ACOUSTICS & TIMBER Recommendations guide

BUILDING BETTER, SAFER STRUCTURES

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Contents

1. Introduction

In today's construction market, acoustic comfort has steadily risen to reach one of the top spots in the list of quality criteria. Different noise sources are a major nuisance that can sweep throughout a building and worm their way into work and relaxation areas. Specific construction measures and objectives must be defined when the project is still on the drawing board to prevent noise from spreading in the later design. Timber boasts a wealth of advantages when it comes to designing and constructing buildings, although it requires a more in-depth acoustic study than with a concrete construction.

To determine the building's acoustic performance as accurately as possible, the characteristics need to be defined for each construction element. That is why Simpson Strong-Tie has decided to produce this guide and present the high-performance range of acoustic connectors and fastenings for timber frame buildings. Each solution features an illustration and is accompanied by a comprehensive set of laboratory test results. Our aim with this guide is to provide a clearer insight into the solutions that offer superior performance for reducing sound transmission in a timber frame structure.

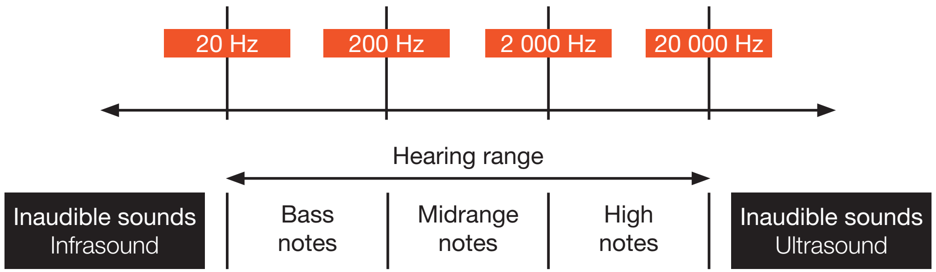
2. Acoustics and buildings

A - Sound

Sound is a wave that propagates through a transmission medium by causing the molecules to vibrate. These vibrations generate pressure on our eardrums, which we perceive as sound. There are several characteristics for defining sound. In this guide, we will focus our attention on two specific characteristics, namely frequency (expressed in hertz - Hz) and amplitude or intensity (measured in decibels - dB).

Audible frequency scale

A sound's frequency refers to the number of oscillations per second and determines whether the sound is low or high-pitched. The human ear is only capable of detecting sounds within a frequency band between 20 Hz and 20,000 Hz.

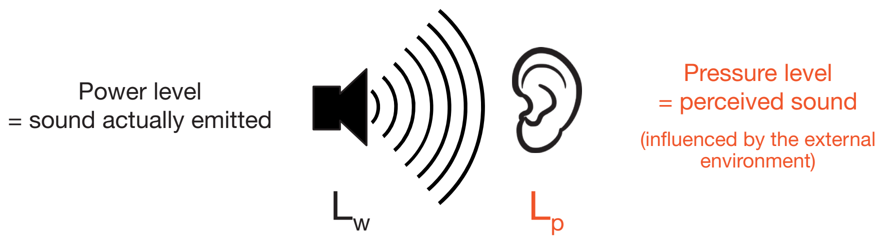


Definition of sound amplitude

Amplitude is what distinguishes between a quiet sound (whispering) and a loud sound (a jet plane taking off).

There are two different types of sound level:

- $\mathbf{L_w}$: the sound power level is the power required to generate sound waves
- $\mathbf{L_p}$: the sound pressure level corresponds to the sound that we can hear



The sound levels can be defined using the following formulae:

$$L_p = 20 * \log(\frac{P_e}{P_0}) \quad | \quad L_w = 10 * \log\left(\frac{W_e}{W_0}\right) = L_p + 10 * log\,(\frac{S}{S_0})$$

Note that doubling the pressure increases the amplitude by 6 dB, whereas doubling the power of the sound source only increases the amplitude by 3 dB.

To understand why this happens, we are going to expand on the previous formulae:

If: $P_e = P_0$ then: $L_p = 20 * \log\left(\frac{P_0}{P_0}\right) = 20\log(1) = 0\ dB$

Consider sound pressure level L_{p1} for sound pressure P_e, and sound power level L_{w1} for sound power W_e.

$$L_{p1} = 20 * \log\left(\frac{P_e}{P_0}\right) \quad | \quad L_{w1} = 10 * \log\left(\frac{W_e}{W_0}\right)$$

If sound pressure doubles, we obtain:

$$L_p = 20 * \log\left(\frac{2 * P_e}{P_0}\right) = 20 * \log\left(\frac{P_e}{P_0}\right) + 20 * \log(2) = L_{p1} + 6\ dB$$

Now if we double the power of the sound source, we obtain:

$$L_w = 10 * \log\left(\frac{2 * W_e}{W_0}\right) = 10 * \log\left(\frac{W_e}{W_0}\right) + 10 * \log(2) = L_{w1} + 3\ dB$$

Key

- $\mathbf{P_e}$: actual sound pressure [Pa]
- $\mathbf{P_0}$: reference sound pressure (2.10^{-5} Pa)
- $\mathbf{W_e}$: actual power [W]
- $\mathbf{W_0}$ = 1pW=10^{-12} W
- $\mathbf{S_e}$: measurement surface area [m^2]
- $\mathbf{S_0}$: reference surface area (1m^2)

Decibel scale

Sound intensity is expressed in decibels using a scale from 0 dB(A), which is the absolute threshold of human hearing, to approximately 120 dB(A), which is the upper limit of the sounds that we are likely to hear in our environment.

