# - General Guidelines –

# Soundproof Doors

Doors and windows are by far one of the the most common reasons for noise leakage within an enclosed enviroment. Since soundproofing is effectively as good as the weakest link within a given structure, doors leading to a room where effective soundproofing is desired are a critical issue, and must be given primary importance.

Since doors cannot be fitted with internally spring-mounted faces due to the nature of their design, size and operation ergonomics, there is no proper substitute for sheer mass in a good soundproof door. Dense materials in this case are the only thing that will stop sound travelling through a door, even if the actual door provides a proper seal. For this reason, soundproof doors weigh a minimum of 85-90 kgs per leaf.

The performance of a soundproof door is dependant on four factors:

- Leaf Design
- Aperture Frame Design
- Gasket Seals
- Installation

**Leaf Design**

The door leaf is the part which opens and closes within a complete door structure. Most soundproof door leaves use a technology called **Constrained Layer Mass Damping**. This employs different materials of different densities layered over eachother in a manner that addresses the reduction of vibrations, where the particular sequence and applied thicknesses of the successive material layers is important.

- Leaf Frame

The door leaf constitutes a frame all around its edge, made of rails and stiles. The two horizontal portions of the frame at the top and bottom are called rails, and the two vertical portions of the frame on either side are the stiles. The frame consituting a soundproof door leaf is subject to three important considerations:

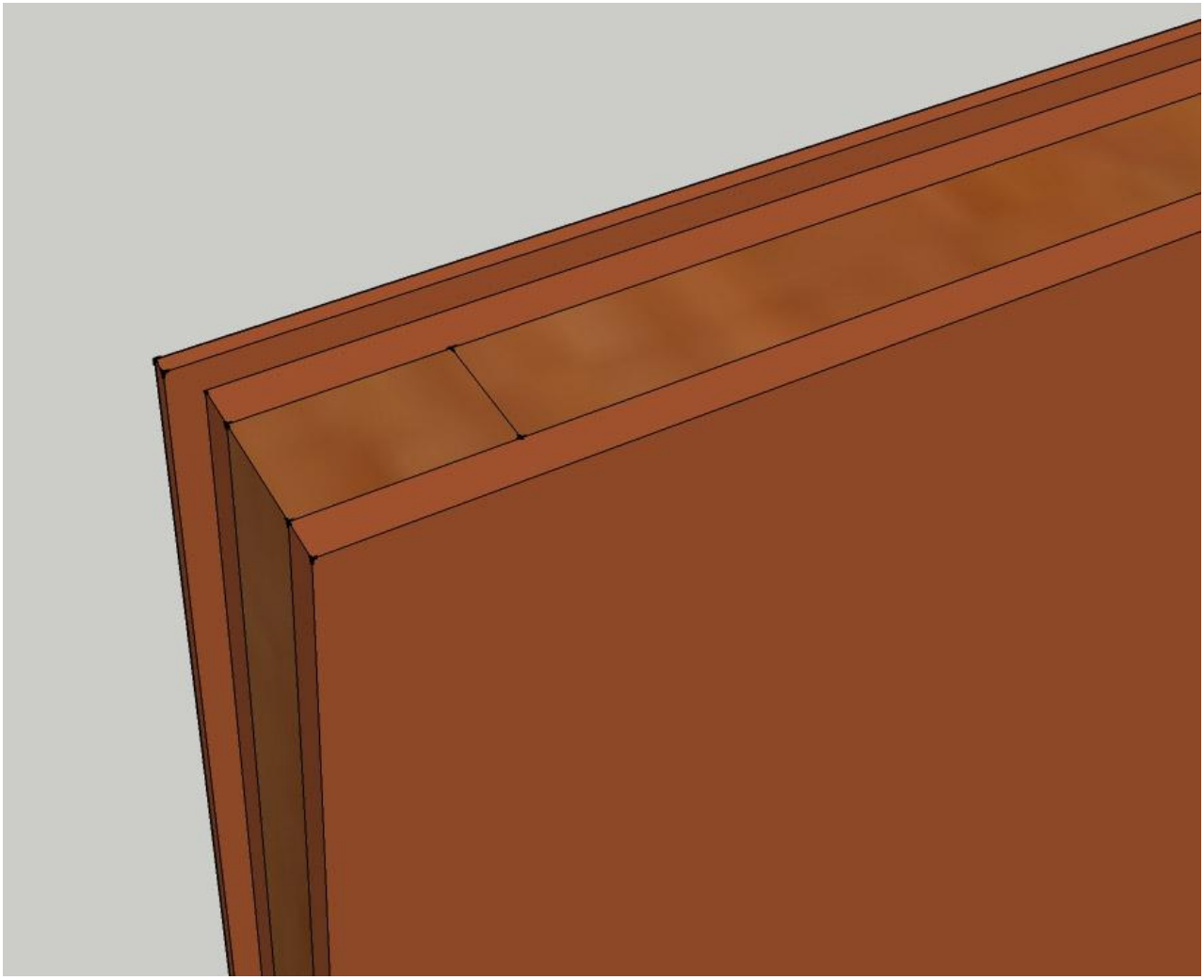
1 – It must be strong in compression tension and sheer, and be as little susceptible to splitting or warping under weight as possible.

