Short report on the research project
Sound insulation of lightweight partition walls

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

Improvement of the sound insulation of lightweight partition walls at low frequencies

Motive / Starting point

Compared to solid walls with the same weighted sound reduction index, the sound insulation of partition walls at low frequencies is considerably lower due to their double-leaf construction. Since this problem cannot be solved by conventional construction measures, alternative ways of improving the sound insulation of partition walls at low frequencies have been investigated.

Subject of the research project

In the project, especially those measures were investigated whose basic principle has already been known, but for which only few insights were available so far regarding their effect in connection with partition walls. After preliminary tests to assess the potential for improvement, the best measures were selected, further developed and optimized. This was done on an experimental basis, with the required measurements being carried out on walls with a reduced area - without affecting the scope of the measurements. The following measures were investigated:

a) sectioning of / dividing the wall leafs into segments by separation joints,
b) $\lambda/4$ resonators installed in the wall cavity,
c) surface damping of the wall shells with bitumen covering,
d) damping of wall shells with vibration neutralizer,
e) periodic weighting of the planking panels.

In contrast to the measures a) to d), which proved to be not sufficiently effective at low frequencies, the periodic weighting achieved good results and was therefore examined more closely. For a periodic weighting of partition walls, the wall shells are provided with small-area additional masses, which are arranged on a periodic lattice. The best acoustic effect is achieved if both the front and back of the wall is weighted. The most important results of the investigations carried out are:

- In comparison to conventional partition walls with the same mass per unit area, the periodic weighting of the wall shells ensures an improved sound insulation at low frequencies, and leads to a deterioration at medium and high frequencies. This results in a reduction of the weighted sound reduction index R_w and a simultaneous increase of $R_w + C_{tr,50\text{-}5000}$, with the decrease and increase being about the same (for the tested walls up to about 5 dB).
- The acoustic effect of periodic weighting primarily is reflected in the fact that the sound reduction curve passes through a maximum at low frequencies. In order to achieve the greatest possible improvement in sound insulation, the weighting should be designed to ensure that the insulation maximum coincides

approximately with the double-panel resonance of the partition wall. The formulas developed in the research project allow to predetermine the position of the insulation maximum based on the design parameters.

- Usually, the masses are arranged on a lattice with square structure. For gypsum plasterboards, a lattice dimension of about 30 to 50 cm has proven to be effective. With a grid dimension of 40 cm, approximately 6 masses per square meter of wall surface are required (for a weighting on both sides of the wall, twice the number of masses).
- As with conventional measures, the effect of periodic weighting of walls rises with an increasing mass. In order to achieve a sustained improvement of the sound insulation at low frequencies, the total mass of the weight should be at least twice as large as the mass of the planking plates, if possible. For standard plasterboard partition walls, this corresponds to approximately 17 kg/m² on each side of the wall.
- In order to ensure the acoustic function of the periodic weighting, the dimensions of the additional masses must be small in relation to the grid dimension of the lattice. In order for the masses to still reach the required weight, they can be produced of material with high bulk density, such as steel for example. However, as this often involves disadvantages in constructional practice, it is alternatively possible to reduce the contact area between the masses and the wall by attaching the masses only partially to the planking. The performed measurements show that this does not impact the acoustic effect.

Conclusion

The research project has shown that the sound insulation of partition walls can be effectively improved at low frequencies by periodic weighting of the wall shells. In addition, the most important acoustic and technical foundations for an implementation into the construction practice were laid. Since the investigations were limited to gypsum plasterboard walls with single studs, statements on other types of walls, such as walls in timber frame construction, are possible only to a limited extend so far. The same applies to the combination of periodic weightings with other improvement measures. This would require further investigations.

