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Simulating the effects on sound attenuation due to structural discontinuities in a floor assembly

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The accuracy of the predictions of the sound attenuation of lightweight building systems using numerical methods is crucial in the prediction of the sound propagation within constructions erected using lightweight construction techniques. A common floor construction in a lightweight building system is the combination of chipboard plates on wooden beams as shown in figure 1. The discontinuities between adjacent chipboards and between the chipboards and the beams are of special interest when assessing the propagation of vibrations stemming either from harmonic (washing machines, dishwashers, HiFi-systems) or transient (walking, dropped items, slamming doors) excitations. However, the simulation of these effects is computationally hard.

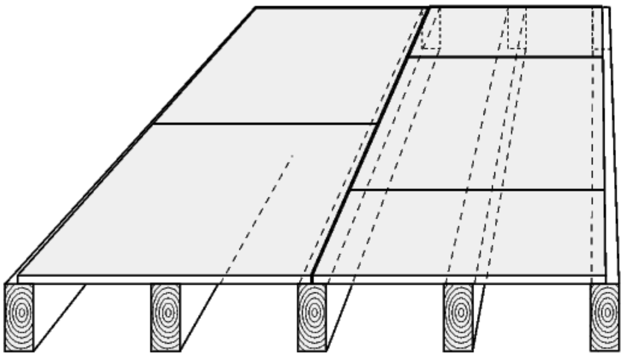

Figure 1: schematic setup of a lightweight floor assembly

The two common junction types in the studied floor construct are shown in figure 2. Note that the floor construct also has discontinuities between the adjacent chipboards. This is not the norm, as there usually is some type of internal stiffener between the two boards, in this study however focus is on the wave propagation through the beams rather than across a board-board junction.

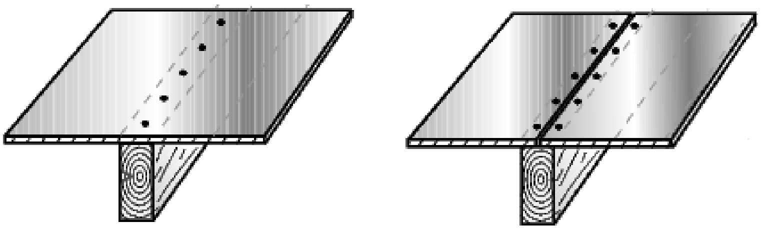

Figure 2: Two types of junctions: to the left a continuous chipboard attached to the beam using screws, to the right two chipboards attached to the beam.

The effects of the junctions have been examined in several studies [1,2,3]. In [1] the behaviour of the junctions when subjected to harmonic excitations in the frequency range of 50-600Hz is studied. In [2] the wave approach is combined with the continuity equation using scattering matrix formulation in order to separate the transmitted from the reflected wave as the structural wave approaches a junction. In [3] finite element models of structure-borne sound transmission and attenuation in a timber lightweight floor construct are discussed including damping effects from the discontinuities in the junctions. The junction between a chipboard and a beam in the floor act as waveguides in this setup. In [4] a number of approaches to estimate reflection and transmission coefficients of a joint from measured data is discussed.

The aim is to produce a finite element model that with high accuracy can be used to predict the wave propagation in lightweight floor assemblies. The finite element is defined including a set of internal parameters which will be identified through inverse modelling and measurements described below. Once a good enough finite element description is arrived at it will be used to optimize the behaviour of the whole floor assembly and thus to give directions on how to construct floor partitions.

To identify the internal parameters to be used in the finite element we look at the effects on one chipboard plate in a floor assembly when the neighbouring plate in the floor is subjected to harmonic as well as transient excitation. The floor topology and material properties will determine the characteristics of the waves induced by the excitations. The phase shift in the waves as they travel past the different types of discontinuities as well as the loss of kinetic energy as a consequence of the of the evanescent wave propagation due to the acoustic attenuation process in the structure is measured and the internal parameters for the finite element is derived from these measurements.

The measurements are made using accelerometers distributed over the floor both on the chipboards and on the beams. The displacement of the target point on the chipboard adjacent to the chipboard with the source point is also measured. The measurements are made in the low frequency range (10-600Hz) and also with transient load.

References

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