- **Reference threshold: 0 dB(A)**

This figure corresponds to the minimum pressure level required for our ears to hear a sound. At these low levels, we can hear noises from our body (joints, heart beat, blood flow, etc.), which might be quite unsettling.

- **Levels at which the non-auditory effects of noise appear: 40-50 dB(A)**

When we are exposed to levels higher than 40 dB(A) at night and higher than 50-55 dB(A) during the day, the World Health Organisation considers that the adverse health effects of noise may appear, including sleep disorders, discomfort, greater cardiovascular risks, concentration problems and impaired cognitive performance.

- **Risk threshold for hearing: 80 dB(A)**

This is an important value, because it is used in “control of noise at work” regulations. Where workers may be exposed to this threshold, the employer must provide information about the potential hearing risks, offer hearing tests (optional) and provide employees with appropriate hearing protection. At 80 dB(A) and above, the length of exposure to the sound source is a significant risk factor.

According to “control of noise at work” regulations, when employees are exposed to a level of 85 dB(A) over an eight-hour period, hearing protection must be worn.

- **Threshold of pain: 120 dB(A)**

The 120 dB(A) threshold is the point at which pain begins to be felt. Our ears hurt. This is a warning message, albeit a late one!

The danger threshold for hearing and the threshold for detecting pain are separated by approximately 40 dB(A).

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2. Acoustics and buildings
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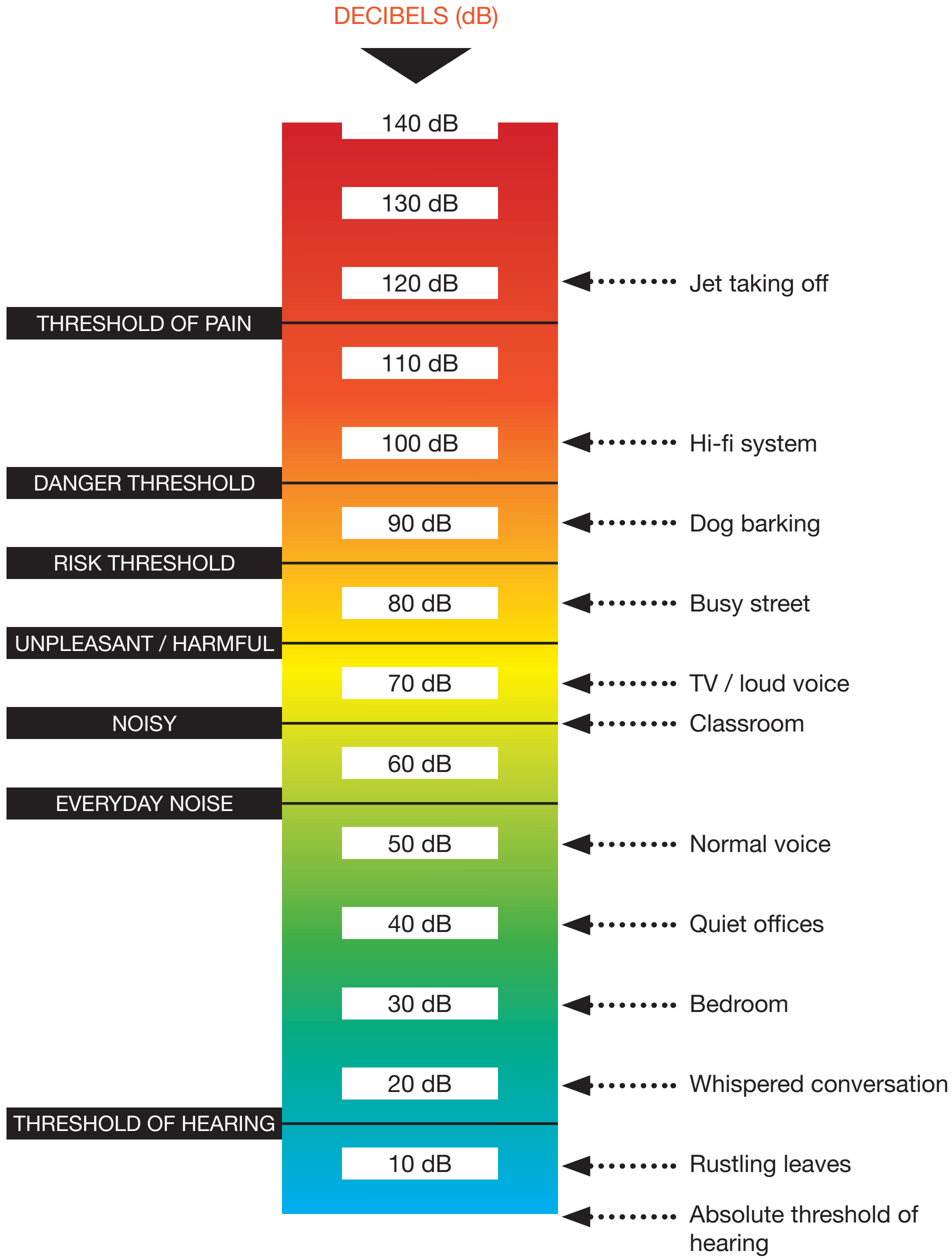


