M.Sc. Wood Technology

Master Thesis

Acoustic improvement and analysis at low frequencies of a joist timber floor

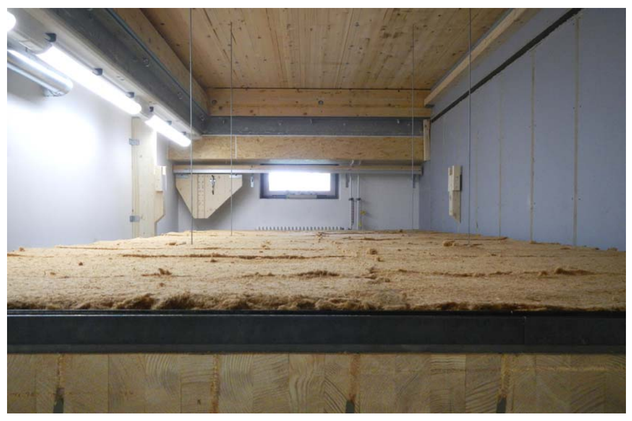
Abstract

In multi-storey buildings, the impact sound insulation plays an important role in the acoustic performance of buildings, being more critical the low frequencies. To improve the behaviour of the impact sound insulation of a dowelled joist timber floor with a dowelled joist timber suspended ceiling was the main goal of this study. To achieve it, a floating floor was installed. A further analysis at low frequencies was carried out. For this analysis, the impact sound pressure level, L_{nT}, the impact sound pressure level of footsteps noise and the radiation efficiency, σ, were measured. Moreover, some other approaches were also followed such as the use of elastic layers. The measurements were carried out in the acoustic laboratory of the Rosenheim University of Applied Sciences. The methods used to measure the L_{nT} were the sound pressure level and the sound intensity. To obtain the σ, the measurements were realized using simultaneously accelerometers and a laser vibrometer. The findings reveal that the developed timber floor has an impact sound insulation that reaches 35 dB, which far accomplishes the Swiss standards. They also show that the modifications done in the cavity and the elastic layers are not relevant for the acoustic improvement of this construction. Further investigation at low frequencies is recommended for the footsteps noise, as well as for the analysis of the σ of this anisotropic system.

Experimental

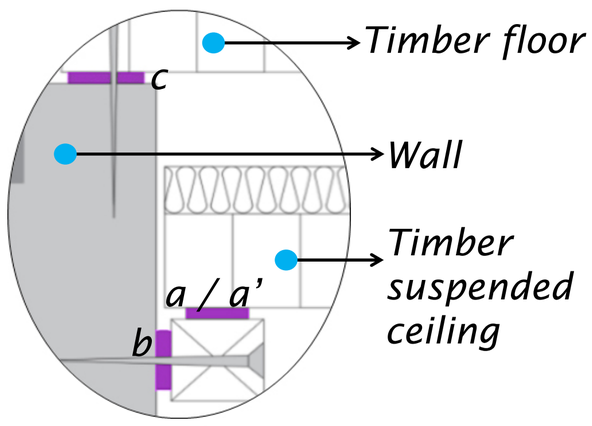
The object was a dowelled joist timber floor out of spruce with a cement floating floor and a dowelled joist timber suspended ceiling, as follows:

- 70 mm Cement plate
- 30 mm Mineral wool
- 200 mm Massive timber floor
- 80 mm Air cavity
- 40 mm Mineral wool
- 80 mm Massive timber suspended ceiling



View of the floor and the suspended ceiling.

Several modifications were done in the junctions between the floor and the wall to analyse the influence of the elastic layers in the impact sound transmission.

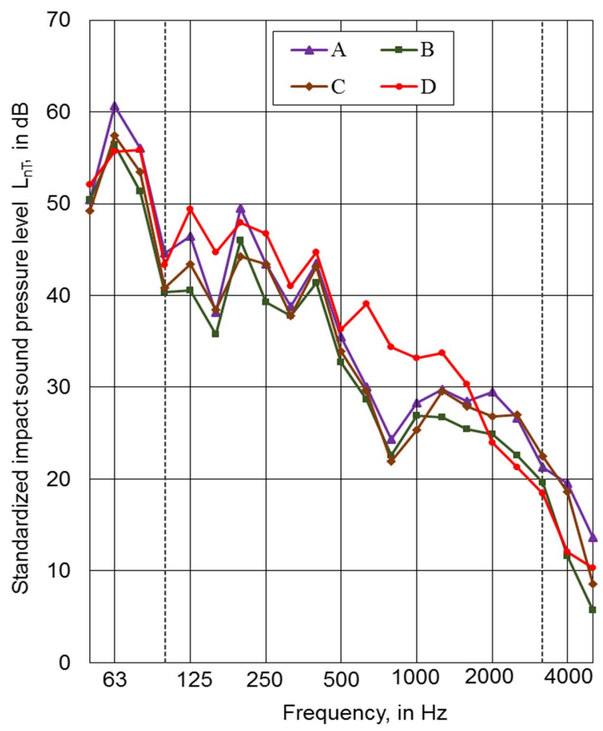


Positions of the elastic layers in the construction (in purple). a as the original, a' the improved, b and c.

