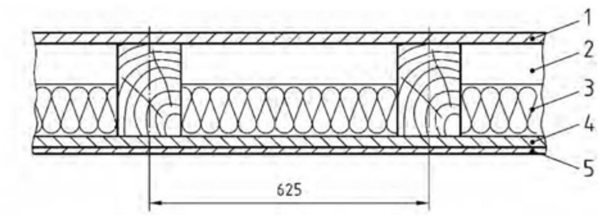
A method to assess the reduction of impact sound level by floor coverings on massive floors by a single number, based on standardised measurements, is laid down since many years in ISO 717-2. A similar procedure for floor coverings on light weight floors however has not been defined until now. Only during the last years ISO 140-11 has been drafted describing the method of measuring the reduction of the impact sound level by floor coverings on typical light weight standard floors with 3 kinds of excitation. With that the question about a single number definition based on the results of these measurements arose.

To gather information on the impact sound level of light weight (wooden) floors with and without floor coverings and useful types of reference curves a series of measurements has been carried out.

Impact sound level measurements

Bare wooden floor and floor coverings tested

A series of measurements was carried out on the standard floor Nr.1 described in ISO 140-11 (typical for European wooden floors) in the facilities in TGM Federal Institute of Technology-Department for Acoustics and Building Physics.



1 22±2 mm wooden chipboard, 600±20 kg/m^3
2 wooden joists 120 mm × 180 mm
3 100 mm mineral wool, 20±5 kg/m^3, 5-10 kPa s/m^2
4 48 mm wooden ceiling battens, 24 mm width, 625 mm spaced
5 12,5 mm gypsum board ceiling, 800±40 kg/m^3, distance of screws 300±50 mm

Figure 1: Standard floor Nr.1 in ISO 140-11

The impact sound level was measured with the 3 types of excitation described in ISO 140-11:

- the standardised tapping machine
- the modified tapping machine with a soft layer on the floor under the hammer area, dynamic stiffness per unit area of the soft layer 34 MN/m^3±10%
- heavy/soft impact source, hollow rubber ball, 180 mm diameter, 30 mm thickness, 2,5±0,1kg weight, dropped from the height of 100 cm

Figure 2 shows an example for the impact sound level for the bare floor and for the bare floor with a floor covering.

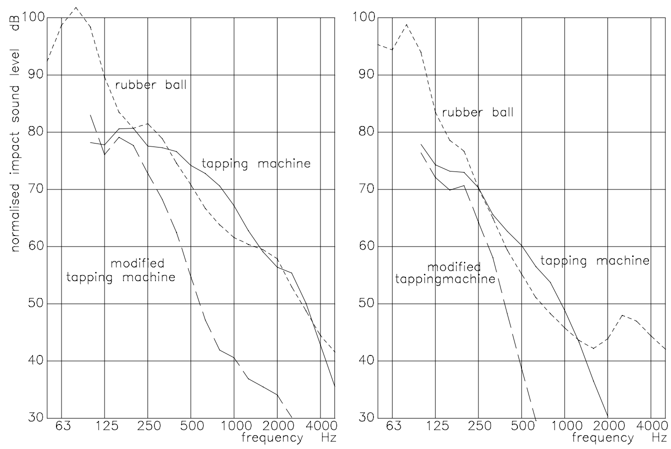


Figure 2: Example of normalised impact sound level measured with the 3 types of excitation, bare floor (left) and bare floor with floor covering from wooden chipboard on mineral wool (right)

The figure shows, that the low frequencies are dominant. Measurements with the rubber ball (heavy/soft impact source) are prescribed therefore only for the 1/3-octave bands 50 – 630Hz.

The measurements were carried out for 16 different floor coverings, some additionally on the bare floor with a resiliently mounted ceiling. The constructions were:

- wooden chipboards or gypsum fibre board dry floor screed on mineral wool with and without lime sand fill beneath
- gypsum fibre board dry floor screed on lime sand
- 2 types of access floor
- calcium sulphate self levelling floor screed on EPS sound insulation board on sand fill
- wooden floors
- special multi layer floor constructions with high impact sound reduction

Reduction of impact sound level by the floor coverings and single number

Measurements of several bare floors of type Nr.1 in Austria, Japan and Germany compared quite well. Based on these the normalised impact sound level for a reference floor could be defined as basis for the calculation of a single number $\Delta L_{t,w}$[1] for the reduction of impact sound on wooden floors (see Figure 3). This together with the method of calculation, quite

[1]) the index t refers to **t**imber floors as the type of bare floor

analogue to that for ΔL_w on massive floors, was proposed by WG 4 of CEN/ TC126 as an addendum to ISO 717-2.

For all above mentioned floor coverings the single number $\Delta L_{t,w}$ was calculated; it ranges from 5 to 30 dB [1]. Examples showed, that measured and calculated values for $L_{n,w}$ of floors with floor coverings compare quite well.

