Short report
(Reference: II 3-F20-11-1-031 / SWD-10.08.18.7-12.20)

Title (long version): Impact sound insulation of exchangeable floor coverings

Initial Situation

The acoustic evaluation of floor coverings is expressed by the impact sound reduction index, which is determined according to internationally standardized procedures by excitation using the tapping machine on a raw ceiling. In practice however, the floor coverings are laid on a screed and the excitation is done by human walkers instead. This leads to deviations of the acoustic effect between laboratory measurement and user perception.

Object of the research project

Aim of the accomplished investigations was to get a representative overview of the acoustic behavior of common floor coverings assembled and excited appropriately in practice. For this eight different floor coverings were selected to be first tested each on the raw ceiling and then on four different floating floors. All constructions first were excited with the standard impact generator. Then the measurements were repeated with alternative impact sound sources that represent more appropriately the spectrum of natural walking noise. In parallel with all measurements the signal of the standard microphone was recorded in the cabin to have the noises evaluated later by test persons. The measurements were performed in a test stand according to DIN EN ISO 10140, whereby not covering the whole surface but on a patch of 1 m x 1 m. Since during evaluation of the impact sound reduction the influence of the floating floor surface stands out from the result, this has no influence on the investigations.

For the comparison of the acoustic effect of the floor coverings on screeds the evaluated impact sound reduction according to DIN EN ISO 717-2 cannot be used, since the standard does not provide a reference floor for this case. Therefore, alternatively the improvement of the evaluated impact sound reduction of the screed caused by the floor covering was determined as $\Delta L_{w,screed+rcovering}$ - $\Delta L_{w,screed}$. The term describes the floor coverings on screeds in a well-suited way for practice. In addition, it is independent from the structure of the raw ceiling. In fig. 1, the results are represented as colored bars. The grey bars mark the evaluated impact sound reduction of the coverings laid on the raw ceiling.

Since there is no planning data available for the acoustic effect of coverings on floating floors so far, the question arises whether the required value can be predetermined on the basis of the existing information. In order to examine this, the improvement of the impact sound reduction of the screed caused by the covering is represented in fig. 2 in dependence of the impact sound reduction of the covering. Thus, a surprisingly simple connection is revealed. For the values of $\Delta L_{w,covering} \leq 20$ dB the value $\Delta L_{w,screed+covering}$ - $\Delta L_{w,screed}$ is constant. Values > 20 dB result in a linear rise.

For the measurements with alternative impact sound sources it was used, by analogy to $\Delta L_{w,screed+covering}$ - $\Delta L_{w,screed}$,the difference of the A-weighted sound pressure levels which was designated $\Delta L_{A.}$ The investigations showed that the modified tapping machine (with standardized elastomer pad) is the most appropriate among the examined sources to simulate real walking with soft footwear or shoeless (see fig. 3). However, this is not applicable to the excitation of carpets as the drop height of the hammers, as well as with the standard tapping machine, is strongly influenced by the carpet fibers.

Since the noticed impact sound reduction always implies a subjective component, subsequent to the measurements hearing tests were performed. For this, 20 test persons analyzed the audio recordings. The reproduction software was integrated into a survey tool (see fig. 4), setting the volume of the headphones to the measured value. The evaluation scale was created according to ISO/TS 15666. In the first stage the annoyance was evaluated on a scale from 0 to 10. In the second stage the felt loudness was roughly assessed on a five-step scale the third step of which again was subdivided into a further ten-step numeric scale. In order to examine the correlation between the evaluated impact sound reduction and the subjectively felt volume reduction, the results of the hearing attempts were compared to the results of the building acoustic measurements. By means of statistic results to evaluate the loudness of noises gained in hearing tests of ISO 16832, the results of the used 50-step scale of the hearing test can be contrasted with the A-evaluated impact sound pressure levels (results for different floor structures see fig. 5).