2. Acoustics and buildings

B - Acoustics in buildings

Noise in buildings has a direct effect on everyday health and quality of life. Standards and regulations have been implemented to guarantee the best level of acoustic comfort for building occupants and users.

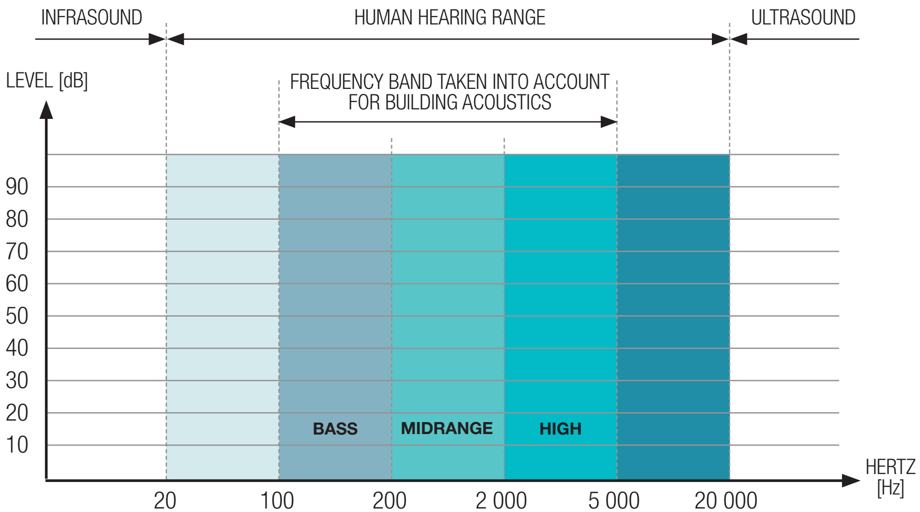
In France, sound insulation solutions in buildings need to meet various legal requirements. The New Acoustic Regulations (NRA) define a number of sound performance objectives for buildings that were granted planning permission after 1 January 2000. The Regulation of 30 June 1999 for the Housing and Construction Code, especially Article R.111-4, relating to the Regulation of 30 May 1996, specifies the required acoustic performance for new builds, roof lifts and extensions.

The minimum requirements stipulated in the NRA are as follows:

- Insulation against external noise $D_{nTA,tr} \geq 30$ dB
- Insulation against internal noise $L_{n,w} \geq 53$ dB
- Impact noise $L'_{nT,w} \leq 58$ dB

Designing a building that satisfies applicable regulations will not necessarily create pleasant conditions for the occupants. Regulations fail to take account of low-frequency noise below 100 Hz. This type of noise can be a significant nuisance, because low-frequency sound is hard to attenuate.

People perceive low frequencies in a different way to other frequencies. They cannot be heard at low amplitudes, but when they do become audible, the sensation of their amplitude increases faster than with other frequencies. A solution is available for overcoming this problem, which involves separating the construction elements to prevent low-frequency waves from spreading.



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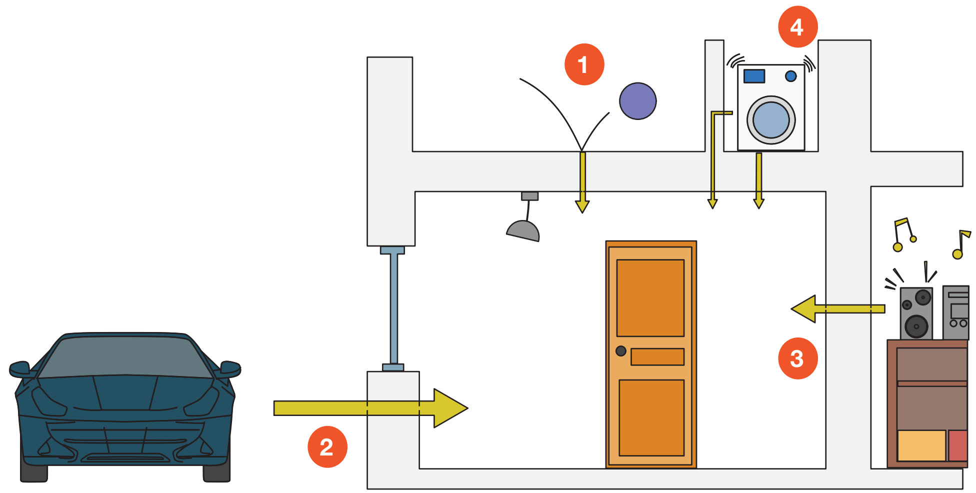
2. Acoustics and buildings

