Within the context of an efficient and sustainable design of buildings a trend towards lightweight structures, e.g. timber structures is recognizable. This trend implies the necessity to be able to predict serviceability and comfort as well as sound transmission in order to fulfil building requirements. To generate reliable prediction methods a detailed understanding of the transfer of energy between building components is compulsory.

The focus of the study is the advancement of sound prediction in wooden building using Statistical Energy Analysis (SEA). Therefore it is necessary to operate with typical building element junctions in experiments (Fig. 1) and to model it in SEA using a commercial tool VAOne® (Fig. 2). This is a task of the University of Applied Sciences Rosenheim funded by Bundesministerium für Wirtschaft und Energie (BMWi). This contribution is a part of a joint research project (DFG and AiF) Vibroacoustics in the planning process for timber constructions, which deals with the modelling of sound transmission in wooden buildings in all relevant frequency range using different computation models. In addition to the University of Applied Sciences in Rosenheim, the Chair of Structural Mechanics, the Chair for Computation in Engineering, the Centre of Mathematics and the ift Rosenheim are also involved in this project. In the future the prediction should be embedded in a Building Information Model (BIM). An overview is given in (Rabold 2015).

In the low frequency range with clearly separated eigenmodes the Finite Element Method (FEM) is a convenient tool to predict the vibroacoustic behaviour. The increase of the modal density with higher frequencies impedes a FEM approach, but
enables the application of statistical methods like the Statistical Energy Analysis (SEA). For the SEA approach a division of the building components into different subsystems with respect to wave polarization and geometry is performed, linked with a low level of detailing. Hereby the subsystem definition is restricted to weak coupling which means (among others) that there should be only direct energetic interaction with the adjacent subsystems but not with the next but one subsystem.

The robustness of the statistical response of the SEA is achieved by averaging over time, excitation frequency and space. Hereby the choice of the frequency bandwidth is linked to the number of eigenmodes per band in order to guarantee a sufficient modal density. The modal density shows how many modes are available to store, respectively to transfer energy from one into another subsystem. Based on the high modal density inside a subsystem it is assumed in the energetic approach that the modal energy is equivalently distributed with respect to the modes and that the modes are almost equally damped. The energy flow from one subsystem to another is proportional to the difference of the modal energies.

Fig. 1: L-shaped junction of wall and ceiling in the Vibroacoustics Lab at University of Applied Sciences in Rosenheim.

Fig. 2: SEA model of the L-shaped junction using a commercial tool VAOne®.

References

