- General Guidelines -

Soundproof Windows and Framed Glass Doors

Before attempting to understand the ergonomics of specified soundproof windows and framed glass doors, it is necessary to diversify between specifications for standard frames and specifications for specified soundproof frames.

First of all, any given window or framed glass door will offer a certain degree of sound attenuation; whether this degree of attenuation is adequate or poor is another issue. Within the European Union, standard (run-of-the-mill) windows and framed glass doors are regulated by law to provide a minimum acceptable degree of sound attenuation. Though specifications from country to country vary slightly, on average, standard frames are required to provide a minimum sound barrier of anything between 20 and 30 db, depending on whether the frame is installed in a quiet or urban area. If the occupant requires a higher degree of sound attenuation, then the seeking of advice for the installation of a proper specified soundproof window or framed glass door should be considered.

It should be noted that for every increase of 6dB in sound attenuation, the effectiveness of a soundproof barrier is doubled, meaning that the apparent volume of sound leaking through the barrier is cut by half. A difference of 12dB therefore, means 4 times the sound attenuation, and 18dB, 8 times the sound attenuation, etc...

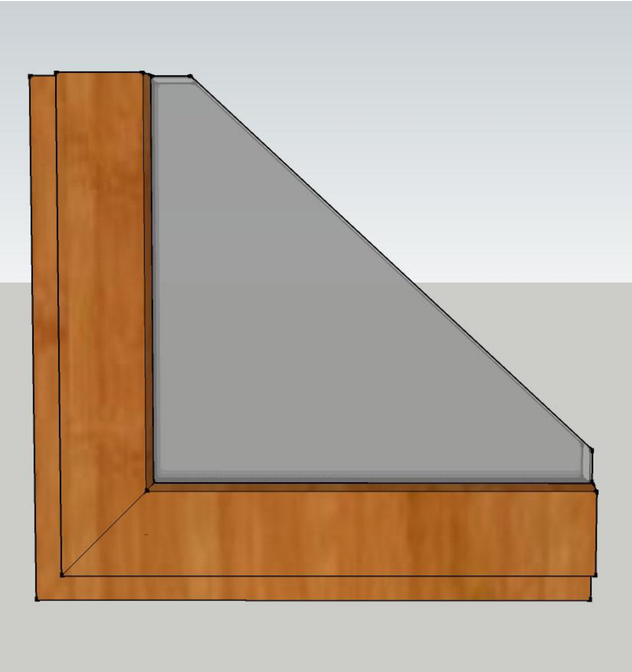
Specified soundproof windows and framed glass doors for domestic applications usually start at a minimum specification of around 33-34dB, and can extend to a maximum performance of around 51dB (for a single window / single door system). In order to achieve high performace in noisy areas, a specification of not less than 40dB is recommended.

Design of soundproof windows and framed glass doors

The effectiveness of a soundproof window or framed glass door is obtained by a collective number of design considerations working together at the same time, namely:

- Air-leakage
- Glazing
- Rubber seals
- Frame construction
- Proper installation

The ergonomics of soundproofing are unfortunately such that any failure in even one of the above design factors will translate into the failure of the soundproof barrier to deliver the desired specification. Transmission of sound can be compared to a balloon filled with water - one pinhole, and the water will leak out of the balloon.



Soundproof window (exterior view)

Soundproof window (interior view)

Air-leakage

Air-leakage, apart from causing implications with thermal efficiency, also carries sound. In theory, the ideal air-leakage through a soundproof window or framed glass door should be zero, but in practice a specified air-leakage of around 0.1 % to 0.3 % is considered important. This is a negligable amount of air-leakage, but allows for a minimum amount of air-exchange, which is an important health consideration.

Glazing

At least two glass panes are specified, the volume between panes being filled with c90% argon gas and hermatically sealed. The viscosity of argon (as opposed to air) limits the amount of convection within the sealed chamber, therefore reducing the transfer of heat across the glass assembly. The preferred reason for using argon as opposed to a vacuum (which would otherwise offer zero convection and zero compression features), is that the gas provides pressure balance to the outer atmospheric pressure on both sides of the assembly and avoids the glass panes cracking and caving in. In any case, argon filled chambers are much more related to heat efficiency than they are to actual soundproofing.

The presence of a third, or third and fourth glass pane is again related to thermal efficiency but also increases soundproofing specifications. Of utmost importance for effectiveness of soundproofing is the width of the gap between any two given glass panes. Two panes with a larger gap between them can perform acoustically as well as three panes with two smaller gaps of half the width between each pane.

- **Gap between glass panes**

The issue with a small gap between glass panes is related to the volume of gas sealed in-between them. If a glass pane vibrates, it tends to compress the gas within the sealed volume and transmit the vibration to the other glass pane. The smaller the volume of gas, the more compression will be applied to the gas, and therefore the higher the pressure (vibration) transmitted to the second glass pane. A larger gap means more sealed volume, less compression for the same amplitude of vibration of the glass, and therefore less transmission of sound between panes.

A specified soundproof window or glass frame door generally uses a minimum air-gap of 16mm between any two glass panes (Spec. 16 Argon), and an air-gap of 20mm (Spec. 20 Argon) for the higher specification frames.