Different noise sources

Regulations make a distinction between several noise sources, such as impact sound (footsteps, falling objects, slamming doors, etc.), external airborne sound (aircraft and road traffic), internal airborne sound (TV, speech, etc.) and service equipment noise, which is a combination of internal airborne sound and impact sound.



1 **Impact sound:** Impact sound is produced directly by an object colliding with a dividing element, which causes it to vibrate. This is also known as structure-borne sound.

2 **External airborne sound:** When external airborne sound comes into contact with an element, it makes the building's facade "vibrate".

3 **Internal airborne sound:** When internal airborne sound comes into contact with an element wall, it spreads through all the adjacent elements.

4 **Service equipment noise:** Service equipment noise can be transmitted as both airborne sound and impact sound (vibrations from a washing machine, a lift, etc.).

2. Acoustics and buildings

C - Acoustics in timber frame buildings

To ensure a good level of acoustic insulation, a solution often used in the building industry involves increasing the mass of the dividing elements. The heavier the element, the harder it will be to make that element vibrate. This is commonly known as the mass law.

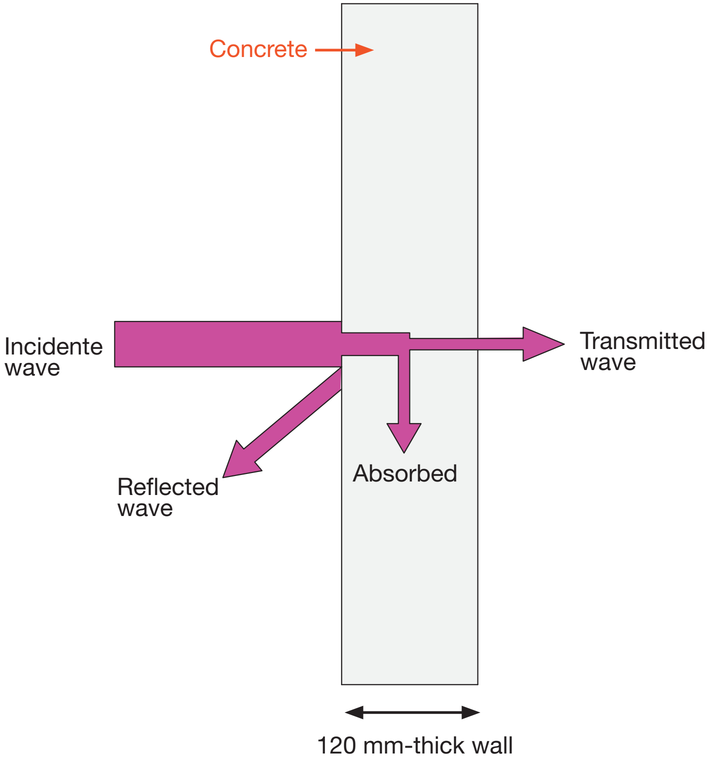
However, increasing the mass of a dividing element is sometimes easier said than done. That explains why the spring-mass system can be used, which involves separating two elements with a material that will act as a spring, such as air or insulation.

Increasing the thickness of the insulation between dividing elements will only affect the building's thermal performance and not its sound performance. Contrary to a popular misconception, increasing thermal insulation will not improve acoustic insulation.

The last solution is to separate the different elements (discontinuous construction). If one element vibrates but not the next, sound will not be transmitted and will stay where it is.

Mass rule: spring-mass system

For a given material, the higher its density, the better its sound insulation performance!