Conclusion:

Main objective of the investigations was the determination of the actual impact sound reducing effect of floor coverings that were practice-adequately laid on a floating floor. Compared to the measurement and evaluation according to standard on a raw ceiling the effect is substantially smaller in all cases. Beyond that, a method was developed for the mathematical estimation of the actual effect based on standardized measured values. The effect during real walking excitation was investigated by measurements with alternative impact sound sources. Here, it showed that the impact sound reduction by human walkers is significantly smaller both on the raw ceiling and on the screed than by the standard impact generator.

Basic information:

Short title: Impact sound reduction of exchangeable floor coverings

Researchers / project management: Mark Koehler, Lutz Weber

Total costs : € 148.657,82

Amount of federal subsidy : € 80.800,--

Project duration: 9.12.2011 – 31.12.2013

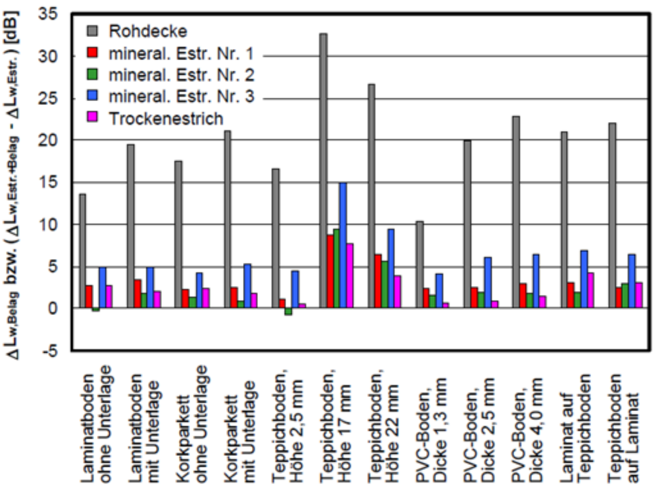

Fig. 1: Impact sound reducing effect of the floor coverings on the raw ceiling (grey bars) and on different prefabricated ceilings with floating floor (colored bars).

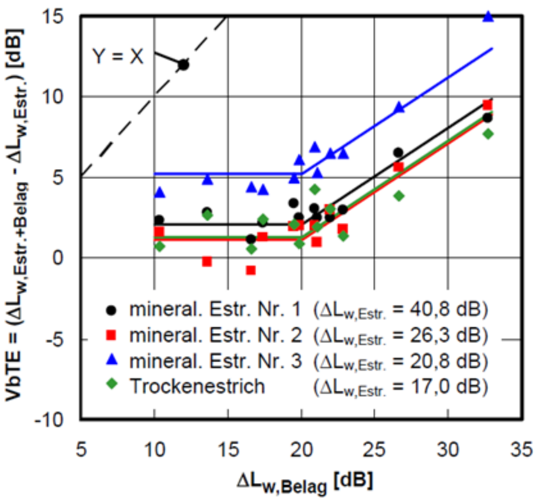

Fig. 2: Model for estimation of the impact sound reduction of floor coverings on prefabricated concrete ceilings with floating floors. Comparison of calculation (line) and measurement (symbols).

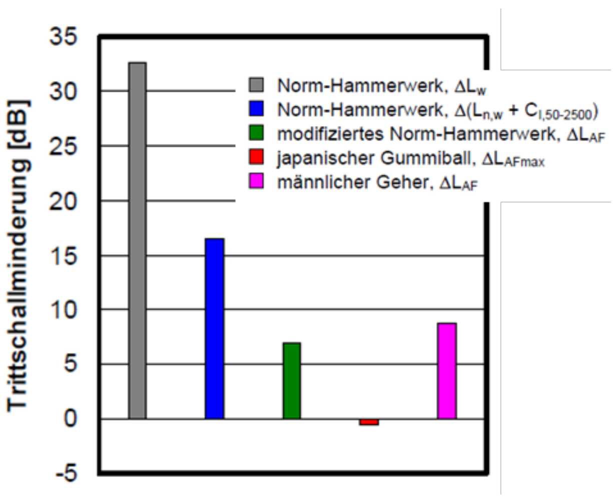

Fig. 3: Impact sound reduction of a floor covering on raw ceiling with excitation by different impact sound sources.