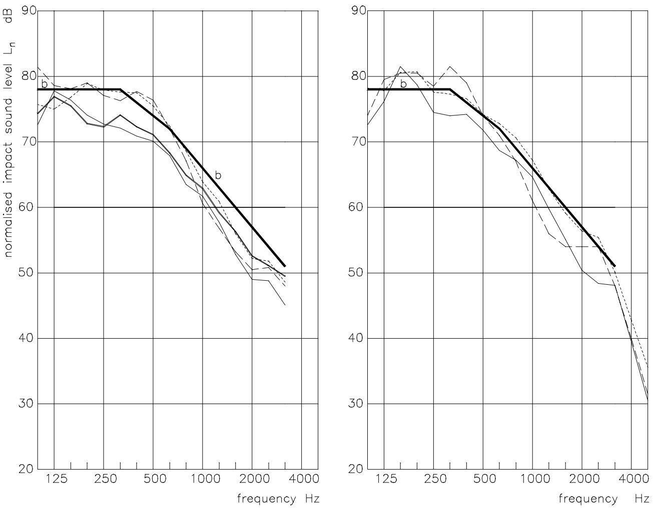


Figure 3: Impact sound level of standard bare floor Nr.1 measured in Austria and in Japan (left) and in Germany (right) and reference floor b for this type of light weight floor

In Austria additionally a reference floor was defined for vertical laminated timber floors and $\Delta L_{tv,w}$–values calculated [1]. The values range from 11 to 41 dB.

Comparison of the different types of excitation

The results for the reduction of impact sound level measured with the 3 different types of excitation showed more or less good agreement, especially in the relevant low frequency range (up to 630 Hz) and did not show systematic differences. It seems therefore sufficient to measure with the standardised tapping machine only. However all results show, that the low frequencies are dominant, especially these with the rubber ball (see Figure 2), the frequency range should therefore be extended down to 50 Hz (also for the normalised reference curve for the impact sound level). Assuming, that the excitation with the rubber ball is typical for the excitation by jumping children and walking persons one may compare the single number "loudness in sone" of the rubber ball with the single number "weighted normalised impact sound level in dB" of the tapping machine $L_{n,w}$ or the sum of this with the spectrum adaptation term $L_{n,w} + C_I$. Table 1 shows the correlation.

$L_{n,w}$	$L_{n,w} + C_I$	$L_{n,w,modif}$	$(L_{n,w} + C_I)_{modif}$
0,866	0,994	0,994	0,993

Table 1: Correlation between loudness of rubber ball and weighted normalised impact sound level, without and with spectrum adaptation term measured with the standardised and with the modified tapping machine

It is to be expected, that the correlation will be higher, if $L_{n,w} + C_{I,50-2500}$ would be calculated. This would be a more useful quantity to define requirements and could substitute the above proposed extension of the reference curve.

Measurements with walking persons

Additionally to the impact sound level measurements described above, measurements with walking persons with 3 different shoes were carried out on some of the floors. The A-weighted equivalent sound level was used as quantity to describe the walking sound level. As it turned out, that the differences between the different shoes were not very high and especially not systematic the average for the different shoes was calculated and compared with the results of the "technical" excitations. As one can show, that there is a very high correlation between A-weighted sound level and loudness of the sound of the dropping rubber ball the correlation between the maximum A-weighted sound level of the dropping rubber ball $L_{A,max}$ and the single numbers of the tapping machine was calculated as shown in Table 2.

number of constructions	$L_{n,w}$	$L_{n,w} + C_I$	$L_{n,w,modif}$	$(L_{n,w} + C_I)_{modif}$	$L_{A,max}$
6	0,847	0,842	0,838	0,835	0,682
5	0,932	0,932	0,933	0,924	0,864

Table 2: Correlation between A-weighted equivalent sound level of walking person and weighted normalised impact sound level, without and with spectrum adaptation term measured with the standardised and with the modified tapping machine, and with the maximum A-weighted sound level of the dropping rubber ball

It turns out, that the measurement with the tapping machine describes the sound produced by walking persons quite well.

Conclusions

A procedure to derive a single number for the reduction of the impact sound level by floor coverings on light weight floors (with a new reference floor) has been proposed and will be added in ISO 717-2.

Data on the reduction of impact sound level by a number of usual floor coverings on light weight floors are now available.

Comparison of the measuring results with the standard tapping machine and a modified tapping machine and the heavy/soft impact source shows that the newly proposed excitation methods don't give additional information on the reduction of impact sound level.

All the measurements, especially these with the rubber ball showed, that for light weight wooden floors the low frequencies are most important to describe the impact sound insulation. Therefore the frequency range should be extended to 50 Hz, also for the reference curve for impact sound level or at least the single number should be $L_{n,w}+C_{I,50-2500}$.

There is a quite satisfying correlation between the single number gained with the tapping machine and the A-weighted sound level of walking noise beneath the floor.

References

[1] ÖNORM B 8115-4 Schallschutz und Raumakustik im Hochbau. Maßnahmen zur Erfüllung der schalltechnischen Anforderungen. Ausgabe 2003-09-01