The aluminium strip (drip cap) lining the perimiter between panes is a moisture collector. The minute holes present in the strip allow the silica gel inside the strip to absorb moisture. The amount of silica gel present is designed to handle the sealed volume of gas within the glass pane assembly without becoming over-saturated.

- **Glass panes**

Considerations of how glass panes work together is also important. Each glass pane, like any other material structure, has a resonant frequency. This is the frequency at which it will most likely be happy to vibrate on its own, the actual frequency being dependant on the glass consituency and thickness. If two glass panes of identical constituency and thickness are used, vibration of one glass pane will most likely cause the adjacent pane to vibrate in sympathy, therfore transmitting sound between panes.

Higher specification soundproof windows and glass frame doors usually use glass panes of different thicknesses to avoid this issue.

The most common glass thickness used in soundproof windows and glass framed doors is 4mm, with 4mm / 6mm combinations being used in the vari-thickness-paned windows.

Rubber Seals

The rubber seals are deterimental to providing a hermatic seal in order to avoid air-leakage, and therefore transmission of sound through air.

Closure seals - Specified high-specification soundproof windows and glass frame doors usually use 3 separate gaskets, meaning the openable frame (on closure) is sealed along three separate sealing contact perimiters. At least one of the three gaskets is a “bubble gasket”.

Glass pane seals - The glass pane assembly is permanently installed to the frame via rubber “bubble gaskets”, and is never in direct contact with the frame or any frame retainers present. The gaskets provides a hermatic seal between the frame and glass pane assembly, cutting off the passage of air and heavily reducing impact noise transmitted from the frame to the glass pane. These seals are never broken unless the glass pane assembly needs to be replaced. In triple- and quadruple-glazed frames, the separate argon chambers are individually sealed from one-another.

Although standard windows and framed glass doors allow various types of rubber to be used in seals (Namely *Chloroprene Rubber*, *PVC Nitrile*, *TPM*, *EPDM* and *plasticised PVC*), *Neoprene* rubber is preferred for specified soundproof aperture units. Neoprene is flame retardant, has good weathering resistance, and is also resistant to acidrain and most solvents. The constituency of this elastometer provides an excellent acoustic seal and resistance to vibration (impact noise), and it is widely used in all soundproofing applications.

Frame

Frames for specified soundproof windows and glass frame doors are universally available as follows:

- 100% Wood
- 100% Laminate
- 100% UPVC (low specification for budget applications)
- Composite Window – Wood / Aluminium
- Composite Window – Laminate / Aluminium
- Composite Window – UPVC / Aluminium

All joints constituting the frame should be either welded, glued, cleated or screwed, depending on the material employed, and should have flush, stepped or lapped surfaces. Under no account should there be visible gaps in any joint.

100% aluminium is generally acceptable for the production of frames for standard windows. It is usually never used in specified aperture soundproofing applications because aluminium is brittle and has poor acoustic absorbtion properties, much more easily allowing both impact and airborne noise through it, even if the frame cross-section is not solid. Aluminium is also a good conductor of heat and therefore also performs poorly as regards energy efficiency. (100% aluminium frames allow the transfer of an appreciable amount of both heat and sound through the frame, irrelevant of applied glazing).

In cases where compliance with local planning authorities is required or an external aluminium finish is desired, composite windows provide an aluminium outer shell (skin) fitted to a main frame body made of wood, laminate or UPVC. In this case, the acoustic specifications are reached as sound is more easily transmitted through the external aluminium skin, but less easily through the next material which constitutes the bulk of the frame.

In the higher specification composite windows, the outer aluminium frame is cut out as one piece from a whole sheet in order to eliminate the 45º joints at the four corners of the frame.

Total thicknesses for good quality double-glazed specified soundproof windows and framed glass doors, typically vary between 68 and 90 mm.

Irrelevant of the composure of the material of the frame, the design and operational criteria are always the same.

Installation

In any soundproofing application, the actual installation accounts for a great deal of the final performance of the applied structure, and it is therefore of utmost importance that the installers know exactly what they are doing, and that meticulous care be taken during the whole process.

- **Fixation of frame to the aperture**

Doors:

The floor rail should be fixed to the floor via a 2-2.5mm thick strip of acoustic neoprene matting rated at around -18dB, cut to the size of the rail and fitted in-between the rail and the floor. The acoustic matting has two purposes: the reduction of impact noise transmitted from the floor to the frame by a factor of 8, and the ability of the elastic mat to compress more at certain points and less at others, therefore sealing of any passage of air due to discrepancies in floor levelling.

The other three sides (the verticals and the top) of the frame should be fixed to the aperture with appropriate screws, leaving a space of c 1cm between the frame and the aperture all the way round. This space is filled with expandible foam and an additional (finishing) batten is used via an inter-lying neoprene strip, both on the inside and outside in order to cover the foam insert. Expandible foam has excellent acoustic absorbtion properties and provides a proper air-tight seal right through the thickness of the frame to the outside. Moreover, it does not deteriorate over time.

