Short report on the research project
ETICS in lightweight construction

Research Initiative "Zukunft Bau" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development
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Title

Sound insulation of external thermal insulation composite systems in timber and lightweight construction

Motive / Starting point

External thermal insulation composite systems (ETICS) can significantly change the sound insulation of exterior walls and must therefore be taken into account in building acoustic planning. In contrast to solid construction, however, suitable acoustic planning tools for lightweight construction are currently not available. The aim of the project was therefore to develop a prediction method for the weighted sound reduction index of wooden and lightweight walls with ETICS.

Subject of the research project

The starting point of the research project was a series of measurements in which the sound insulation of lightweight walls equipped with ETICS was systematically investigated. The measurements were carried out in a building acoustic test facility where a special test set-up with demountable ETICS and reduced test area were used in order to minimize the construction efforts. A total of 56 different walls were investigated, which included the following constructions:

Base walls:	16 wooden stud walls, 3 metal stud walls and a solid wooden wall,
Insulation systems	10 ETICS made of different insulation materials (XPS, EPS, elasticized EPS, rendering and lamella panels made of mineral fiber as well as wood fiber), partly additionally fixed with dowels.

Based on the results obtained in the measurement series, the acoustic behavior of lightweight walls with ETICS was analyzed. A calculation model could be derived from the gained knowledge, in order to predict the improvement of the sound insulation of the base wall by the ETICS. The most important results of the research project can be summarized as follows:

- Values in the range of $-2.2\ \text{dB} \leq \Delta R_w \leq 12.3\ \text{dB}$ occur for the examined lightweight walls concerning the improvement of the weighted sound reduction index by the ETICS. The mean value is 3.3 dB. This value range is only about half as wide as compared to solid construction according to earlier investigations. The difference is mainly due to the lower insulation thickness (and the resulting higher resonance frequency) in lightweight construction, which considerably reduces the acoustic impact of ETICS, as compared to solid walls.
- Apart from the usually lower insulation thickness, ETICS on lightweight walls behave acoustically similar to solid construction in many respects. For example, the improvement in sound insulation achieved by the ETICS in both cases has the same characteristic frequency response with the typical insulation minimum in

the resonance frequency range. Therefore, the acoustic relationships known from solid construction can, in principle, usually also be applied in lightweight construction.

- Based on the results of the study, a simple semi-empirical prediction method was developed, with which the improvement of the weighted sound reduction index of lightweight walls by ETICS can be precalculated from the component data. The prediction accuracy of the method (difference between measurement and calculation) has a standard deviation of about σ = 2.1 dB, with values ranging from -4.0 dB to 5.2 dB (largest deviation in terms of amount with negative and positive sign). The calculation accuracy is in the same order of magnitude as for other building acoustic prediction methods, and is normally quite sufficient for practical application (e.g. in the field of structural noise protection planning).
- The scope of application of the developed calculation method includes all conventional wooden and metal stud walls, as long as the planking consists of standard construction materials (e.g. chipboard, OSB boards or gypsum plasterboards) and there are no special structural features (elastically mounted planking boards, etc.). It also applies to walls with separate stud frame, walls with installation level, and standard solid wood walls. The ETICS can consist of all conventional façade insulating materials and can be additionally fastened with dowels. The direct installation of the insulation onto the studs (common installation for wood fiber panels) is also described correctly by this calculation method.
- A major advantage of this method is that it only requires relatively few input data, and that the calculation formulas used, apart from a few exceptions, apply equally to all constructions. As the distinction between different types of construction is eliminated, a compact and clear model is obtained which is easy to use in practice. The spectrum adaptation value $C_{tr,50\text{-}5000}$ was not included into the model as this would have been too laborious. In fact, this is also not necessary, since in this case sufficient information is available for the structural noise protection planning even without calculation.

Conclusion

As the most important result of the research project, a reliable method for predicting the weighted sound reduction index of exterior walls with ETICS is now, similar as for solid construction, available for lightweight construction. Investigating the acoustic effects and interrelations now allows to properly understand them also with regard to ETICS on lightweight walls. For the spectrum adaptation value $C_{tr,50\text{-}5000}$, suitable planning information has been specified to avoid structural sound insulation deficiencies. Thus, the intended objectives of the project were fully achieved.

