MEASUREMENT AND ASSESSMENT OF IMPACT SOUND IN THE SAME ROOM

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ABSTRACT

Drum sound, that is the walking noise in the same room as the walker, is a well-known problem that has been under discussion for many years. It is generally recognized to be a problem but as yet it has not been possible to get enough agreement on the issue in order to prepare an international standard. Waiting for international agreement Sweden has recently introduced a SIS Technical Report specifying one laboratory and two field measurement methods. In addition guideline values for the assessment of the noise are given. The report can be used to put up requirements and to verify the compliance with these requirements for floors both in the laboratory and the field.

1. INTRODUCTION

1.1. Background

Drum sound, that is the walking noise in the same room as the walker, is a well-known problem that has been under discussion for many years. It is generally recognized to be a problem but as yet it has not been possible to get enough agreement on the issue in order to prepare an international standard. Some years ago the European Producers of Laminate Flooring (EPFL) prepared a test method based on [2, 3] but it was later withdrawn. There is also a French standard, [1]. Work was then started within CEN TC 126 but after a few years the work item was deleted from the program because of lack of sufficient progress. It was re-instated at the last plenary meeting in September 2007. In the meantime it was decided to prepare some guidelines in Sweden which would make it possible to test and get rid of the most noisy floor coverings. For this purpose a SIS Technical Report, [4] has been issued and the contents will be presented in this paper. Reference to this report is, however, only made in a note in a Swedish standard, [5]. This means that it is not a full standard but only a recommendation. The laboratory method used is similar to but not identical to the method published in the French standard.

1.2. General considerations

When making the technical standard the following technical considerations were made:

- The method should be simple and work as well in the field as in the laboratory
- It is a huge advantage if we can use standardized available equipment, e.g. the tapping machine
- The reproducibility has to be good and we have to get the same result with different tapping machines
- The measurand is not important as long as the ranking of different floors is reasonable
- We need a method now and not in 10 years!
- The method should follow ”the spirit” of the CEN work

1.3. Swedish provisional standard

The SIS Technical Report uses the standardized ISO tapping machine as sound source. It includes three different methods, one laboratory method and two field methods.

The laboratory method is very similar to the French method. However, it also includes rules on how to correct measured impact sound levels for the noise generated by the mechanics of the tapping machine. The error due to this background noise is then determined using the rules of the ISO Guide for Uncertainty of Measurements.

One field method is very simple as it only requires measurement of the impact sound level and no correction of this level in case the room is normally furnished. There is also one more detailed method which both requires the measurement of reverberation time and correction for the influence of the background noise generated by the mechanics of the tapping machine. In addition guideline values for the assessment of drum sound are given.

2. THE SOUND SOURCE

The standardized tapping machine referred to in ISO 140 parts 6-8 were chosen although it has been criticized by many researchers. However, although it is a bad solution it has one major advantage: It is better than all alternatives! Other requirements on the the tapping machine are

It has to have a known sound power level
It must not screen the impact areas more than necessary
The bottom facing the floor must not be sound absorbing

As to self-generated noise the SIS Technical Report gives guidance on how to calibrate the tapping machine. An example of a test rig screening most of the noise from the hammer impacts is given, see figure 1 and 2. It should be noted that this test rig is by no means perfect. There will still be some radiation from the ends of the concrete rods which might be of importance. As there has not yet been time to estimate this radiation the uncertainty of this calibration method is rather large.

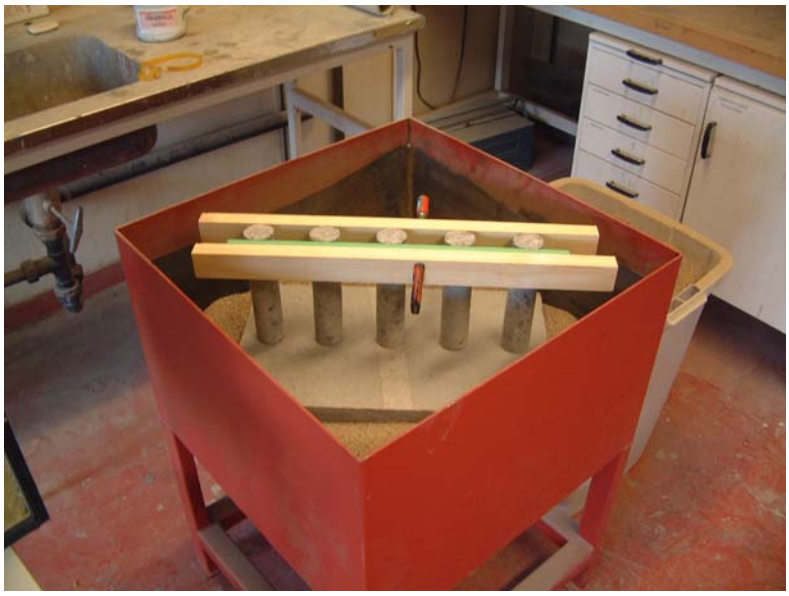

Figure 1. *Inside of sand box used to calibrate the tapping machine*.

