Popular science summary of master's dissertation in structural mechanics, LTH, Lund University.

Vibrations in a High Frequency CLT floor panel

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Vibrations in floors can cause annoyance for residents. Moreover, with the increased technical advancement there is a growing need for floors that can accommodate different types of sensitive equipment. The vibration criterion for the floors that house sensitive equipment can be 2–3 times stricter in comparison to the limit for human annoyance. To meet this design limit, it is recommended to use floors with the first resonance frequency above 10 Hz, so called high frequency floors (HFF).

The test setup for measuring the material properties of the CLT-floor panel

The purpose of this master´s dissertation is to gain greater knowledge about measurement, prediction and evaluation of vibrations in HFF. The following questions were investigated:

- How should response measurements of a walking person be conducted: How will the path of the pedestrian affect the response measurements? How will the vibrations deviate between individuals?
- Can the weight of the pedestrian be neglected when calculating the modal properties of floor panels?
- Which evaluation method according to ISO 10137:2007 and ISO 2631-1:1997 will be decisive when evaluating footfall induced vibrations in HFF?
- Can a time domain model be used to predict the vibrations in HFF with adequate accuracy?

When studying vibrations in floors, it is common to sort the floors as low frequency floors (LFF), where the first resonance frequency is below 10 Hz, and HFF where it is above 10 Hz. A higher first resonance frequency is to prefer because it makes it more difficult for a walking person to induce resonance in the floor. Therefore, the probability of resonance triggered by footsteps is generally lower for HFF in comparison to LFF.

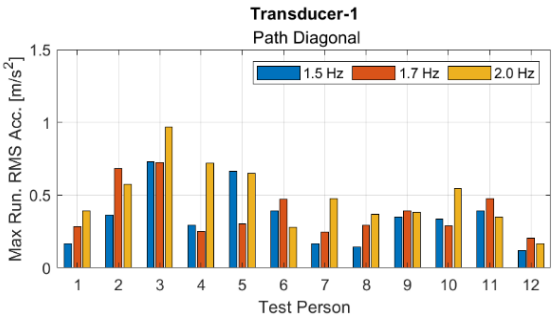
Analysis The measurements and simulations were conducted on a high frequency CLT-floor panel. Two types of measurement were conducted. Thereby, the first type was used to determine the material properties of the CLT-floor panel and to investigate the dynamic effects from the supporting beams on the test setup. For the second type of measurement, the vibrations in the floor from a single pedestrian were investigated. For this purpose, twelve different individuals were invited to walk across the floor while the vibration level was measured. Each person walked straight and diagonally and used three pacing rates, 1.5, 1.7, 2.0 Hz, for the respectively path. The weight of each person that participated in the study were also measured to determine if the dynamic properties of the CLT-floor panel were affected by the pedestrian's mass.

To predict the vibration levels from the measurements, a finite element (FE) model was constructed in the software Abaqus. In the model, the load from the pedestrian was applied footstep–by–footstep and the striding length dependent on the pacing rate.

Result The vibration level deviated to a large extent between different individuals and paths. Therefore, is it important to take those aspects into consideration when conducting response measurements of a walking person. The mass from the single pedestrians was found to have a neglectable effect of the dynamic properties of the floor panel.

When comparing different evaluation methods for HFFs, the base curve for human perception according to the ISO-standards was decisive for evaluating footfall induced vibrations. Further, it could be concluded that it is doubtful that the additional methods presented in these standards will be limiting for vibrations due to footsteps on floors with similar dynamic properties as the investigated floor.

The vibration levels from the measurements were highly affected by the supports that the floor rested on. This made it difficult to create a FE-model with comparable vibration amplitudes as from the experimental measurement. However, it could be recognised that the used calculation model was sensitive to resonance at certain walking paces while the experimental measurement indicated that the vibrations had a more impulse–like behaviour and therefore, increased with the pacing rate.



Measured vibration level in one transducer for all persons included in the study

Master´s dissertation ended 2023: ***Vibrations in a High Frequency CLT Floor Panel*** *– Report TVSM-5263. Supervisor Peter Persson. In cooperation with Sweco.*