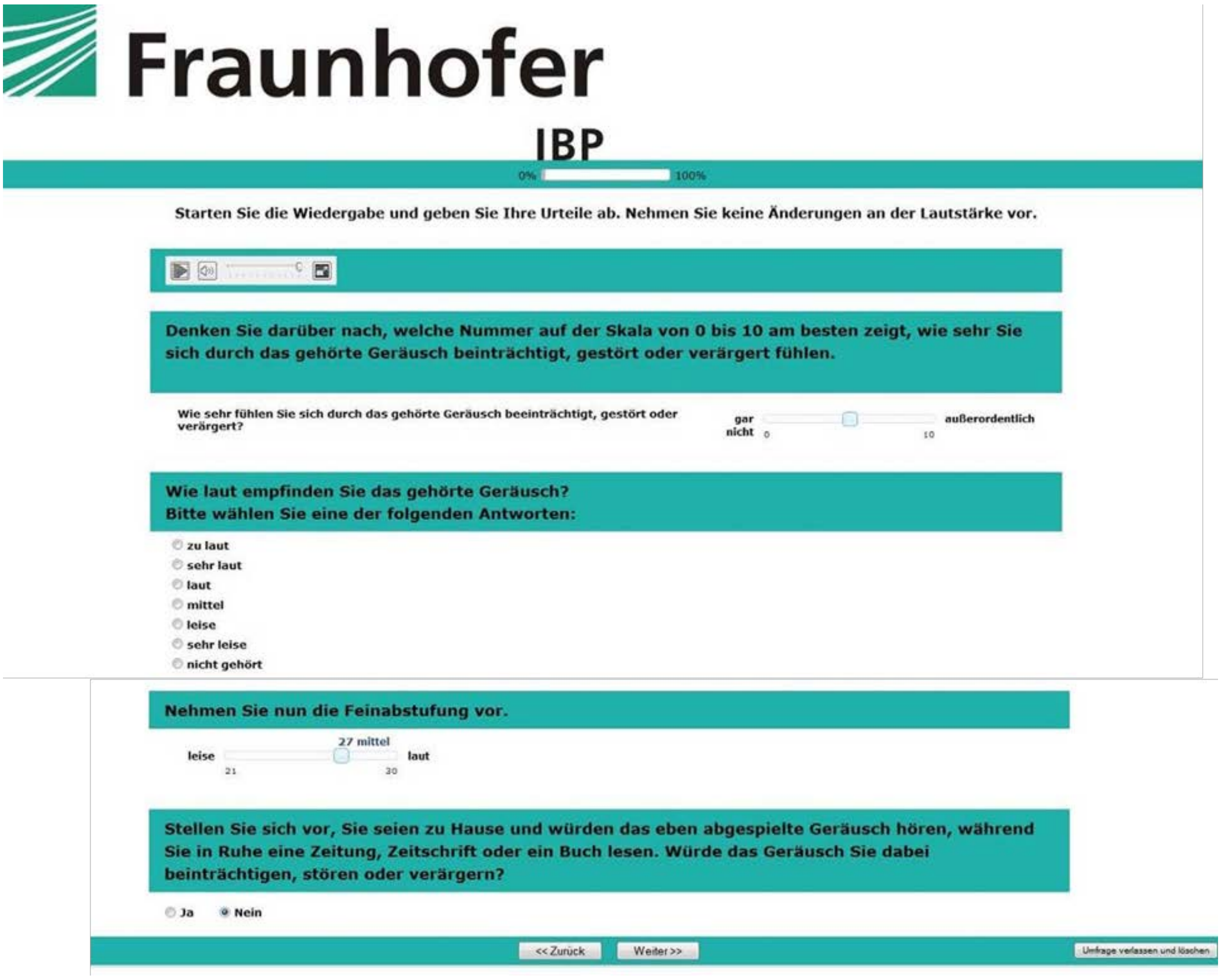

Fig. 4: Questionnaire for hearing test to evaluate the loudness and annoyance (extract).

