Evaluation of walking noise on floors

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Introduction

Apart from impact noise in adjacent rooms, walking noise in the source room itself – also referred to as drum noise – is of increasing interest. From the physical point of view, walking noise is mostly the same as impact sound. The difference is mainly the person receiving that noise. For impact noise this person is dwelling in another apartment. When talking about walking noise in the source room, it is either the walking person itself, which is annoyed, or a second person in that same room.

The topic of walking noise was brought up by manufacturers of floor coverings, who aimed at improving the sound of their products. Therefore a classification of the products is wanted.

Measuring walking noise

Keeping in mind the similarities between walking noise and impact noise, a first idea for a measurement method could be to use the standard tapping machine as a noise source and then carry out sound measurements as described in ISO 140 (with some modifications).

An opposite approach would be to use a natural person, walking around on the floor covering under test. Having the advantage of being as close as possible to real walking noise, this method lacks of sufficient reproducibility.

Another idea is throwing ping-pong balls on the floor covering. Here a better reproducibility can be achieved, while still using a sound source with single impacts, which are well distinguishable one from each other. In this case the sound measurement technique must be based on transient signals. Unfortunately, there is little experience on how to evaluate the outcome.

Modifications to ISO 140

Using the standard tapping machine as an artificial noise source permits to conserve the experience gathered in evaluating impact noise. This approach is used in the French standard NF S31-074 [1]. Here an impact sound pressure level is measured in the source room. The tapping machine shall be used together with an acoustic enclosure in order to reduce its mechanical background noise. The noise emitted by the floor covering is corrected by a term representing the noise emanating from the bare floor.

Some points within this method shall be discussed:

- The background noise of the tapping machine
- How to evaluate the sound of the floor covering and not just its noise level

Background noise of the tapping machine

Some tapping machines produce a considerable amount of airborne sound, which will dominate the sound pressure level in the source room for many types of floor coverings. Some elder tapping machines are provided with a wooden box and possess reduced noise levels. An enclosure will reduce its noise additionally, so that some of the noisier floor coverings - as wood parquets or laminate floors – can be measured.

The tapping machine produces a mechanical noise component due to the engine and the mechanic lifting of the hammers. Another noise component results from the impact, as not only the floor will radiate sound, but also the hammer and indirectly the structure of the machine, too. Finally, structure-born sound in the floor can be re-transmitted to the tapping machine via its feet.

In order to carry out measurements correctly, the background noise of the tapping machine must be determined separately prior to measuring the floor covering. The mechanical noise component can be determined easily by putting the tapping machine on a soft underlay. Figure 1 shows the mechanical sound pressure levels for two commercially available tapping machines as an example.

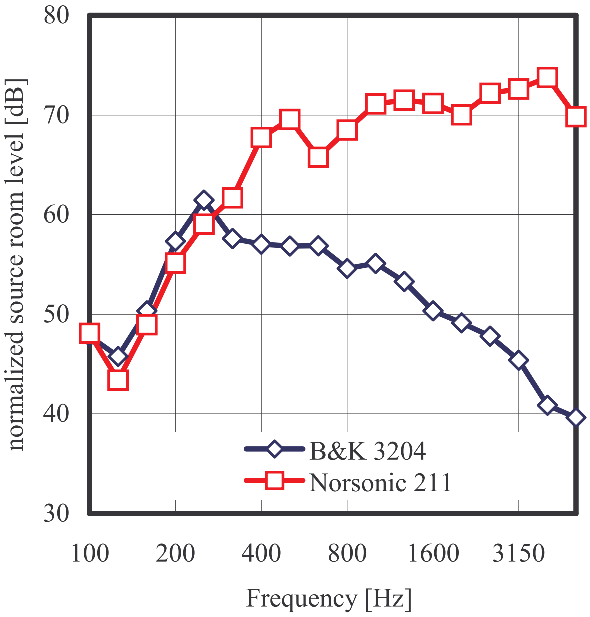

Figure 1: Sound pressure level of different tapping machines on a soft underlay.

In order to evaluate all noise components of the tapping machine, it was put on a special mock-up. This mock-up consisted of a massive concrete block of about 25 kg with some cylindrical attachments. The whole construction was isolated from the ground and surrounded by an enclosure. A sketch is shown in Figure 2.