2 – It must be very dense (heavy) in order to provide as large a sound barrier as possible.

3 – It must expand and contract minimally under conditions of variable temperature and humidity, in order to avoid significant weather warping, which upsets proper seating against the seals on closure.

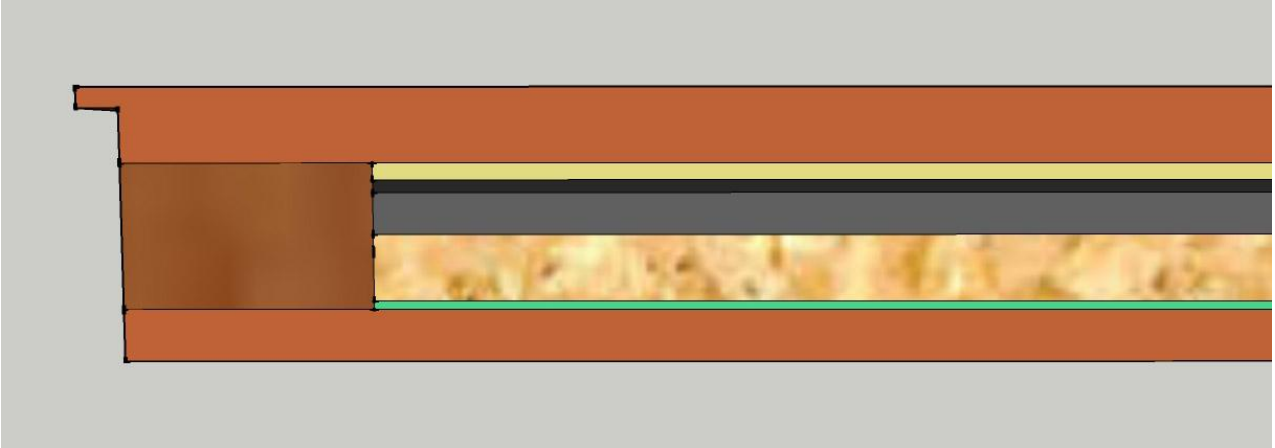
The preferred material for the frame is therefore a well dried and aged coniferous hardwood. The hardwood provides the strength and the density, and the drying and ageing makes it less susceptible to expansion and contraction. A most commonly used wood in the manufacture of soundproof door frames is aged oak.

The outer faces on both sides of the door are usually made of HDF. Importantly, one sheet is always thicker than the other in order to avoid the two boards having the same resonant frequency. The thicker (front-facing) board has an outward-protruding lip running around the edge of the door leaf. This lip is known as a **rebate**, and significantly blocks the passage of air between the door leaf and the aperture frame. It is always machined out of the thickness of the HDF sheet for strength and never is a separate (slightly larger) sheet of wood used to create the rebate. Use of a full rebate is only possible with single-leaf doors.