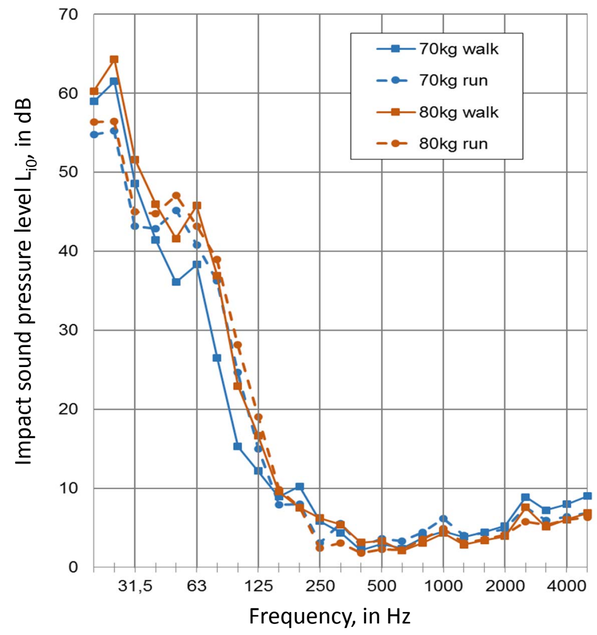
The radiation efficiency was measured with the standard tapping machine in the source room and accelerometers and a laser vibrometer in the receiving room.

Results

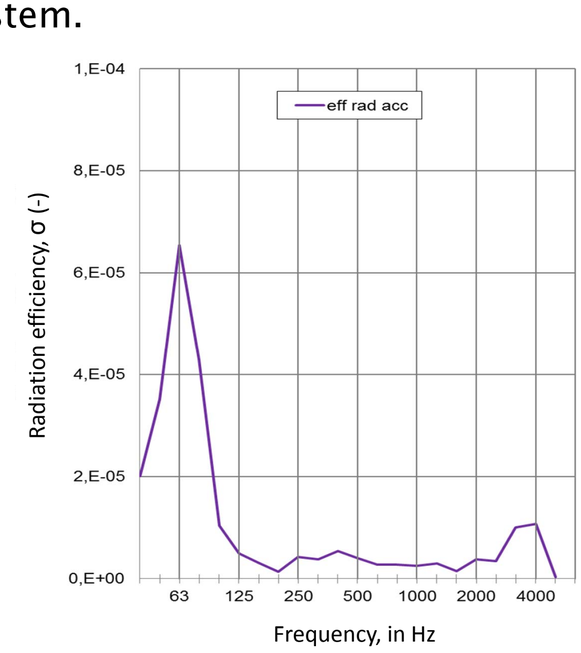
The improvement of the joist timber floor by adding 70 mm cement plate was 28 dB for the $\Delta L_{nT,w} + C_I$ and an improvement of 19 dB for the $\Delta L_{nT,w} + C_{I50\text{-}2500}$.



Impact sound insulation of the floor in dB from 50 Hz to 5000 Hz in third octave bands for each modification of the elastic layers. A (all the elastic layers, a, b and c); B (all the elastic layers a', b and c); C (a' and b) and D (a').



Impact sound pressure levels in dB from 18 Hz to 5000 Hz in third octave bands measured with the excitation of walking persons.



Radiation efficiency of the suspended ceiling from 50 Hz to 5000 Hz in third octave bands measured with accelerometers.

Conclusions

The developed floor system reaches an impact sound insulation which equalizes the levels of the massive timber floors in the Swiss market but with a lighter and thinner system.

The analysis of using the elastic layers showed that the difference between using them or not was 4 dB for $\Delta L_{nT,w} + C_I$ and 2 dB for $\Delta L_{nT,w} + C_{I50\text{-}2500}$.

In terms of the levels of footsteps, the noisiest bands are from 20 Hz to 100 Hz, overpassing 60 dB at 20 Hz.

The results of the radiation efficiency exposed that the critical frequency of the joist timber suspended ceiling corresponds to the critical frequency in the longitudinal direction of the spruce plates. Deeper research in this kind of constructions is recommended in order to see the influence of the three different critical frequencies in anisotropic materials as wood when the complete system is measured .

Author
Amabel Melián Hernández

Number
MHT/PA/MA/051/16/00

Embargo Period
No embargo period

Bern University of Applied Sciences

Architecture, Wood and Civil Engineering

Solothurnstrasse 102 | CH-2500 Biel 6
bfh.ch | mht.ahb@bfh.ch