Basic data

Short title: ETICS in lightweight construction
Scientist / Project management: Dr. Lutz Weber
Total cost: 189.079,60 €
Federal subsidy: 119.079,60 €
Project term: 24 months

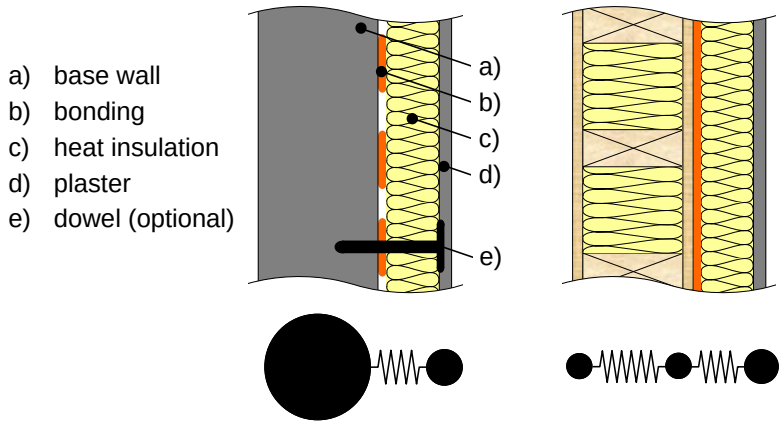

Fig. 1: Solid and lightweight stud wall with ETICS with resulting acoustic operating principle as mass-spring-mass system (source: Fraunhofer Institute of Building Physics).

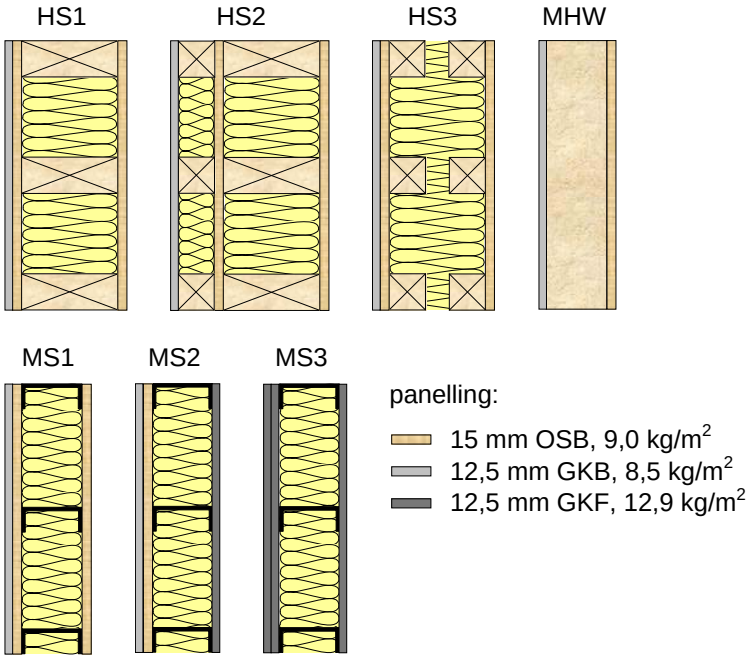

Fig. 2: Diagram of the investigated lightweight stud walls (width true to scale, height compressed) incl. the applied abbreviations and the panels used for planking (source: Fraunhofer Institute of Building Physics).

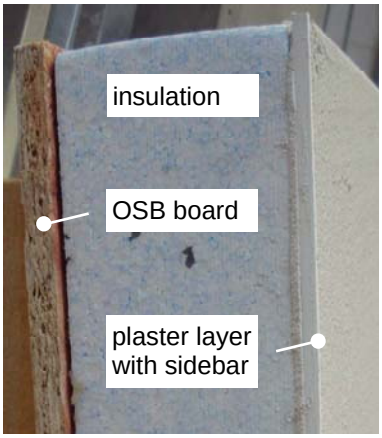

Fig. 3: Completed ETICS made of EPS bonded onto an OSB plate (upper left corner of the setup having a size of 1.23 m x 1.48 m). After drying, the OSB panel with the ETICS was attached to the wall studs by using a special back-to-back fitting with bolts and nuts, with the panel also serving as the exterior paneling (source: Fraunhofer Institute of Building Physics).