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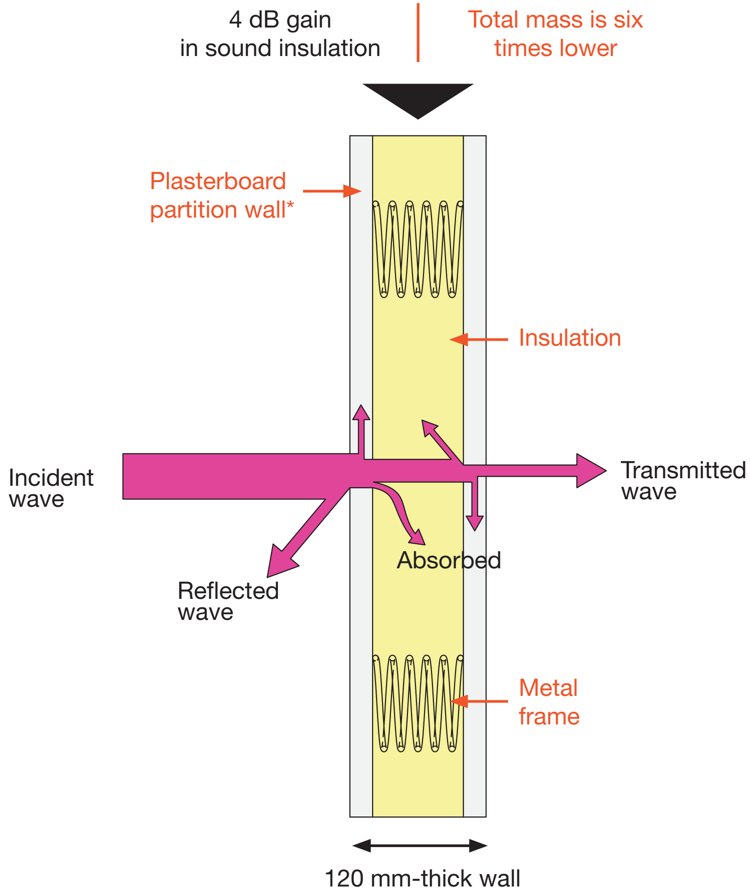
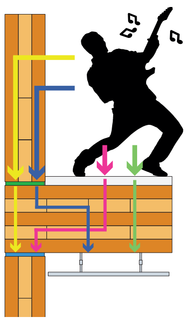
2. Acoustics and buildings



When the incident wave comes into contact with a material, part of the wave is reflected and absorbed, while the rest of the wave is transmitted into the adjacent room.



When it comes to a building's acoustics, the principle is straightforward, i.e. increasing the mass improves performance. One of the advantages with a timber frame building is its lightweight structure (~550 kg/m³ for CLT compared to ~2,200 kg/m³ for concrete), which represents a weakness in its acoustic performance according to the mass law. In this case, a combination of different methods is required to obtain the desired performance levels (insulation, extra mass and discontinuous construction).

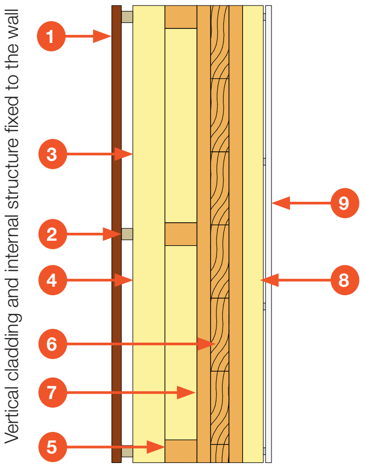
Simpson Strong-Tie offers a number of solutions for discontinuous construction, especially for isolated dividing elements and airtight wall junctions.

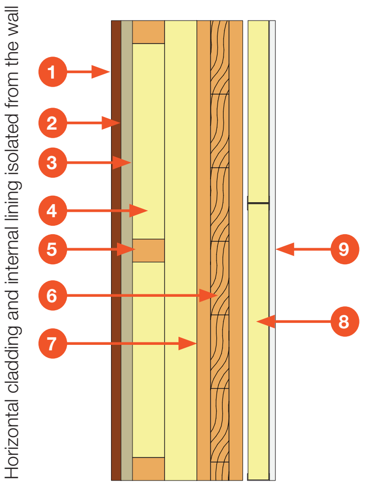
* : 13 mm-thick plasterboard

D - Example of the performance levels with timber walls

The ACOUBOIS study financed by CODIFAB provides the performance for isolated wall linings based on different parameters. The following example calculates the sound reduction index to external noise R_w+C_{tr}.

Front wall made from cross-laminated timber panels (CLT) : [R_w + C_{tr}]base = 39 dB





1. 21 mm timber cladding (tongue and groove)
2. Timber battens creating a cavity of at least 25 mm
3. Breather membrane
4. Double layer of rigid or semi-rigid mineral wool insulation (maximum of 70 mm) fitted between timber studs
5. 70 x 50 mm² timber studwork
6. CLT panel at least 93/94 mm thick (subject to technical approval)
7. Vapour control layer if necessary
8. Metal rails with intermediate supports, incorporating 45 mm mineral wool or bio-based insulation, or
   - Horizontal or vertical timber battens, incorporating 45 mm mineral wool or bio-based insulation: Δ[R_w+C_{tr}] = - 5 dB
   - 48 mm metal studs separated from the timber frame, incorporating 45 mm mineral wool or bio-based insulation: Δ[R_w+C_{tr}] = + 1 dB
9. Wall lining with one layer of plasterboard, or
   - 1 x 13 mm acoustic plasterboard: Δ[R_w+C_{tr}] = + 4 dB
   - 1 x 18 mm plasterboard: Δ[R_w+C_{tr}] = + 4 dB

Three corrections can be combined. The sum will be capped at Δ[Rw+Cr] = + 8 dB

The full ACOUBOIS study is available on the CODIFAB website (https://www.codifab.fr).

