

The Attached Soundproof Window. The Building Physics All-Rounder.

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Introduction

Both the medical and building authority requirements not to exceed a night-time indoor sound pressure level of 30 dB(A) in bedrooms and to ensure a sufficient hygienic minimum air exchange repeatedly pose major challenges for building professionals. The newly developed "attached soundproof window" (silenzio) [1] can be a solution for this. The "attached soundproof window" ensures both sufficient air exchange, with low heat losses thanks to heat recovery, as well as very good sound insulation of up to 20 dB sound level difference in the case of a fully open window. The advantages of an "attached soundproof window" also include excellent summer thermal insulation, thermal bridge-free installation on the façade and all without reducing sound insulation.

This article presents the operating principle of the "attached soundproof window" and shows which applications can be derived from it.

The Attached Soundproof Window

The operating principle of the "attached soundproof window" is in principle a pre-built box in front of a window. It can be used for retrofitting as well as for new construction. With the box in front, both ventilation and sun protection can be implemented. The glazing of the attached box is a self-cleaning glass [titanium effect] with a catalytic effect against pollution.

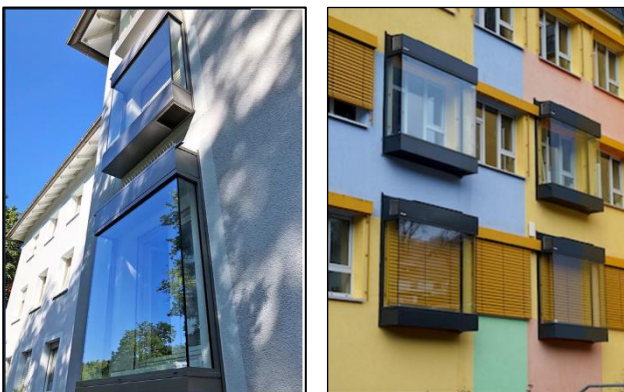


Figure 1: View of a retrofitted soundproof window.

The soundproofing element (silenzio) has a frame body, three pane elements and two ventilation units. The frame is made of recycled Aluminium in a profile shape. Figure 2 shows the soundproofing element which consists of a large window in front and two side windows.



Figure 2: Schematic image of a soundproof window.

Airborne Sound Insulation

The soundproofing element (silenzio) and a reference window are measured in a test laboratory according to EN ISO 10140-2 [2]. The reference window consists of a standard glazing made of laminated safety glass (VSG) with thickness of 16.76 mm = 40 kg/m² had sound insulation if closed of 34 dB. Introducing the attached soundproof window in front of the window results in a sound insulation of 53 dB depending on the glazing of the soundproofing element. If the interior window is opened, the sound insulation is 36 dB. The weighted sound reduction index and the spectrum adaptation terms of the tested installation situations are given in Table 1. The reference window is a double-leaf plastic window with central mullion as a single window.

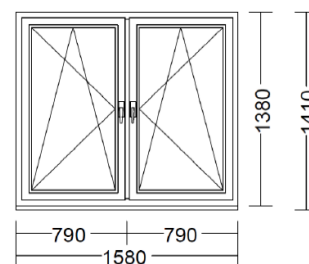


Figure 3: Sketch of the reference window.



Figure 4: View of the reference window with closed casements, installed in the test laboratory.

Table 1: Comparison of measured values in the test laboratory for different installation situations

a	Weighted sound reduction index	Spectrum-adaptation-terms					
	$R_w(C;C_{tr})$ dB	$C_{50-3150}$	$C_{50-5000}$	$C_{100-5000}$	$C_{7,50-3150}$	$C_{7,50-5000}$	$C_{7,100-5000}$
Window-closed	34(-2;-5)	-2	-1	-1	-5	-5	-5
Window-closed-and-attached-soundproofing-element(silenzio)	53(-1;-4)	-1	0	0	-6	-6	-4
Window-open and-attached-soundproofing-element(silenzio)	36(-1;-4)	-1	0	0	-4	-4	-4

The results of the sound insulation measurements of the three cases examined are shown in Figure 4, 5 and 6. Figure 4 shows results of the closed reference window. Figure 5 shows results for the closed reference window with the installed soundproofing element (silenzio) and finally Figure 6 shows results of the case where the reference window is open, and the soundproofing element is installed.