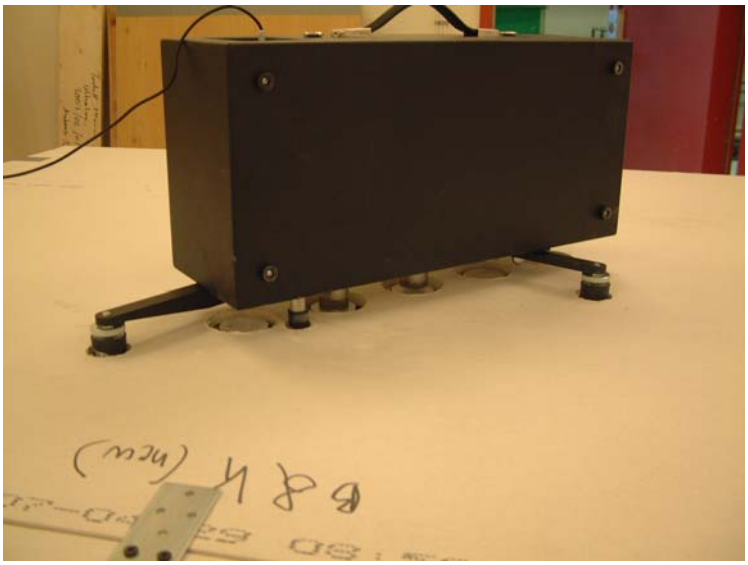

Figure 2. *Outside of sand box used to calibrate the tapping machine*..

In figure 3 examples of noise from four different models of tapping machines measured with the test rig shown are given when tapping on bare concrete.

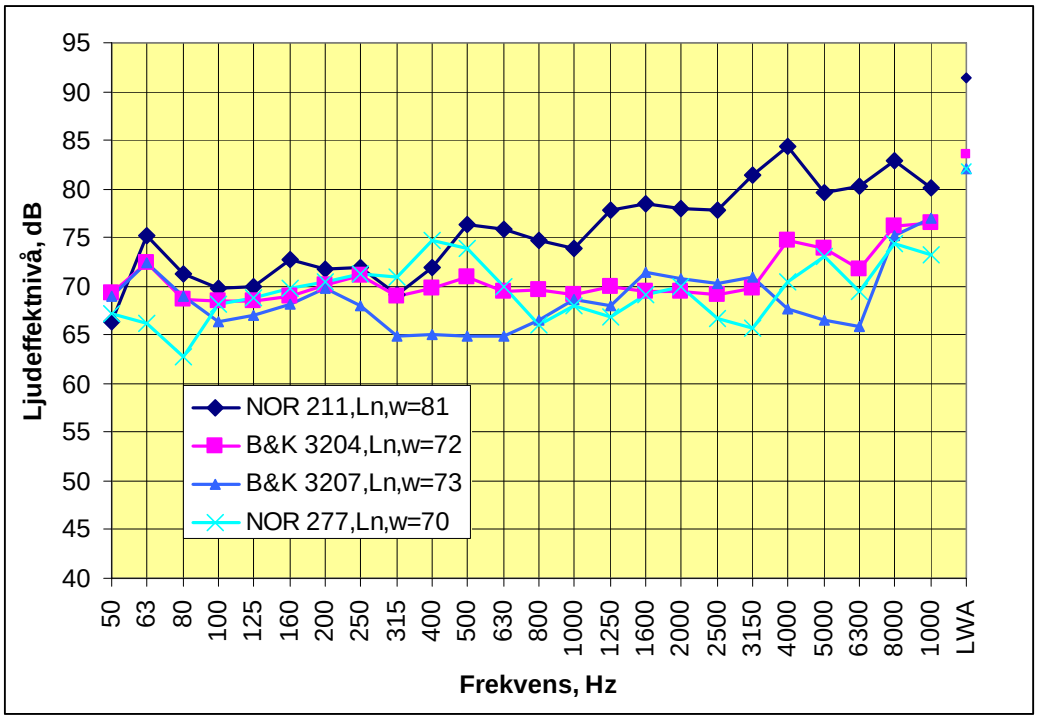

Figure 3. *Sound power levels of self-generated noise from 4 different tapping machines.*

3. LABORATORY MEASUREMENTS

The measure in the laboratory is the normalized impact level, excluding self-generated noise, on a flooring in the emission room on a standardized concrete floor according to ISO 717-2, [6], defined by:

$$L_{n,e,s} = 10\lg\left(10^{0,1\cdot L_{n,e}} - 10^{0,1\cdot L_n} + 10^{0,1\cdot(L_n + L_{n,r,0} - L_{n,b})}\right) \quad (1)$$

where

$L_{n,e}$ Normalized impact level with flooring in emission room excluding self-generated noise;

L_n Normalized impact level with flooring in receiving room

$L_{n,r,0}$ Normalized impact level from reference slab defined in EN ISO 717-2;

$L_{n,b}$ Normalized impact level from bare floor, assumed to be equal on top and below, but measured below with negligible self-generated noise.

$$L_{n,e} = L'_{n,e} + 10\lg\left(1 - 10^{-0,1(L'_{n,e} - L_{n,e,ham})}\right) \quad (2)$$

