Walking noise and its characterization

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The increasing distribution of hard wooden floors increased also problems with annoyance by the noise emission from walking into the same room a person is walking. This shall be called walking noise emission to distinguish it from the impact sound insulation topic which is still equally important. In the last years efforts were made to characterize this noise and to quantitatively measure it. It turned out that at the moment no technical device is available which is able to satisfactory simulate the walking noise. Therefore, an alternative method for walking noise measurement worked out is topic of the presentation.

INTRODUCTION

Laminate and other types of hard wooden floors became very popular in the last decade with a market share of over 10% in Western Europe. Not so popular is the annoyance by the noise emission from walking on these floors. So the manufacturers made considerable efforts to design low noise floors. The success of such design can only be estimated by an appropriate test method. As there is no agreed method available this was the starting point for the development of such a method. Throughout this process the new vocable 'walking noise' was introduced to distinguish the problem from the related impact sound insulation. Also some theoretical insight into the generation process of walking noise was gained.

THEORY

Laminate floor is usually laid on some elastic underlay. Therefore from a mechanical point of view it can be seen as a plate on bedding. Cremer and Heckl [1] gave some expressions on bending wave propagation on such plates. Damping in the laminate plate may be considerable high. So, in order to study walking noise it is necessary to study the noise generated by an impact on a damped plate on bedding. The impact of a body will generate two kinds of sound. First there will be a direct airborne sound generation through the sudden stop of the fluid mass (density ρ_0) surrounding the impacting body. It is very difficult to get an estimate of this sound as the impact speed U_0 must be known. Sound energy for a hard sphere of volume V sudden stopping is [1]

$$E = \frac{1}{4}\rho_0 V U_0^2. \qquad (1)$$

For other shapes of the body the equation must be slightly modified. The second kind of sound generated trough the impact is structure-borne sound, mainly bending waves in the plate. This sound is radiated back into the room and contributes to the overall audible walking noise. The generation of structure borne sound depends on the elastic properties of the laminate versus the impacting body, the area mass of the laminate and the characteristics of the underlayer. The propagation of bending waves in the laminate plate depends also on the damping.

Table 1. Reverberation room measurements: SPL decrease in dB compared to reference for 7 samples

	A	**B**	**C**	**D**	**E**	**F**	**G**
tapping machine	3.0	2.6	0.2	2.7	3.7	5.2	4.7
walking person	0.7	1.1	0.8	5.1	1.6	0.2	0.9

TEST METHODS

There are two general possibilities to generate walking noise - by a person walking or by a technical device producing some impact sound. The reproducibility of the results gained by a specific test method is very important. Thats why two technical devices - tapping machine and falling steel ball - were preferred at the beginning of the development of walking noise test methods.

For the test of the tapping machine some samples were laid in the reverberation room and the tapping machine was used in the same way as for impact sound insulation measurements. A mean sound pressure level (SPL) was measured in the room using a spectrum analyzer. To test for meaningful results these experiments were compared to the SPL from a walking person on the same samples. Special care was taken to make the results from the person not subjective. With both methods the measured SPLs where compared to a reference sample which was the loudest. The congruence of both methods was unsatisfactory, see table 1, and could not be improved by calculatory alignment of spectra (fig. 1).

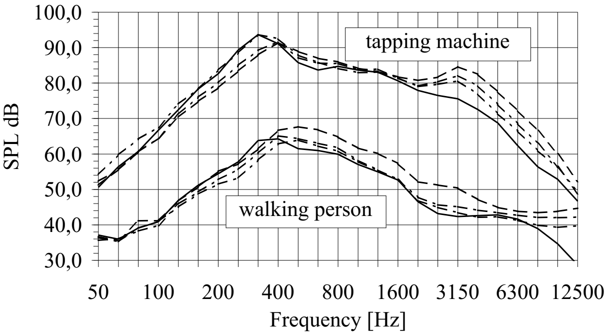

FIGURE 1. SPL in third-octave bands, unweighted, for 4 different laminate samples for tapping machine and walking person

A second method was tested using a steel ball (ø16 mm) falling from a defined height. The SPL was averaged over the first 100 ms after impact. Comparison to results from a walking person was bad again.

The reason why the technical devices failed is twofold. First, impact speed and mass are too different from that of a walking person. The fact that spectra could not be aligned indicates that nonlinear processes are of importance during the impact. Second, the direct airborne sound power is considerable compared to the overall sound power, but it is different for different objects[1].

As a consequence from the results with technical devices a test method was set up which uses a walking person to generate walking noise on a test facility. Within a reverberant test room a special 60 mm concrete basis with an even and an uneven surface part was laid. On top of this basis samples could be easily laid and tested. Testing procedure is as follows: The walking person starts on a soft carpet and then walks onto the test sample. Measurement equipment is triggered on the first step on the test sample to average over 100 ms. For the overall result this is repeated at least 15 times. It was experimentally verified that this procedure assures a good reproducibility so that results from different measurement campaigns lie within an ±1 dB interval. The

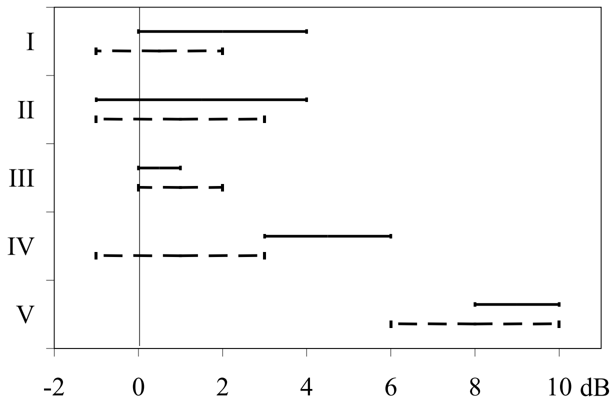

FIGURE 2. Test facility measurements: typical SPL decrease compared to reference sample - I foams (except PE), II cardboard, III cork, IV heavy underlay mats, V thermoplastic damping treatment on laminate underside; — even basis - - - uneven basis

results for each sample are compared to a reference sample[2] to get a measure of the enhancement. Fig. 2 shows typical enhancements for different low noise technologies for laminates. Except from the laminates with thermoplastic damping treatment on the underside the enhancement is poor or average.

SUMMARY

Currently there is no technical device available which may generate walking noise in a manner comparable to a person walking. A preliminary test facility was set up to be able to estimate the performance of low noise laminate floorings. A walking person generates the noise which is then measured taking only one step. With this procedure a good reproducibility can be achieved.

In the future a "walking machine" should be constructed which is able to reproduce meaningful results also on other test facilities.

REFERENCES

1. L. Cremer, M. Heckl, *Körperschall* 2nd edition, Springer, Berlin, 1996.

[1] rough estimates after (1) sound power level for 100 ms: 95 dB for tapping machine, 75 dB heels shoe single step

[2] reference is defined as 8.1 mm DPL laminate laid on PE foam of brand Noppaschaum