f sound insulation of

Short title: Calculation model timber walls

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1 Introduction

Timber walls offer a wide variety on construction principles and materials. For different reasons the manufacturers of timber products, the owner of the houses and planning engineers favour different and mostly individual constructions which allow a great variety on combinations.

For this great variety of constructions of timber walls only a limited number of construction details with certified sound insulation is currently available in the collection of construction examples DIN 4109 incl. Beiblatt 1. Although in future editions of DIN 4109 more construction details will be published, there will be still a lack of information about sound insulation because of the great variety of timber wall constructions.

Furthermore it is desirable for the planning engineer to know the effects on building physics if the construction details of the walls are changed. For thermal insulation or protection against moisture a recalculation of the quantities is possible, for sound insulation it is not.

The primary goal of this research project is the development of a calculation model, which enables the planning engineer to estimate the sound insulation of typical timber wall constructions (upon knowledge of the construction details and the used materials) with a sufficient accuracy.

For the calculation model two model designs were investigated within this research project:

With respect to the great variety of parameters influencing the sound insulation of these walls and in regard of the practical application an empirical single number model was chosen as basis for the main calculation model.

In addition to the empirical approach the applicability of frequency-dependent models were also checked within this research project. The frequency dependent calculations were only applied to the basic-wall construction.

2 Summary and outlook

Summary

Empirical single-number model

Measurements in the archive of the **ift** centre of acoustics were analysed with respect to the parameters relevant for the sound insulation of the wall elements. Additional measurements were performed in order to close the gaps in the data collection.

For the analysis of sound insulation the complex wall constructions were divided in functional layers. To these layers a sound reduction index resp. a sound reduction improvement was assigned for characterising their acoustic efficiency. The sound reduction indices and sound reduction improvement were linked to the materials properties via a statistical analysis. On this basis a calculation model was designed which was capable of estimating the sound insulation of complex wall constructions solely on basis of the used materials.

The calculation model was designed on basis of 291 data sets from measurement in the **ift** centre of acoustics. Verification of the model was done by using 31 independent data sets by other testing institutes. The root mean square deviation between the measured sound reduction index R_w and the estimated value was 1,9 dB for the verification conditions. It is therefore in the typical order of magnitude for calculation models in building acoustics.

Frequency dependent calculation models

From the literature review two models (by Sharp and Davy) were chosen for a detailed analysis within this project. The results of calculation according to these models were compared with the 96 data sets from measurements on basic wall constructions from the archive of the **ift** centre of acoustics. The difference between calculation and measurement in the single one-third octave bands was within the order of +/- 20 dB, the mean difference of the weighted sound reduction index was –1 dB resp. 6 dB The root mean square deviation was within both models 3 dB.

An improvement of these models could be achieved by employing various modifications as published in literature or proposed on the experience of the **ift** centre of acoustics. A comparison of the results of calculation with the measurement results shows clearly the limits of these models: By assuming a highly sound absorbing cavity in the basic wall the modal coupling of resonant vibrations of the plasterboard linings cannot be modelled. For a further improvement the model design has to be modified.

Outlook

Within the work on this research project it became evident, that the strong correlation between the different material parameters and their effect on sound insulation is difficult to describe in terms of simple formulas.

2 Summary and outlook

For the different types of calculation models different perspectives for further development arise.

For the improvement of the empirical models the application of analytical methods of artificial intelligence appear to be useful tools for a consideration of the complex intercorrelations apparent in these constructions. An improvement in the accuracy of the models is expected.

The following extensions of the model might be incorporated:

- Extension of the calculation model for the sound insulation to additional wall constructions: partition walls and walls for terraced houses.
- Extension of the model by incorporation of the sound insulation at low frequencies, being a very sensitive subject for timber constructions. The extension could be modelled in terms of a sound reduction index with spectrum adaptation term $R_w + C_{tr}$.
- Transfer of calculation model into a computer program for application purposes.

A further improvement of frequency-dependent calculation models by Sharp and Davy requires the incorporation of additional parameters with effect on the sound insulation and the combination of different calculation models. Based on today's knowledge an extension of the model from the basic wall construction to more complex structures will be feasible only by incorporation of empirical or semi-empirical methods. For this purpose the solutions from the empirical single-number calculation model described above will be very helpful.