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MOISTURE-DEPENDENT SOUND INSULATION OF BUILDING COMPONENTS

INTRODUCTION

Airborne sound insulation of single-leaf component parts is influenced by a variety of essential factors like frequency, mass per unit area, bending stiffness, loss factor and sound incidence [2] [3] [4]. In the production of building materials and massive building components a considerable amount of water is bound in the microstructure of the respective building material and included there for years. The question if and how this moisture contained in building materials has an influence on the sound insulating properties of building components was the topic of the investigations of this paper [1].

Literature research showed that only a few publications deal with the acoustic properties of humid building components so far. In the context [5] and [6] should be mentioned. The statements represented there, however, offer a very vague and contradictory image.

Therefore, the paper was aimed at systematically investigating the influence of variable moisture contents on the sound insulation of building components.

INVESTIGATIONS

Movable monolithic walls (120 cm wide, 145 cm high and 11.5 cm or 24 cm thick with thin plaster) were built of different types of stone for experimental investigations. The single stones of lime sand, lightweight and aerated concrete were previously stored in water until free saturation. The airborne sound reduction index, the structure-borne reverberation time, and the pulse time delay of the respective wall test specimen was measured in the building acoustical test facility for windows of the Fraunhofer IBP. After demounting the masonry walls dried until the next measurement cycle. By almost daily weighing the stepwise reduction of the moisture content could be documented.

Until the dry state of the building material was achieved each wall ran through up to six measurement cycles. The weighted sound reduction index was determined for each moisture stage of each test specimen by the frequency-dependent sound insulation curve. The total loss factor resulted from the measured structure-borne reverberation time and the longitudinal wave velocity of the building component from the pulse time delay.

In order to find out the building physical correlation of moisture and sound insulation the temporal change of moisture and thus mass of the partition and external wall made of aerated concrete was calculated by means of the hygrothermal simulation WUFI®. The calculation results were converted into the respective volume-related moisture content and coupled with the moisture-dependent modification of the sound reduction index, which was previously measured. In the process, an acoustic-hygric connection of the data of the building components was achieved.

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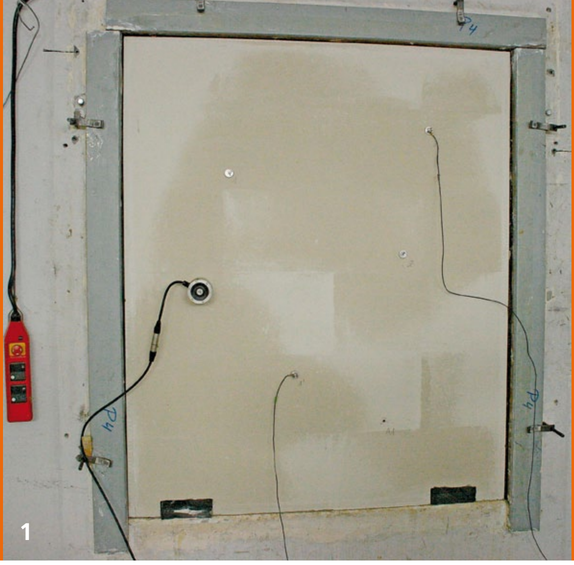

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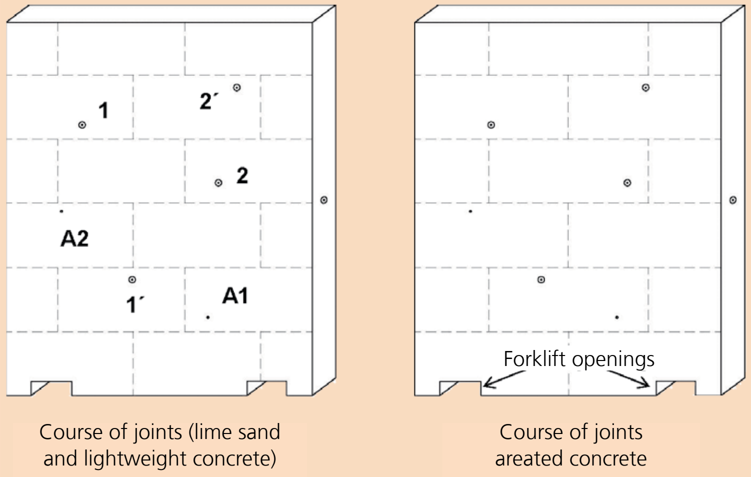

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SELECTED RESULTS

Differences of up to five decibel are measured for the weighted sound reduction index between the water-saturated and dry state of a wall according to the building material. Diagram 1 shows the frequency-dependent sound insulation curves for lime sand and aerated concrete. Diagram 2 represents the modification of the weighted sound reduction index in dependence of the volume-related moisture content for all investigated materials.