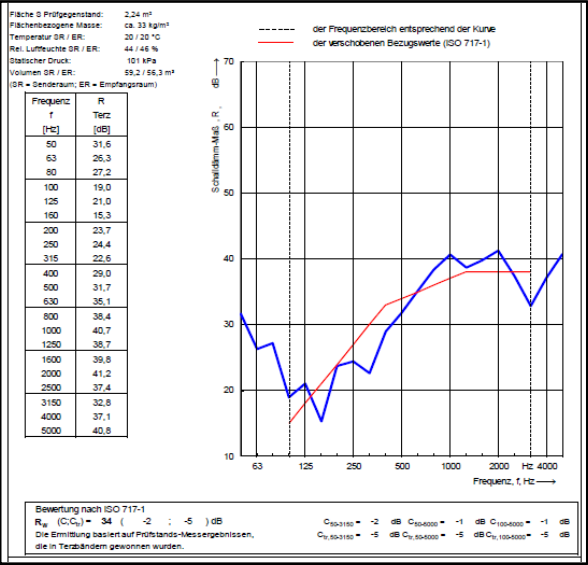


Figure 5: Airborne sound insulation as a function of frequency of the reference window. The window is closed. The weighted sound reduction index is: $R_w = 34$ dB.

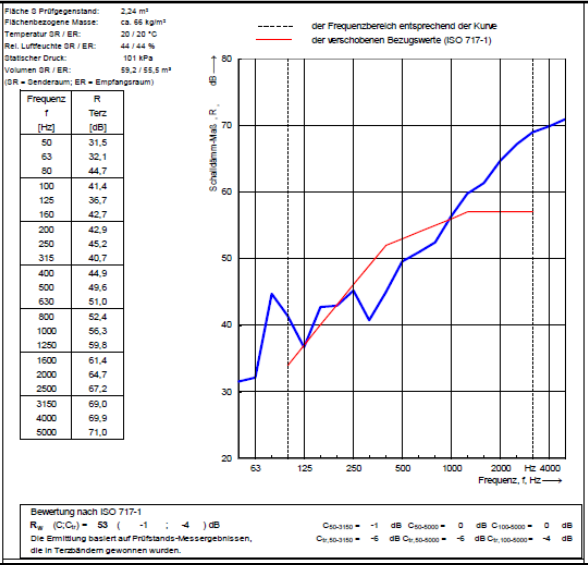


Figure 6: Airborne sound insulation as a function of frequency of the reference window closed and an installed soundproofing element (silenzio). The weighted sound reduction index is: $R_w = 53$ dB.

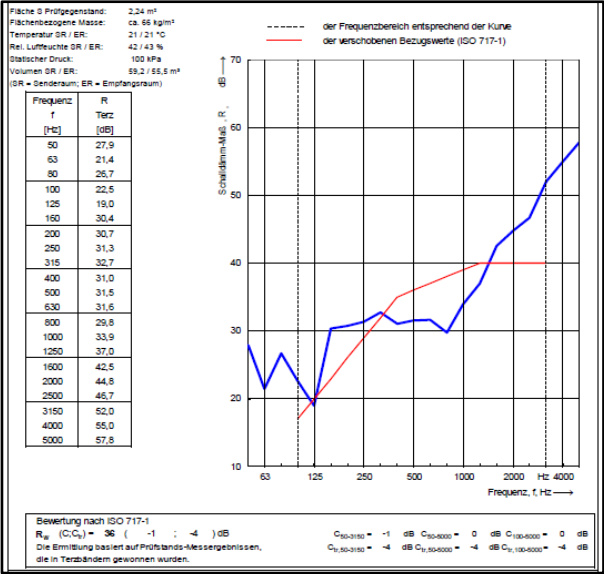


Figure 7: Airborne sound insulation as a function of frequency of the reference window fully open and with the installed soundproofing element (silenzio). The weighted sound reduction index is: $R_w = 36$ dB.

A comparison of the individual measurement results is shown in Figure 8 where it can be seen that a significant improvement in all frequencies of the airborne sound insulation is observed.