Non-rusting screws (stainless steel, aluminium or brass) should be used for fixation of the outer frame to the aperture. (Rusting causes inflation of the screws, with the possibility of applying enough pressure to warp the frame, resulting in consequences later explained below)

The combination of the acoustic floor matting and the expandible foam perimiter helps to “float” the frame within the aperture with minimum points of contact, therefore minimising on transmission of impact noise

Windows:

The window frame should be manufactured smaller than the aperture, allowing a 1cm space all the way round. This is similar to the technique employed for the door with the exception of the floor rail, which is not required. The rest of the installation is identical to that employed for the door (less the floor rail).

Sealing issues:

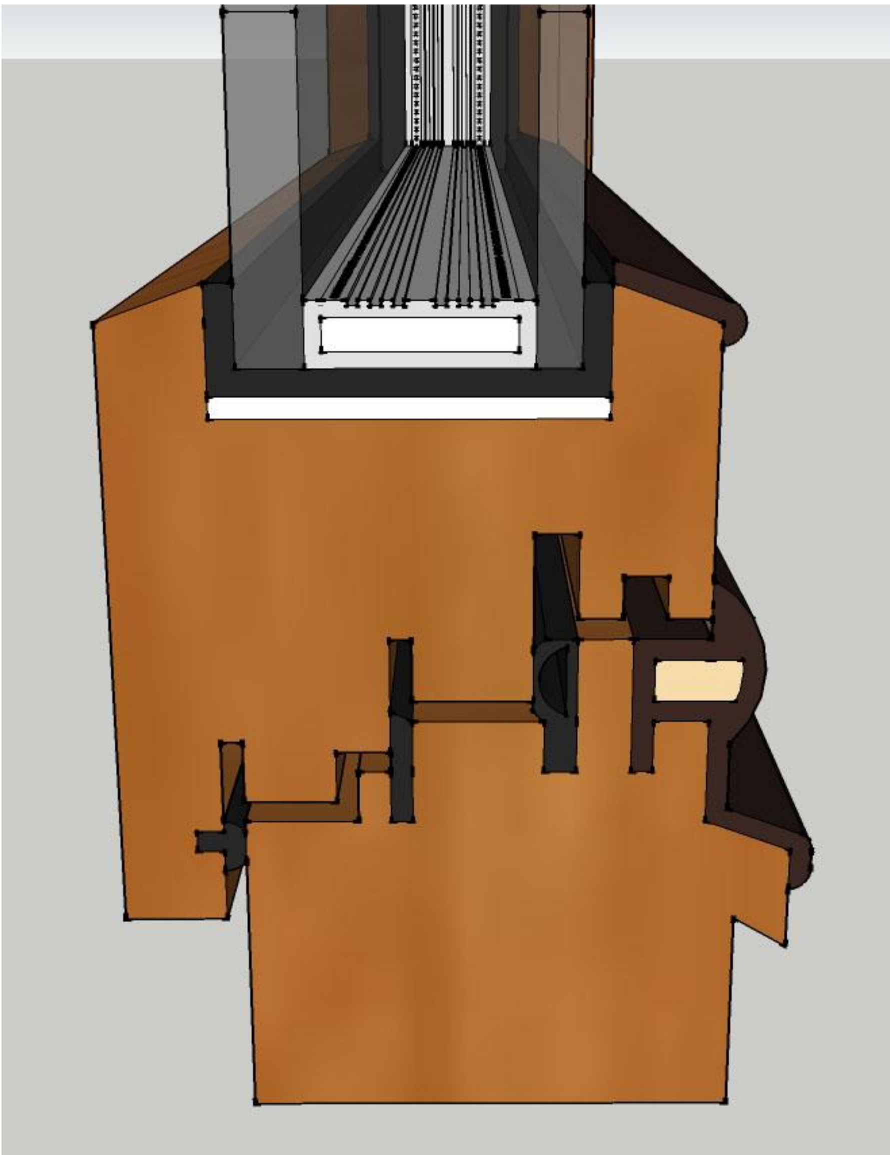
Use of silicone or acrylic compound is inadequate <u>on its own</u> for the sealing of soundproof frames to apertures for the following reasons:

- These materials do not have adequate acoustic properties to sufficiently seal off a <u>straight line</u> gap, crack or fissure to the other side.
- They are applied only to the edge of the frame on both sides, leaving the gap through the thickness of the frame untreated.
- They are not sufficiently weather resistant and tend to deteriorate over time, even indoors. The seals eventually break, allowing the passage of air and therefore sound.

In such applications, silicone is in fact often used as a second seal (over the primary seal). When soundproof windows and framed glass doors are in fact usually tested, it is required that breakage of silicone seals should not in any way affect the performance of the whole assembly.

- **Alignment of the frame**

Frame alignment is also deterimental to such an installation - frames warped even slightly by unequal or excessive tensions applied to fixation screws will not allow the closure rubber seals to sit properly and degrade the final specification obtained. In addition, warped frames transmit unnecessary stress to the glass panes, making them more liable to cracking.



Soundproof window showing the 3 seals and glazing
with wide air-gap and panes of different thicknesses