Concerning the drying out of the moisture in building components dehumidification periods occurred, which cannot be observed in the general testing processes in building acoustical test laboratories. Even after a waiting period of six weeks the weighted sound reduction indexes are still too high with more than two decibel.

Due to the different material matrix in the individual building materials the influencing parameters are not equally effective. The maximum moisture-related modification of the weighted sound reduction index in case of aerated concrete is caused for approx. three quarters by the moisture-dependent increase of mass. In case of lime sand this effect causes not even a quarter, since the increase of the sound reduction index essentially occurs due to an increase of the loss factor as a result of the stored water (diagram 3).

A significant shifting of the coincidence frequency occurs only in case of aerated concrete. But also in this case the influence on sound insulation is relatively low.

CONCLUSION

Moisture contained in the pore volume of building materials change the airborne sound reduction index of the corresponding building component. It is demonstrated without any exception that the airborne sound insulation of the investigated building components is higher with increasing moisture content.
The modification of the airborne sound insulation, however, is not only dependent on the water-dependent increase of mass. The loss factor has also an essential influence on airborne sound insulation.

A critical verification of the periods of drying out of newly manufactured building components to be tested in the laboratory or by in-situ measurements in new buildings is needed.

An appropriate moisture reduction of the measured values could contribute to a more realistic classification of sound insulation, and to achieve more security in designing buildings.

This kind of moisture reduction could also provide that on the basis of an adequate application building components can permanently maintain the desired and required sound insulation function even after dehumidification. This is not only an improvement of the durability of the acoustical comfort of a building but also of the preservation of the value.

1 *Test wall in the building acoustic test facility for windows.*

2 *Test walls – positions of the structure-borne sound sensor ((1, 2, 1′, 2′) and the shaker (A1, A2).*

Diagram 1: Sound insulation curves

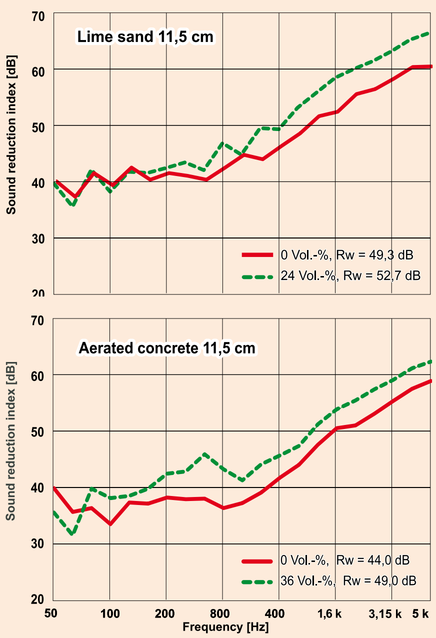


Diagram 2: Change in sound reduction index

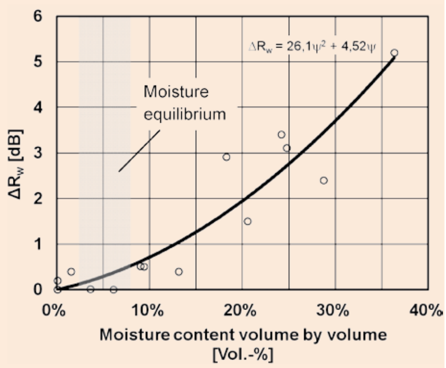
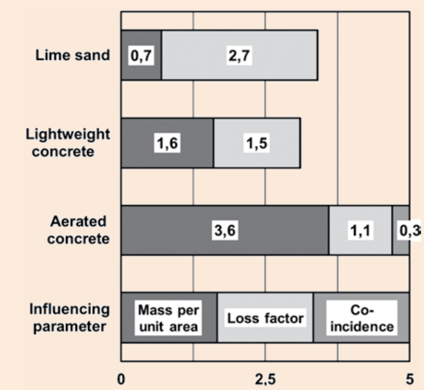


Diagram 3: Influencing parameters



Decibel-split-up of the influencing parameters upon the sound reduction index [dB]