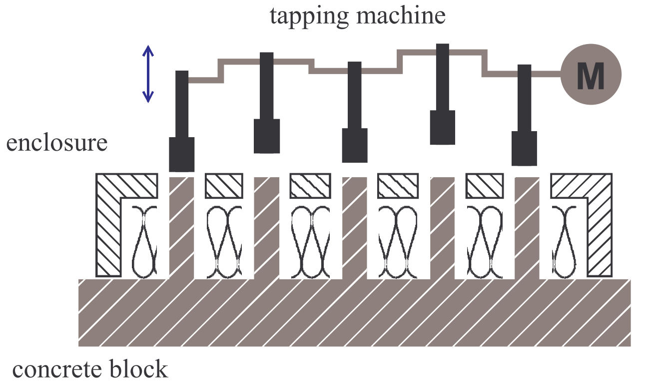

Figure 2: Mock-up to determine the background noise of the tapping machine.

Figure 3 shows the sound pressure levels measured in the source room, when putting the tapping machines on the mock-up. For the noisier 'Norsonic 211' tapping machine, there is a minor increase in sound pressure level. However, the sound pressure level of the 'B&K 3204' increases by more than 20 dB at high frequencies.

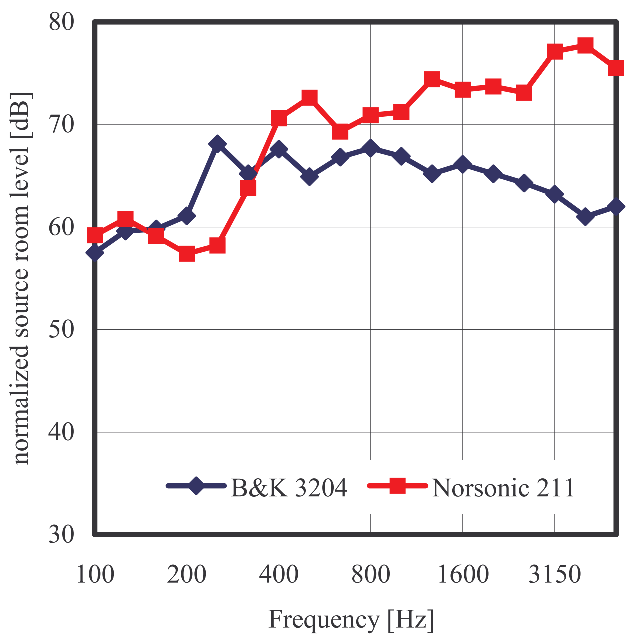

Figure 3: Sound pressure level of different tapping machines on the mock-up.

Evaluating walking noise

Certain types of laminate floors are in the focus when talking about inconvenient walking noise. These floors can produce high sound pressure levels in the source room of 80 - 90 dB(A), when they are excited by the tapping machine. These floor coverings generate a sensible noise component at high frequencies, which is noticed as 'clicking'. However, wooden parquets generate even more noise (> 90 dB(A)), while their sound is considered as more convenient

The example shows, that the A-weighting procedure is not appropriate to characterise walking noise. The same holds for the rating curves defined in ISO 717, as they have been designed for separating construction elements. The question is, if such simple weighting curves can give a correct evaluation of walking noise.

Modern measurement techniques enable us to make binaural sound recordings with an artificial head and determine psychoacoustic parameters like loudness, sharpness and others virtually in real-time. Johansson [2] investigated the correlation of such psychoacoustic parameters, derived from sound recordings of walking people, with the subjective impression of test persons, listening to that sound recordings. She found that the best correlation to the subjective responses of the listening persons was observed with the 10-percentile loudness N_{10}. The correlation was better than that with the loudness of the averaged sound pressure level. Sharpness was not a significant parameter.

However, a test procedure for the determination of product characteristics cannot employ extensive field tests with test persons. For psychoacoustic quantities derived from measurements with walking persons the type of shoes and the walking persons used in the test must be defined precisely. This is rather difficult.

A practical compromise for a test code is to use the standard tapping machine as a noise source, to measure the sound power level (i.e. sound pressure level and reverberation time in a reverberant environment) as proposed in NF S31-074. The background noise of the tapping machine has to be handled with care. An evaluation of the loudness according to Zwicker, based on third-octave-band values of the averaged sound pressure level, yields a better correlation to the subjective sensation of walking noise.

References

[1] NF S31-074: Acoustique - Mesurage de l'isolation acoustique des immeubles et des elements de construction – Mesurage en laboratoire du bruit de choc dans une salle par les revêtements de sol posés dans cette salle

[2] A.-C. Johansson, P. Hammer, E. Nilsson: Prediction of Subjective Response from Objective Measurements Applied to Walking Sound. Acta Acustica united with Acustica **90** (2004), 161-170