Where the normalized impact level of the self-generated noise is given by

$$L_{n,e,ham} = L_{W,ham} + 10\lg\left(\frac{4}{A_e}\right) + 10\lg\left(\frac{A_e}{A_0}\right) = L_{W,ham} - 4 \quad (3)$$

4. MEASUREMENT UNCERTAINTY DUE TO BACKGROUND NOISE

One of the most important uncertainty components is the influence of self-generated background noise. It is dealt with according to the principles of the ISO GUM, [7].

$$L = L' + 10\lg\left(1 - 10^{-0,1(L'-L_{res})}\right) \quad (4)$$

$$c_{L'} = \frac{\partial L}{\partial L'} = 1 + \frac{10^{-0,1(L'-L_{res})}}{1 - 10^{-0,1(L'-L_{res})}} \quad (5)$$

$$c_{res} = \frac{\partial L}{\partial L_{res}} = \frac{-10^{-0,1(L'-L_{res})}}{1 - 10^{-0,1(L'-L_{res})}} \quad (6)$$

$$u_L = \sqrt{c_{L'}^2 u_{L'}^2 + c_{res}^2 u_{res}^2} \quad (7)$$

5. FIELD MEASUREMENTS

In situ the standardized impact sound pressure level in the same room is used. There are two methods in the SIS Technical Report: one engineering method requiring measurement of the reverberation time and one survey method with either no correction or a default correction. The enginnering method, but not the survey methods, corrects for the self-generated noise of the tapping machine. For the engineering method we get

$$L'_{nT,e} = L'_e - 10\lg\left(\frac{T_e}{T_0}\right) \quad (8)$$

where T_0 = 0,5 s and the prime sign indicates that the measured level includes self-generated noise of the tapping machine. After correction we get

$$L_{nT,e} = L'_{nT,e} + 10\lg\left(1 - 10^{-0,1(L'_{nT,e} - L_{nT,ham})}\right) \quad (9)$$

where

$$L_{nT,ham} = L_{W,ham} + 10\lg\left(\frac{4 \cdot T_e}{0{,}16 \cdot V_e}\right) - 10\lg\left(\frac{T_e}{T_0}\right) = L_{W,ham} + 10\lg\left(\frac{4 \cdot T_0}{0{,}16 \cdot V_e}\right) \quad (10)$$

V_e being the volume of the emission room.

For the survey method no correction is made for self-generated noise. For furnished rooms or rooms with acoustic treatment no correction is made for sound absorption. Thus the measure is

$$L'_{nT,e} = L'_e \quad (11)$$

In unfurnished rooms without acoustic treatment 3 dB is subtracted, that is

$$L'_{nT,e} = L'_e - 3 \quad (12)$$

6. GUIDANCE VALUES

In the laboratory floor coverings on concrete floors can be rated according to table 1. Sound class C corresponds to minimum requirements yielding acceptable noise levels whereas B and A yield a higher standard.

Table 1 Rating in the laboratory

Sound class	Requirement $L_{n,e,s,w}$	Largest increase of drum sound level when measured on a bare reference 12 cm thick concrete floor, $\Delta L_{n,e,s,w}$
C	84 dB	$\leq$ 6 dB
B	80 dB	$\leq$ 2 dB
A	76 dB	$\leq$ -2 dB

Table 2. Highest impact sound level in the same room – Care rooms, offices, hotels and restaurants

Standardized impact sound level in the same room	$L'_{nT,w}$ dB			
	Sound class			
Type of space	A	B	C	D
All spaces with floor area > 30 m^2 where people constantly dwell	72	76	-	-

Table 3. Highest impact sound level in the same room – Rooms for education

Standardized impact sound level in the same room	$L'_{nT,w}$ dB			
	Sound class			
Type of space	A	B	C	D
Lecture rooms or large spaces for joint gatherings	68	72	-	-
Other spaces with floor area > 30 m^2 where people constantly dwell	72	76	-	-

7. REFERENCES

[1] French standard NF S 31-074, Acoustics – Measurement of sound insulation in buildings and of building elements – Laboratory measurement of in room impact noise by floor covering put in this room

[2] A_C Johansson, E. Nilsson, Measurement of drum sound – NT 1636-03, Report TVBA-3127, LTH, Engineering acoustics

[3] A-C Johansson, Drum sound from floor coverings – Objective and subjective assessment, dissertation, Lund University, 2005, ISBN: 91-628-6531-5, ISSN: 0281-8477

[4] SIS-TR 2007:15 Riktlinjer för mätning och bedömning av stegljud i samma rum

[5] SS 25268 Byggakustik – Ljudklassning av utrymmen i byggnader – Vårdlokaler, undervisningslokaler, förskolor och fritidshem, kontor, hotell och restauranger

[6] SS-EN ISO 717-2, Building acoustics – Rating of sound insulation in buildings and for building elements – Part 2: Impact sound insulation

[7] Guide to the expression of uncertainty in measurements (GUM), BIPM/IEC/IFCC/ISO/IUPAC/IUPAP/OIML, 1993 (corrected and reprinted 1995)