Soundproof door leaf showing internal frame, front and rear HDF faces,
and rebate machined out of the front HDF face

The thinner of the two outer **HDF** faces is glued to a sheet of **high density Baltic Birch plywood** using **acoustic glue**. The acoustic glue dries into an elastometer which greatly improves sound-transmission loss between these two surfaces. Adjacent to the plywood is a **mass-loaded elastometer sheet** held in-between a sheet of **high density (c 28 kg/m³) acoustic foam** and a sheet of **soundboard** or **acousti-board -** (These are rigit sheets of highly-compressed mineral fibre weighing c 4kg/m²). The soundboard / acousti-board sheet is in contact with the thicker of the two HDF faces, and the acoustic foam is slightly compressed when the materials are sandwiched together into a completed door leaf.



Soundproof door leaf - horizontal cross-section

## Aperture Frame Design

The aperture frame is the fixed frame lining the wall aperture over which the door leaf closes. Since the surface area of this frame is too small to feature appreciable expansion in critical directions, there are much less rigorous requirements for the use of hard materials.

The lower specification soundproof doors (34-38 dB) employ an aperture frame fixed to three sides of the aperture (excluding the floor). In this case the door leaf employs a **drop-seal** which lowers a weighted neoprene-lined strip to the floor when the door is closed, in order to seal off the air-gap between the bottom of the door and the floor.

Medium and high specification doors (>38 dB) employ a system known as **full-lock**. Here the aperture frame surrounds the whole perimiter of the door leaf by including a floor threshold, and the door is therefore able to form a hermatic seal against rubber gaskets all the way round its edge.

** It is to be noted that if good soundproofing is required, nothing beats a full-lock soundproof door. (Full-lock applies only to single-leaf doors).

## Gasket Seals

Soundproof doors installed in the interior of a building employ at least one gasket seal, and perhaps two, depending on the required specifications and practical function of the actual door.

Although various types of rubber are used in the manufacture of rubber seals, (Namely *Chloroprene Rubber*, *PVC Nitrile*, *TPM*, *EPDM* and *plasticised PVC*), *Neoprene* rubber is preferred type of material employed in the seals of soundproof doors. 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.

Soundproof door – full-lock aperture frame with threshold, featuring gasket seals for the front door rebate and the rear face perimiter.