This example demonstrates the beneficial effects of:
- A discontinuous structure; separating the studs can improve performance by 1 dB,
- Adding extra mass; using 13 mm acoustic plasterboard (which is heavier) can improve performance by up to 4 dB.

Some designs can achieve even higher increases in performance.

E - Parameters for calculating sound propagation

Internal sound reduction index and impact sound level

Carrying out a study into the building's acoustic performance can provide a clearer understanding of how sound can spread between the building's different rooms.

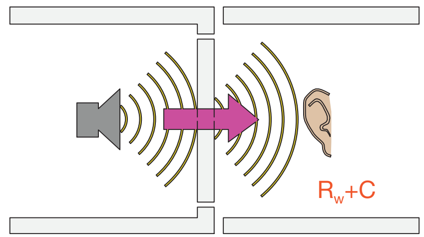
Several parameters have been defined for quantifying acoustic performance. Some parameters are used to assess the acoustic performance of dividing walls, such as the sound reduction index $R_w(C;C_{tr})$, while others evaluate the weighted pressure level of the standardised impact sound $L_{n,w}$.

Some building-specific parameters assess in-situ acoustic performance, namely the weighted standardised level difference $D_{nT,w}(C,C_{tr})$ and the weighted pressure level of the standardised impact sound $L'_{nT,w}$.

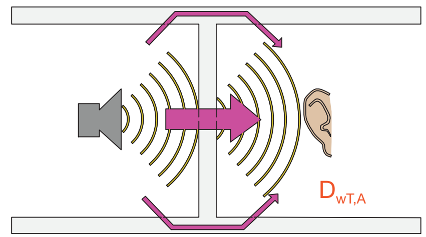
The R_w and $L_{n,w}$ values are used in laboratory tests, where the global level $L_{n,w}$ is calculated according to EN ISO 717-2 from spectrum L_n, and the sound pressure level in dB in the receiving room is measured in the laboratory according to EN ISO 10140-1 and 3.

These laboratory values are different to the field measurements, since the model used for the laboratory measurements cannot replicate the flanking transmission, defects and other differences in the building's construction.

Airborne sound

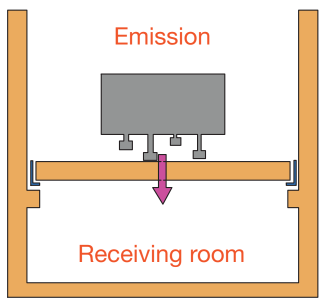


Laboratory

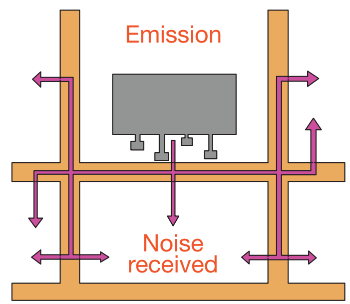


In-situ

Impact sound



Laboratory

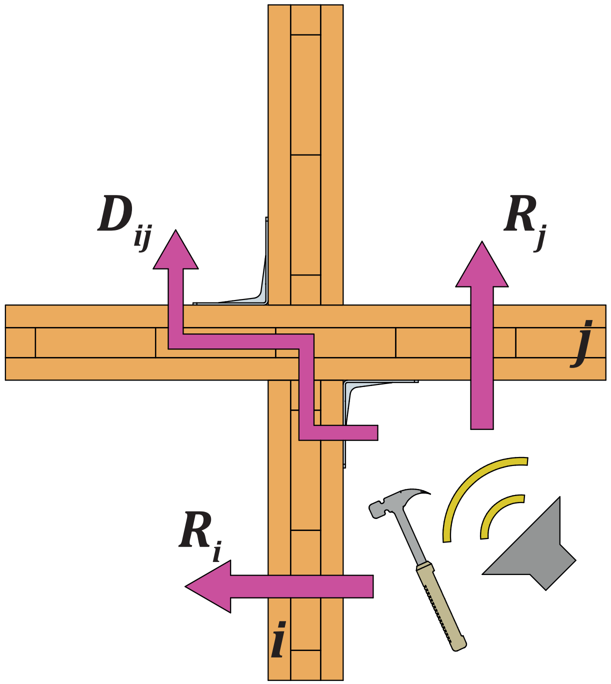


In-situ

Calculating flanking transmission - Gerretsen method (1986) - EN 12354-1

First published in 2000, EN 12354 contains calculation models for estimating the airborne sound insulation between adjacent rooms in buildings. The standard is based on the Gerretsen model and uses measured data that characterise direct or indirect flanking transmission by the participating building elements.

$$R_{ij} = \frac{R_i}{2} + \frac{R_j}{2} + \frac{D_{ij} + D_{ji}}{2} + 10 * \log(\frac{S_0}{\sqrt{S_i * S_j}})$$



R_{ij} is the flanking sound reduction index according to the transmission path from *i* to *j*

R_i and R_j are the sound reduction indices of elements *i* and *j* respectively

D_{ij} and D_{ji} are the vibration reduction factors of paths *i* to *j* and *j* to *i*

S_0 is the reference area, which is equal to 10 m²

S_i and S_j are the surface areas of elements *i* and *j*

The thing that interests us with this calculation method is that it takes account of the path travelled by the sound wave. In a timber frame building, Simpson Strong-Tie connectors are an integral part of the junctions between the different structural elements, meaning that they play a key role in the building's acoustic performance.