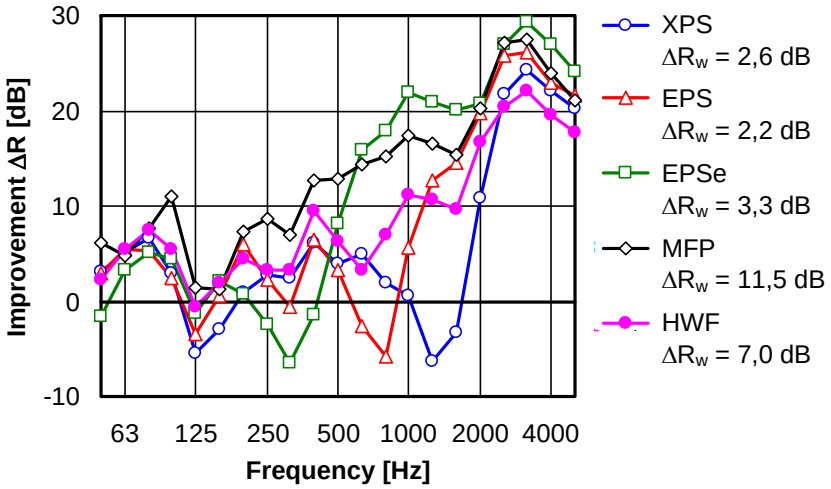

Fig. 4: Improvement of the sound insulation of the wooden stud wall HS1 by means of ETICS made of different insulation materials with otherwise identical structure. The ETICS were installed in all cases without dowels (source: Fraunhofer Institute of Building Physics).

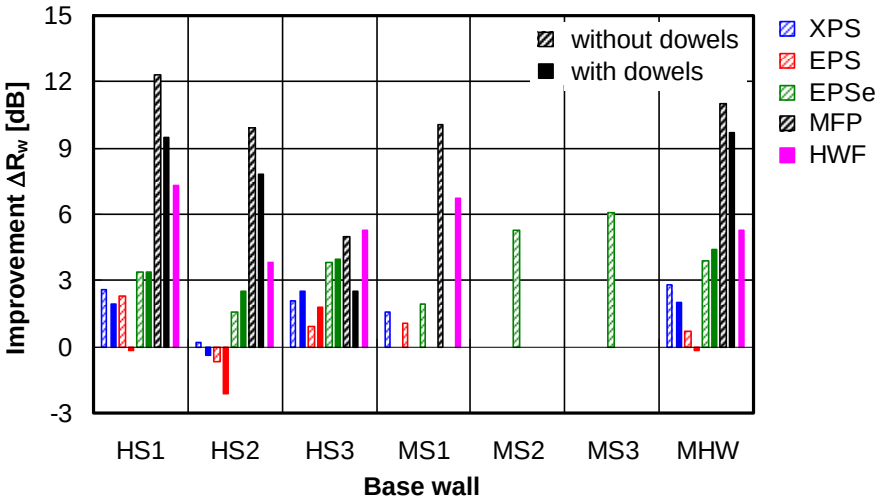

Fig. 5: Improvement of the weighted sound reduction index of the base wall by the ETICS for all walls investigated to develop the calculation model (in total 43 different lightweight walls). The base walls are indicated on the x-axis, the ETICS are represented by varicolored bars (source: Fraunhofer Institute of Building Physics).

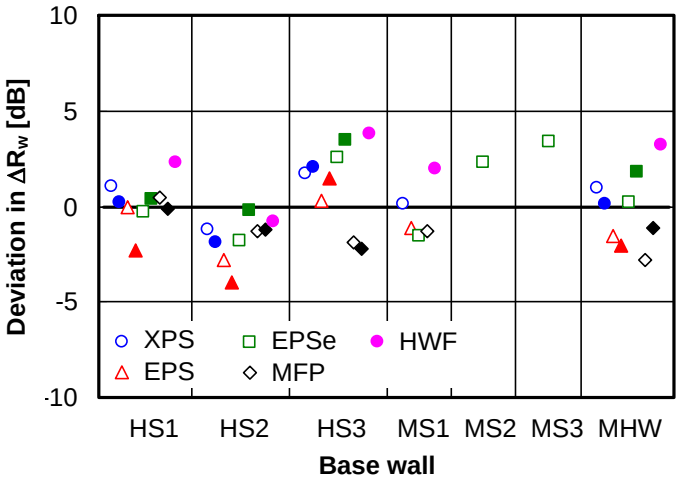

Fig. 6: Difference between measurement and calculation (measured value minus calculation value) for the model developed for the precalculation of the improvement ΔR_w. The open symbols indicate the ETICS, which were mounted only by bonding, the filled symbols indicate those that were additionally fastened with dowels. The diagram shows all assemblies used for the model development (in total 43 different walls with ETICS) (source: Fraunhofer Institute of Building Physics).