Basic data

Short title: Sound insulation of lightweight partition walls
Scientist / Project management: Dr. Lutz Weber
Total cost: 159,800.00 €
Federal subsidy: 99,800.00 €
Project term: 18 months plus 7 months extension

Pictures / Drawings

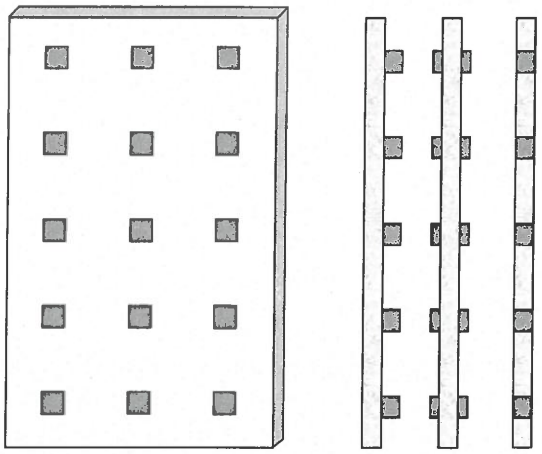

Fig. 1: Example of the periodic weighting of a plate in front view (left) and in cross section (right). The masses in the form of square plates are arranged on a square lattice. They can be applied to the plate on one side or on both sides, or can be integrated into the plate during production.

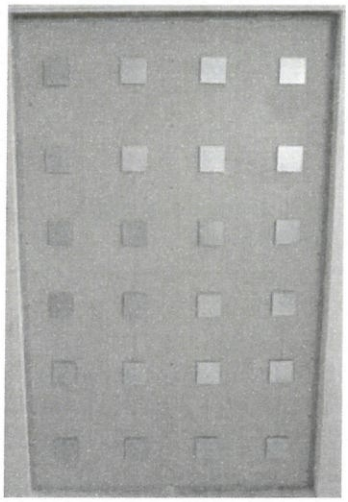

Fig. 2: Periodically weighted gypsum plasterboard wall in the test opening between sending and receiving room (w x h = 1.25 m x 2.0 m). The wall was weighted with steel plates having a size of 10 cm x 10 cm and a mass of about 1.6 kg each. The lattice had a grid dimension of 30 cm.

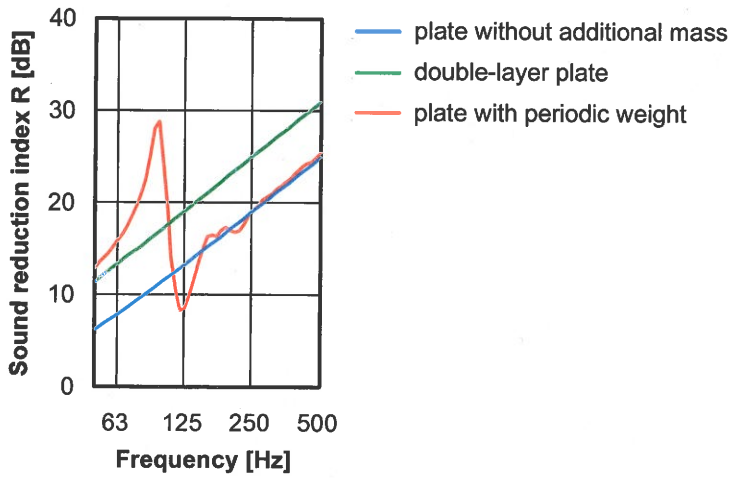

Fig. 3: Sound insulation curve of a plasterboard with periodic weighting. The displayed curves were calculated using the program HYPERAKUS. For comparison, the sound insulation of the panel without additional mass is also displayed (blue curve). The green curve represents the sound reduction index of a double-layer plasterboard having the same mass as the weighted plate.