EN 12354 offers quantities for expressing the vibration reduction indices between two structural elements *i* and *j* : K_{ij}, which can be found in Chapter 5 of this guide along with the associated Simpson Strong-Tie solutions, as well as in the following equations:

$$D_{v,ij,n} = K_{ij} = \frac{D_{ij} + D_{ji}}{2} + 10 * \log(\frac{l_{ij} * l_0}{\sqrt{S_i * S_j}})$$

$$R_{ij} = \frac{R_i}{2} + \frac{R_j}{2} + K_{ij} + 10 * \log(\frac{S_0}{l_{ij} * l_0})$$

l_{ij} is the common length of the junction between elements *i* and *j*

This allows us to calculate the sound reduction index R_{ij} for each transmission path and thereby determine the apparent sound reduction index R':

$$R' = -10\log(10^{-\frac{R}{10}} + \sum_{ij} 10^{-\frac{R_{ij}}{10}})$$

R is the sound reduction index of the different elements.

The apparent sound reduction index R' lets us calculate the standardised level difference D_{nT}:

$$D_{nT} = R' - 10\log(\frac{V}{6T_0S_s})$$

T_o is the reference reverberation time (equal to 0.5 s)

V is the volume of the receiving room [m³]

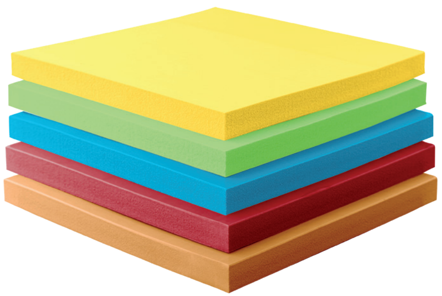
S is the surface area of the element separating the two rooms [m²]

3. Suitable products

3. Suitable products

A - Acoustic isolating strip - SIT

SIT acoustic isolating strips are recommended for CLT buildings that are required to deliver superior acoustic performance. They guarantee acoustic insulation between timber walls and floors. The choice of the strip's density depends on the weight of the wall.



Material

- Polyurethane with a closed cell structure
- Thickness: 6, 12.5 and 25 mm

Advantages

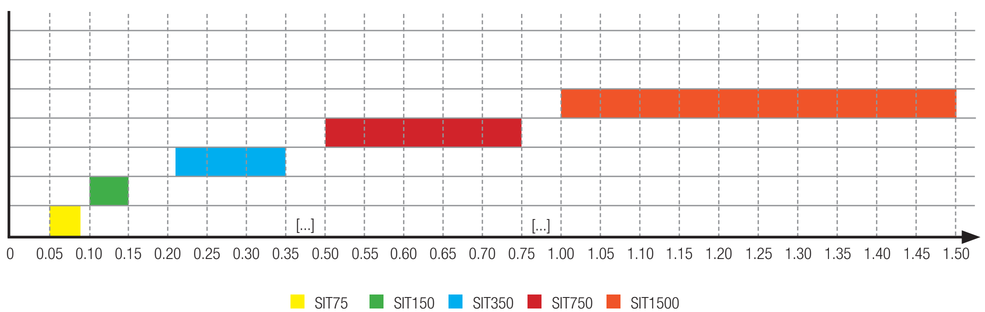
- Available in 2-metre strips; widths can be cut on demand
- Absorbs vibrations
- Can be used in humid environments without any loss of performance or reaction to water
- Estimated service life of 50 years

Mechanical properties

Item code	Colour	Dynamic pressure(1)	Peak pressure(1)	Mechanical loss factor(2)	Static E-modulus(2)	Dynamic E-modulus(2)	Static shear modulus(2)	Dynamic shear modulus(2)
SIT75		0.12	2	0.06	0.63	0.92	0.16	0.27
SIT150		0.25	3	0.03	1.25	1.65	0.22	0.35
SIT350		0.5	4	0.03	2.53	3.25	0.35	0.52
SIT750		1.2	6	0.04	5.21	8.88	0.8	1.22
SIT1500		2	8	0.05	9.21	16.66	1.15	1.69

The values provided in this table are expressed in N/mm².
(1) Values apply for a shape factor of q = 3. (2) Measured at the maximum limit of the static application range.

