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ift RESEARCH REPORT
Short Report
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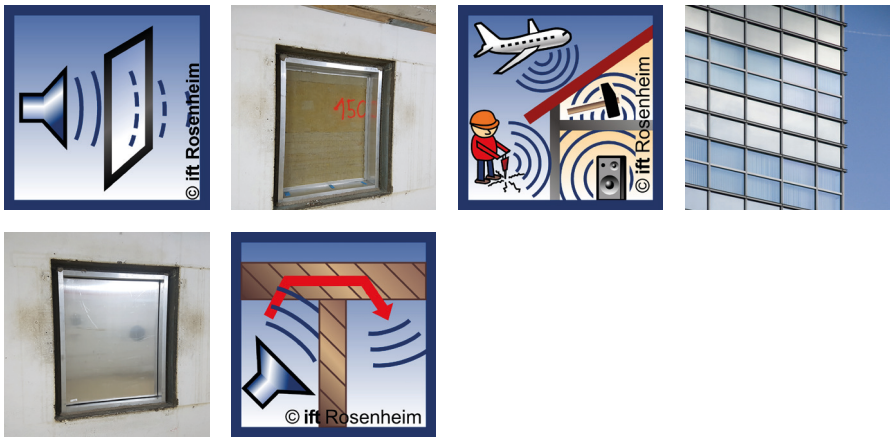
Developing a component catalogue for determining airborne sound insulation of opaque infills



Short Report

Topic	**Developing a component catalogue for determining airborne sound insulation of opaque infills**
Short title	Component catalogue sound insulation opaque infills (panels)
Sponsored by	Research initiative Zukunft Bau of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (File number: SWD-10.08.18.7-17.65)
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The authors are responsible for the contents of this report.

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1 Motivation and Project Goal

In the architectural acoustic planning of buildings, information on the airborne sound insulation of exterior components is required. For opaque infills (panels), such information - in contrast to transparent infills (glazing) - can currently only be verified on the basis of measurements in the laboratory. There is no possibility for planning and verification using a tabular procedure.

The aim of the project was therefore to create such a component catalogue for planning the airborne sound insulation of opaque infills.

The need for a component catalogue for the planning of airborne sound insulation of opaque infills was demonstrated in the context of the completed research project "Development of a component catalogue for the determination of airborne sound insulation and flanking sound insulation of curtain walls" (SWD-10.08.18.7-14.26). For opaque infills there are currently no tabulated building acoustic performance characteristics available depending on the structural design.

By developing a component catalogue for opaque infills, information on airborne sound insulation for standardised panels could be verified without measurements. The available information on the acoustic properties could then be used to determine the airborne sound insulation of the complete building element (window or curtain wall). The remaining gaps (missing input data of the airborne sound insulation of panels) in the determination of the airborne sound insulation of curtain walls would thus be closed. This considerably reduces the effort required for verification. This influences both the costs and the time sequence in the planning. In addition, a well-founded data base increases planning reliability.

2 Procedure

The basis for creating the component catalogue was measurement data from the ift Rosenheim archive as well as data collected from industrial partners and other testing institutes. However, it was not to be expected that a sufficiently comprehensive component collection for the practical application could be created simply by statistical analysis of the existing data. This is due to the fact that "relatively" few measurement data are available for the component opaque infill, since panels are usually produced for concrete building projects and the building acoustic properties for the complete component, i.e. the curtain wall or the window, are determined by measurement. The airborne sound insulation of the panel alone is generally not determined.

In order to achieve the research goal, it was therefore necessary to carry out a larger number of measurements. During the measurements themselves, the parameters decisive for the airborne sound insulation of the panel were varied. These are among others:

- Material and thickness of the outer and inner claddings (e.g. glass, steel sheet, aluminium sheet),
- Material and thickness of the filling (usually thermal insulation),
- Position of the filling (alignment of the fibres) and bond between filling and cladding,
- Distance between outer and inner cladding,
- Influence of the dimension of the opaque infill,
- Influence of the constructive design of the panel, e.g. plain panel or box panel,
- Measures to improve efficiency, e.g. heavy foils, gypsum plasterboard, etc.

The work is also based on the existing calculation methods for planning in building acoustics. At this point the EN 12354 and DIN 4109 as well as the test procedures according to EN ISO 10140 should be mentioned.

The component collection was created with the aim of integrating tabulated data into the component catalogue of DIN 4109-35 and, if needed, into other regulations.

3 Results

A proposal for a component catalogue is created from the preceding elaborations and measurements. Basis for the general structure of the component catalogue is the framework document according to DIN 4109-31, which provides the following chapters for the structure of a component collection

- Description of the component group,
- variables influencing the sound insulation,
- Information for planning and execution,
- Data for computational verification,
- Origin of the data .

The method proposed for the component catalogue is a calculation for the three parameters Rw, RA and RA,tr, based on the area-related mass, rounded to whole single-number values. In the calculation equations, a safety deduction amounting to a simple standard deviation was taken into account.

3.1 Airborne sound insulation of opaque infills (panels)

The following chapters contain a suggested text for a component catalog.

3.1.1 Parameters influencing sound insulation

The sound insulation of opaque infills (panels) is influenced by the type of construction and by the area-related mass of the component.

Types of panels are

- Sandwich panels with EPS or PU core insulation,
- On-site panels in facade frames with mineral wool filling,
- Box panels with mineral wool filling,
- Plain panels with mineral wool filling.

In the case of the type of box panels, the box joint, i.e. the installation joint between the box and the facade frame, is also a relevant influencing factor.