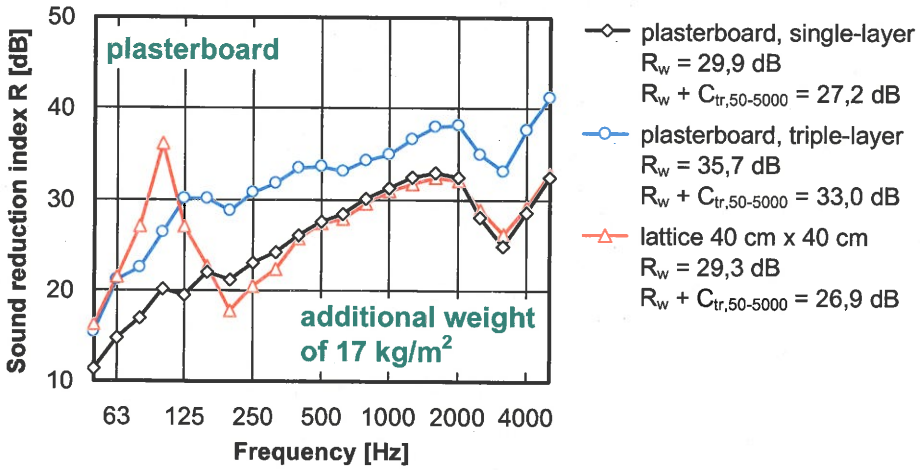

Fig. 4: Measured sound insulation of a periodically weighted plasterboard. The plasterboard was weighted by steel plates with a total mass of about 17 kg/m² placed on a lattice with a grid dimension of 40 cm.

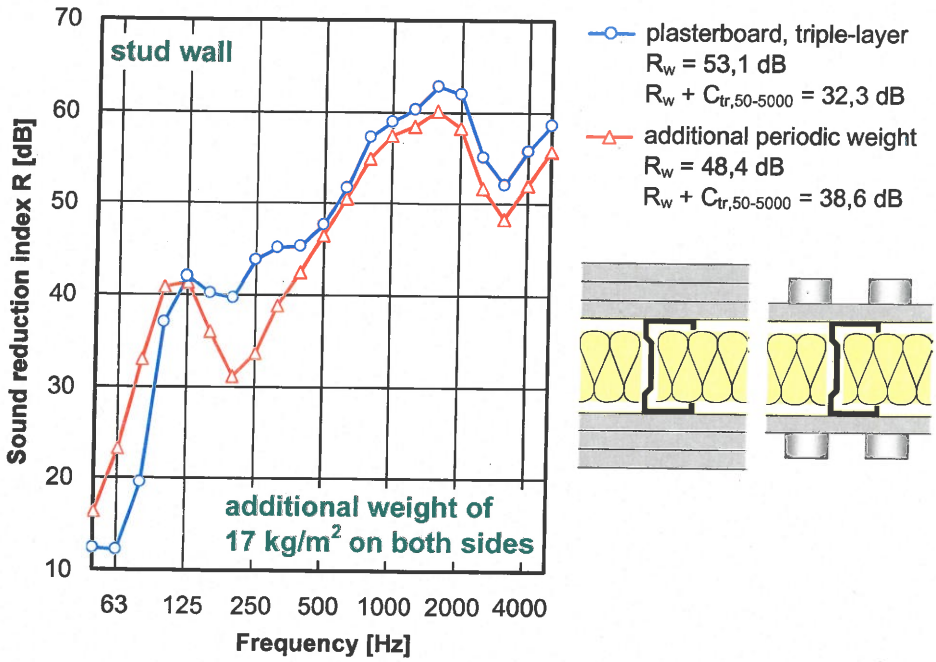

Fig. 5: Measured sound insulation of a plasterboard partition wall which was periodically weighted on both sides (same weighting on both wall shells). The wall was weighted by steel plates having a total mass of about 17 kg/m² each. The grid dimension of the lattice was 40 cm. The conventionally structured stud wall with triple-layer planking (blue curve) had the same mass per unit area as the weighted wall.

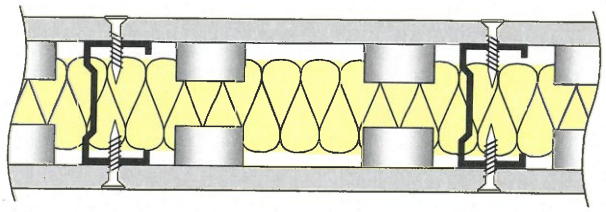

Fig. 6: Example of a plasterboard partition wall with periodic weighting of the shells on both sides of the wall and with the masses being integrated into the wall cavity. If the cavity is not sufficiently wide, the masses on the front and back of the wall can also be arranged offset. According to the performed investigations, it is irrelevant for the acoustic effect whether the masses are applied inside or outside the wall.