## Installation

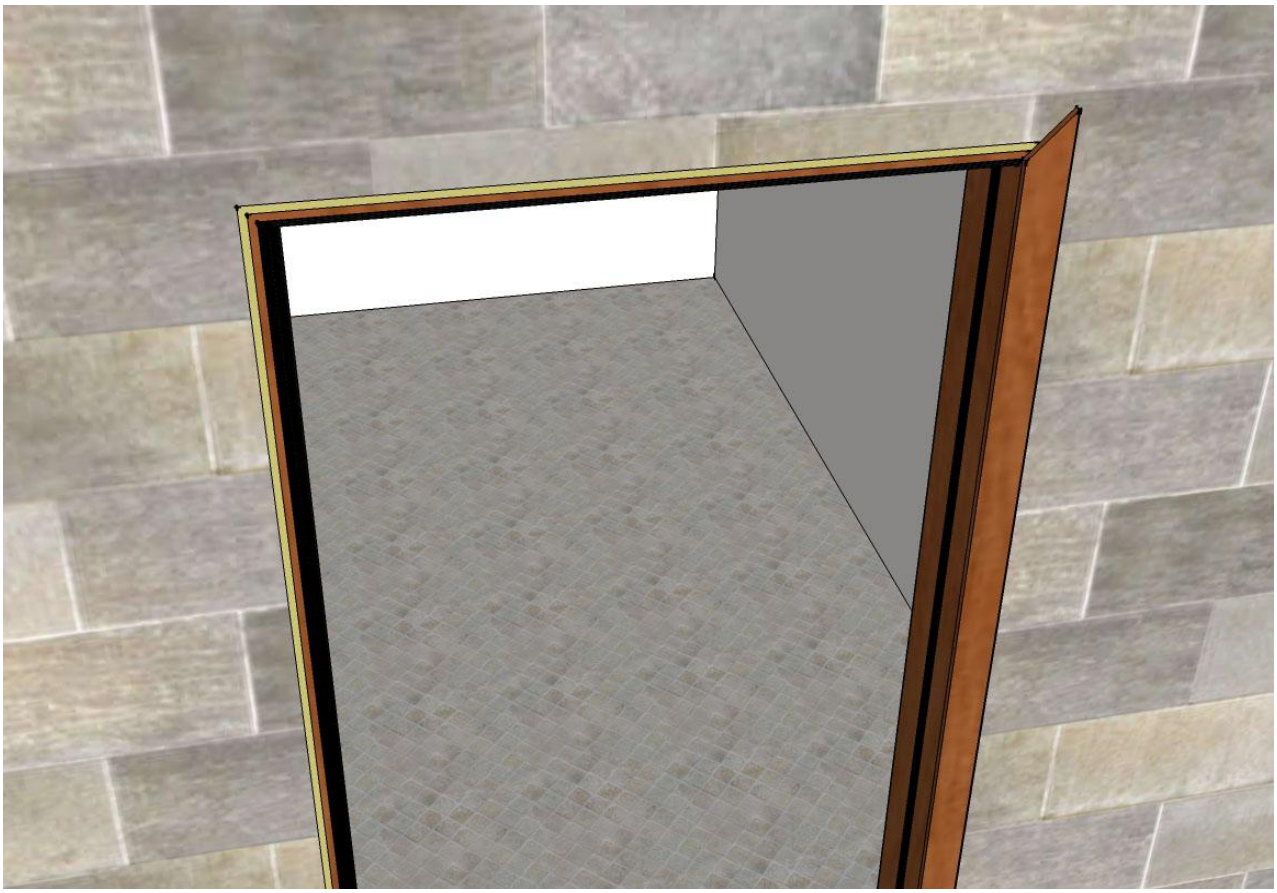
Since soundproof doors are required to provide a hermatic seal between two areas, installation is critical because it needs to guarantee this requirement. Under the circumstances, the installers are responsible not only for ensuring zero air-leak between the apertrure frame and the aperture (wall or partition) when the installation is finished, but also a proper soundproof seal. If there is as much as a pinhole or a

weak soundproof seal between the aperture frame and aperture, the installation will fail and the door performance will be considerably degraded.

The aperture frame must not be in contact with the aperture at any point in order to protect the door structure against impact noise. Full-lock door apertures are installed with acoustic rubber sheeting between the threshold and the floor, and the two edges of the threshold are sealed with acoustic mastic. The rest of the frame requires 1cm of space all the way round.

The frame is screwed to the wall with recommended screw tensions provided by the manufacturer, in order to avoid warping of the frame. All the screw tensions must be the same. Following fixation of the aperture, the whole gap (one side to the other throughout its depth) is filled with expandible foam. 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.

Finally the aesthetic frame is fitted and sealed all the way round with acoustic mastic, where the edges are in contact with the wall or partition.



Installed aperture frame showing expandible foam sealing the gap between the aperture and the wall, and part of the aesthetic frame

## Fitting Soundproof Doors

In order to determine the specifications required for a soundproof door in any particular application, the noise levels within the particular room must be measured accordingly, and the correct door to address the issue nust be selected.

Soundproof door specifications range from around 34dB up to 56dB. Door leaf thicknesses vary between c 55mm to 95mm, depending on the required door specifications.

Ratings higher than 56 dB can be attained by installing two doors in series with a suitable gap in between them. The larger the space between the two doors, the better will be the performance rating. This is because when one door vibrates, it tends to compress the air in the sealed space between the two doors, and transmit the vibration to the other door. The smaller the volume of air, the more compression will be applied, and therefore the higher the pressure (vibration) transmitted to the second door.

All doors are required to be certified by means of a test certificate in document form, or a certification plate attached to the edge of the door leaf on the side of the hinges.

Security soundproof doors employ outer steel sheets on both sides of the door leaf and usually employ a steel aperture frame and a steel internal leaf frame.

Because of the precise material combination engineering, precision manufacture required, (including precision tight-fit of the door leaf to the aperture frame), necessary certification and critical installation to support such certification, soundproof doors are usually purchased as ready-made and factory-tested units from a reputable manufacturer, and installed by certified personnel.