In the case of mineral wool filling, the fibre orientation is a relevant factor. The most favourable installation position for sound insulation is the horizontal fibre, i.e. the fibre orientation parallel to the top layer.

3.1.2 Guidelines for planning and execution

Board materials in the centre of the panel installed as weights have no significant influence on the sound insulation and must not be taken into account when calculating the mass per unit area for the application in Table 1. The insulation materials are not meant in this context.

In the case of sandwich panels, it must be ensured that the claddings are fully bonded (glued) to the insulation core. The values in Table 1 may not be used without the full-area bond.

For the application of Table 1, mineral wool fillings shall be installed in opaque infills with so-called planar fibres (fibre orientation parallel to the top layer).

A thorough filling of the space between the profiles of the façade with a room-side flush-mounted cladding reduces the sound radiation of the mullion profiles and can thus lead to advantages in sound insulation.

The calculation of the sound insulation according to the calculation methods described below refers to the areas of an opaque facade element including the frame profiles installed if the visible width of the profiles does not exceed 70 mm.

The calculation rules stated here apply to mullion-transom facades and to element facades. The calculation rules apply to the frame materials aluminium, wood-metal and steel.

With box panels, the box joint (room-side joint between box panel and facade profile) must be closed with a suitable sealing profile or sealant. Constructions with an open box joint reduce sound insulation considerably in some cases and cannot be described independently of the system.

No requirements are formulated for the minimum thickness of the panels with regard to sound insulation.

There are no facts on the influence of deviating component formats on the sound insulation of opaque infills. The values determined according to this procedure can be used for the planning of facade frames without a correction, i.e. independent of the actual visible area of the panel.

3.1.3 Data for the mathematical verification

The following table contains a proposal for the calculation of the airborne sound insulation of panels (opaque infills) installed in frame elements with a maximum profile width of 70 mm.

For box panels with mineral wool with normal fibre orientation (orientation orthogonal to the cladding), numerical values for sound insulation are given in Table 2 instead of the calculation.

Table 1 Acoustic insulation of panels (opaque infills)

type of construction	Range of application for m‘ in kg/m²	Calculation of sound insulation in dB
Sandwich panel with EPS core. Fully bonded between the claddings and the insulation core.	5 ≤ m‘ ≤ 50	$R_w = 16 \cdot \lg\left(\frac{m'}{m'_0}\right) + 12$ $R_A (= R_w + C) = 16 \cdot \lg\left(\frac{m'}{m'_0}\right) + 11$ $R_{A,tr} (= R_w + C_{tr}) = 16 \cdot \lg\left(\frac{m'}{m'_0}\right) + 9$
Sandwich panel with PUR core. Fully bonded between the claddings and the insulation core.	5 ≤ m‘ ≤ 40	$R_w = 16 \cdot \lg\left(\frac{m'}{m'_0}\right) + 10$ $R_A (= R_w + C) = 16 \cdot \lg\left(\frac{m'}{m'_0}\right) + 9$ $R_{A,tr} (= R_w + C_{tr}) = 16 \cdot \lg\left(\frac{m'}{m'_0}\right) + 8$
Panel made on site with mineral wool with planar fibre, claddings installed individually (not connected to each other), installed in frame elements	15 ≤ m‘ ≤ 80	$R_w = 24 \cdot \lg\left(\frac{m'}{m'_0}\right) + 6$ $R_A (= R_w + C) = 29 \cdot \lg\left(\frac{m'}{m'_0}\right) - 3$ $R_{A,tr} (= R_w + C_{tr}) = 34 \cdot \lg\left(\frac{m'}{m'_0}\right) - 17$
Box panel, mineral wool with planar fibre orientation, box joint sealed, installed in frame elements	25 ≤ m‘ ≤ 80	$R_w = 24 \cdot \lg\left(\frac{m'}{m'_0}\right) + 0$ $R_A (= R_w + C) = 29 \cdot \lg\left(\frac{m'}{m'_0}\right) - 9$ $R_{A,tr} (= R_w + C_{tr}) = 34 \cdot \lg\left(\frac{m'}{m'_0}\right) - 23$

Table 1 Acoustic insulation of panels (opaque infills)

type of construction	Range of application for m‘ in kg/m²	Calculation of sound insulation in dB
Plain panel, mineral wool with planar fibre orientation, incorporated in frame elements	15 ≤ m‘ ≤ 80	$R_w = 24 \cdot \lg\left(\frac{m'}{m'_0}\right) + 0$ $R_A (= R_w + C) = 29 \cdot \lg\left(\frac{m'}{m'_0}\right) - 9$ $R_{A,tr} (= R_w + C_{tr}) = 34 \cdot \lg\left(\frac{m'}{m'_0}\right) - 23$

The following boundary conditions apply to the application of the table:

1. Boards in the centre of the panel shall not be considered in the determination of the mass per unit area.
2. glass, steel sheet or aluminium sheet are usually suitable as cladding layers for panels filled with mineral wool.
3. the cavity for panels with mineral wool filling need not be filled with mineral wool in full volume.
4. there is no further requirement for the mineral wool quality except for the mass required for the calculation.

Table 2 Sound insulation index of box panels (opaque infills), mineral wool with normal fibre orientation (orientation orthogonal to the cladding), glued, installed in frame elements

Type of construction	R_w (C;C_{tr}) in dB
Cladding: 3 mm Aluminium, total thickness ≥ 50 mm	30 (-2;-4)
Cladding: 3 mm Aluminium, total thickness ≥ 200 mm	33 (-2;-5)

4 Acknowledgement

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