EVALUATION OF DIFFERENT MATERIALS AS PROTECTIVE FLOOR COVERING IN-SITU IMPACT NOISE MEASUREMENTS

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1 Introduction
Brazil’s new building standard NBR15575 :2013 [1] - establishes requirements, criteria and evaluation methods to determine the performance of residential buildings in order to provide thermal, lighting, and acoustic comfort. For acoustic comfort, the standard specifies minimum performance values for airborne sound insulation and impact noise through by means of the parameters $D_{n,T,w}$ and $L_{n,T,w}$, respectively. Thus, in-situ measurements of the airborne sound transmission and impact noise are required to verify if the new buildings match the requirements established by the standard. According to ISO 140-7 :1998 [2] which defines methods for in-situ measurements of impact sound insulation of floors, it is necessary to use a standardized tapping machine (STM). As the hammers might damage the floor finishing a modified tapping machine (MTM), that uses a protective material between the floor and the hammers, is used as an alternative. The present study was carried out in a laboratory set-up in order to identify a suitable material to be used in the modified tapping machine to protect the floor from damage during the acoustic in-situ measurements.

2 Method
In order to find a suitable material to protect the flooring, tests were conducted in the impact sound transmission chamber of the Acoustic Laboratory at the Federal University of Santa Maria, in Brazil.

Following the recommendations of ISO 10140 :2010 [3], parts 1, 3 and 4 , ISO 717 :2013 [4], part and ISO 354 :2003 [5] (reverberation time of the receiving chamber) measurements of the impact sound pressure level were carried out exciting the different floors with a tapping machine modified by inserting different materials between the hammers and the floor finishes.

Three different materials were tested in a laboratory set-up : felt, non-woven fabric (NWF) typically used for decoration, and polypropylene, according to Figure 1.

![Figure 1: Felt, NWF and pieces of polypropylene, respectively.](image)

These materials, that were easily available for the users all over Brazil, were tested with two very common types of floors : laminate and porcelain tiles, using samples of flooring according to Figure 2. The floorings were excited with and without the protective materials. When excited with the protective covering, materials were used unfolded (1 layer) as well as folded two, three and four times.

![Figure 2: Tapping machine with the samples of laminate and porcelain tiles, respectively.](image)

Measurements of $L_{n,T}$ and $L_{n,T,w}$ were conducted in the laboratory impact chamber having a solid 10 cm-thick concrete slab. The samples of laminate flooring and porcelain tiles were placed directly on the concrete slab and measurements without and with unfolded and folded protective coverings were carried out for different receiver positions.

The polypropylene chips were attached directly to the hammers as proposed by the second method for preparing the MTM according to ISO 10140 :2010 [3] part 5. Felt and NWF were tested according to the first method described in the same standard, placing the material directly on the floor.

3 Results
Both for the reference floor using the STM as well as for each combination of floor/protective covering (MTM) $L_{n,T}$ and $L_{n,T,w}$ were obtained and the influence of the protective coverings were quantified.

3.1 Felt on laminate and porcelain tiles
According to Figure 3, the influence of the felt on the impact SPL measurements with laminate or porcelain titles was very significant, with high values of $\Delta L_{n,T}$, mainly at medium and high frequencies. Changes in $L_{n,T}$ were more evident for the porcelain floor, and increased significantly with the addition of layers by folding the protective covering.

As the standardized impact SPL spectrum was modified using the felt the weighted parameter $L_{n,T,w}$ also does. For the laminate flooring the reductions of $L_{n,T,w}$ were between 1 dB and 5 dB. For porcelain tiles reductions of $L_{n,T,w}$ of 4 dB to 14 dB were found, compared to the standard situation without felt.
3.2 NWF on laminate and porcelain tiles

The influence of NWF on the impact SPL measurements was found to depend on the type of flooring, according to Figure 4. For laminate flooring, NWF was found to change the $L_{n,T}$ in almost all frequencies, except for some frequency bands between 160 Hz and 630 Hz. On porcelain floors, NWF covering resulted in small reductions of $L_{n,T}$, except for some frequencies, mainly at low and high frequencies.

Figure 4: $L_{n,T}$ and $L_{n,T,w}$ measured without and with $n$ layers of NWF on laminate and porcelain tiles.

On laminate flooring, two, three and four layers of NWF changed the $L_{n,T,w}$ up to 2 dB. No reduction in $L_{n,T,w}$ was found for a single layer of NWF. On porcelain tiles, NWF reduced the $L_{n,T,w}$ only when more than three layers were used, resulting in differences from 1 dB to 3 dB compared to the standard situation.

3.3 Polypropylene on laminate and porcelain tiles

Polypropylene chips fixed to the hammers changed $L_{n,T}$ at all frequencies, but more pronounced at low and high frequencies, both for laminate flooring and porcelain tiles, as shown in Figure 5.

On laminate flooring, polypropylene chips on the hammers reduced the $L_{n,T,w}$ by only 1 dB, with one and three layers, and no reduction was found using two and four layers. On porcelain floors, the polypropylene fixed to the hammers resulted in a $L_{n,T,w}$ 2 dB higher than without the protective material, using two, three and four layers.

Figure 5: $L_{n,T}$ and $L_{n,T,w}$ measured without and with $n$ layers of polypropylene on laminate and porcelain tiles.

4 Discussion

Felt was found to provide the stongest modification of $L_{n,T}$ and $L_{n,T,w}$ compared to other materials (NWF and polypropylene chips), especially on porcelain tiles. Nevertheless it presented an excellent capacity of flooring protection, even with just one layer and no damage to the covering itself from the impact hammers was found.

Using non-woven fabric (NWF) a considerable alteration of $L_{n,T}$ but lower changes in $L_{n,T,w}$ (3 dB on laminate flooring and 2 dB on porcelain tiles) were found. The material was able to protect the flooring only with four or more layers.

Polypropylene was the material that presented minor modifications of $L_{n,T}$ and $L_{n,T,w}$, with alterations of 1 dB on laminate flooring, and 2 dB on porcelain tiles. Is also proved to be a durable material and showed good flooring protection capability.

5 Conclusions

This study demonstrated that polypropylene chips fixed to the hammers ensured proper protection of the flooring and resulted in minor changes to $L_{n,T}$ and $L_{n,T,w}$, for both laminate flooring and porcelain tiles, even with the addition of more layers.

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References