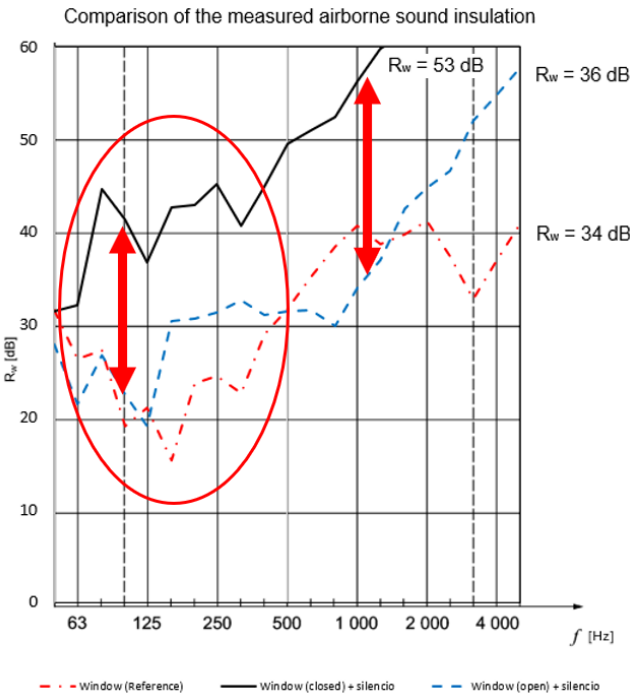


Figure 8: Airborne sound insulation as a function of frequency of the three-situation depicted in Figure 5 to 7.

In Figure 8 it is seen that an improvement of about 17 dB in average is obtained in the important frequency range of 500 Hz to 1.6 kHz which is for traffic noise. Even at low frequency a remarkable improvement is observed.

Ventilation

With the "attached soundproof window" a ventilation is possible. The ventilation was measured in a test laboratory according to EN 13141-1:2019 [3]. The soundproofing window provides either a passive ventilation, i.e. natural ventilation, or a driven ventilation with a ventilator installed. In addition, a cooling or even a heating could be installed. In the summer therefore, combined with a solar control glazing and a cooling ventilation, an optimal air conditioning is possible. Figure 9 is showing the ventilation in principle.

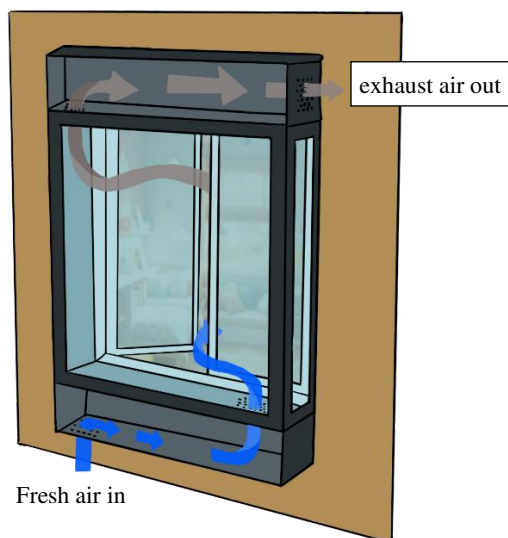


Figure 9: Schematic image of the ventilation.
Fresh air in (blue) and exhaust air out (brown).

If the inner window is completely open and the outer soundproof window with an installed fan is attached, an active ventilation is enabled with a ventilation rate of up to 4.9 per hour. If the volume flow varies with pressure the following flow rate results:

Pressure difference +5,0 [Pa] → Flow rate 111,0 [m³/h]

Pressure difference -7,0 [Pa] → Flow rate 115,0 [m³/h]

This means that by means of a ventilation by natural convection a certain amount of ventilation can always be achieved when the window is fully open, even without an active fan. The sound insulation is 36 dB according to the glazing of the attached soundproof window, as in this case.

Thermal Bridges

A thermal bridge is in general a localised area where the heat flow is different in comparison with adjacent areas. Eliminating thermal bridging around windows poses a significant challenge in energy-efficient design. In the case of the "attached soundproof window", the inner window is covered by the outer soundproofing element (silenzio), so that there are no more thermal bridges in the reveals of the windows.

Summery

A novel soundproofing element (silenzio) reveals an excellent sound insulation as high as 53 dB at closed inner window and a sound insulation as high as 36 dB if the inner window is fully open. This soundproofing element allows therefore a good ventilation of a room if needed. Additional building

physics features as well as safety properties can be added if required. For example, a best possible sun protection as well as outstanding burglary protection can be ensured. This makes the soundproof window an all-rounder that can be integrated into the façade as a simple attachment. Even with a thermal insulation composite system, the use is problem-free. Overall, an improvement of about 17 dB in average is obtained in the important frequency range of 500 Hz to 1.6 kHz which is for traffic noise. Even at low frequency a remarkable improvement is observed which is important for a reduce noise emitted from heat pumps.

Literatur

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