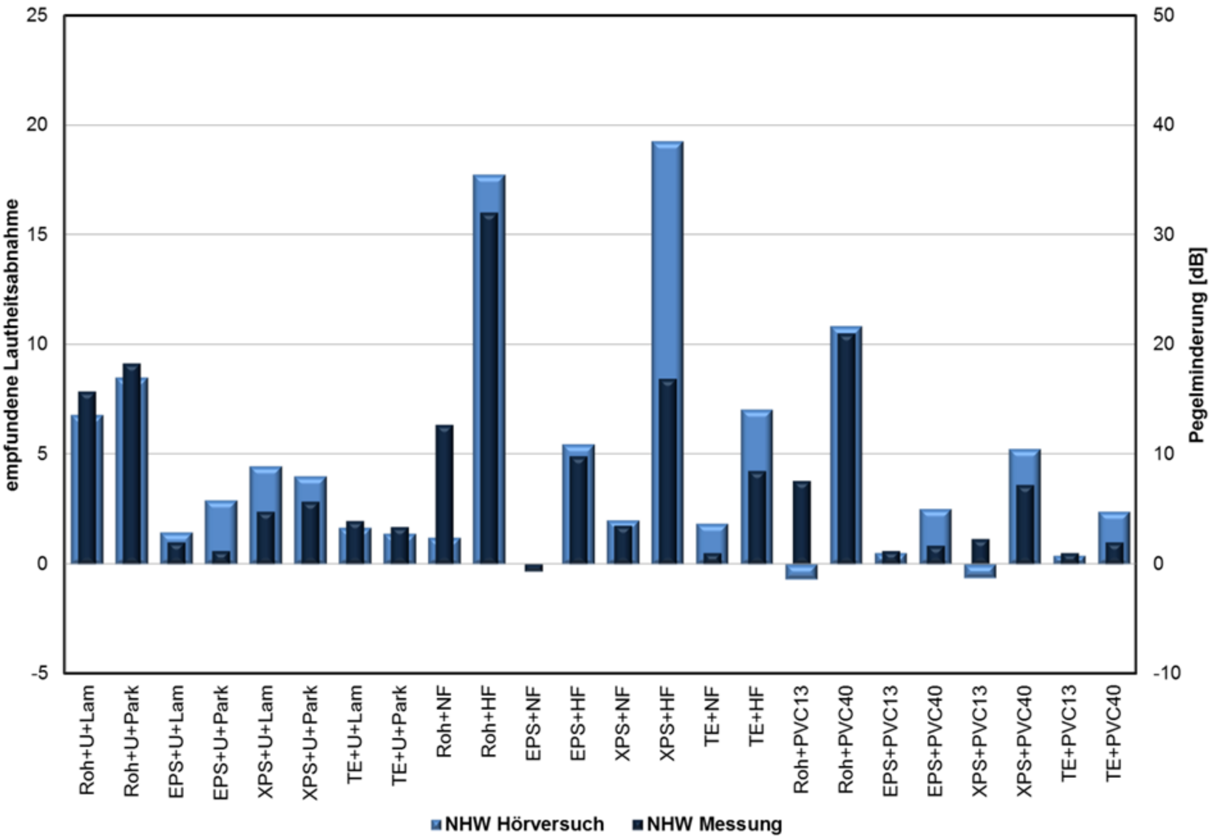

Fig. 5: Loudness sensation and measured level reduction of different ceiling coverings (floor covering on raw ceiling or floating floor).