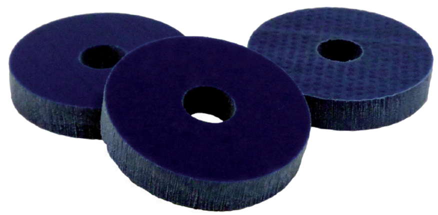
Permissible static loads by type of SIT [N/mm²]



3. Suitable products

B - Acoustic isolating washer - SITW

SITW washers are combined with SIT isolating strips to create a high-performance system in CLT buildings that are required to deliver superior acoustic performance. The isolating washer is fitted between a metal washer and the CLT when assembling with screws, which prevents vibrations from spreading through the fastenings.



Material

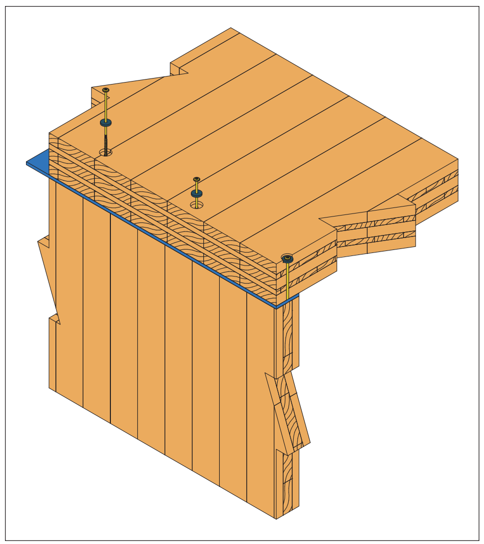
- Polyurethane with a closed cell structure

Advantages

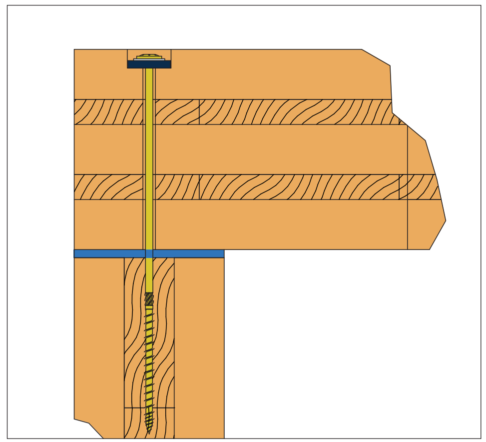
- Reduced sound transfer between structural components
- Improved draught sealing

Dimensions and drill holes

Item code	Screw diameter [mm]	Washer dimensions [mm]				Pilot holes [mm]	
		Inner diameter	Outer diameter	Thickness	Tolerance	Diameter - unthreaded screw section	Washer outer diameter
SITW-M0608	6 or 8	8.5	34	6	0.5	8 ou 10	35
SITW-M1012	10 or 12	12.5	49	6	0.5	12 ou 14	30



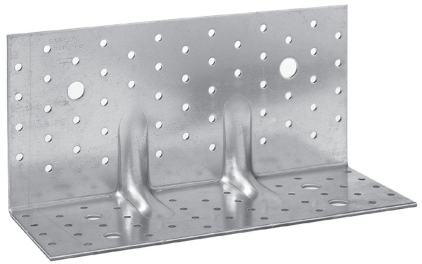
Pilot holes must be drilled in the first CLT panel to avoid transferring vibrations through the unthreaded section of the screw.



3. Suitable products

C - Reinforced angle bracket for CLT - ABR255

The ABR255 reinforced angle bracket has been especially developed for fixing CLT panels to timber or concrete substrates. These highly versatile brackets are particularly resistant to shear loads due to their enhanced geometrical design.



Material

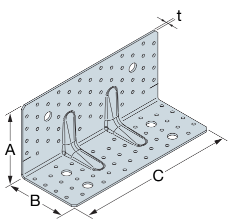
- Galvanised steel S250GD + Z275 according to EN 10346
- Thickness: 3 mm

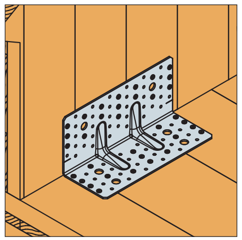
Advantages

- Ideal for use with CLT buildings
- Highly versatile: can be fixed to timber and concrete substrates
- Superior performance for forces in horizontal ($R_{2,k}$/$R_{3,k}$) and vertical directions ($R_{1,k}$)

Dimensions and drill holes

Item code	Dimensions [mm]				Holes Flange A		Holes Flange B	
	A	B	C	t	Ø5	Ø14	Ø5	Ø14
ABR255	120	100	255	3	52	2	41	4





Characteristic values - Timber to timber - Partial nailing

Item code	Fastenings			Characteristic values - C24 graded timber - One bracket [kN]							
	Flange A	Flange B	Type	$R_{1,k}$		$R_{2,k} = R_{3,k}$		$R_{4,k}$		$R_{5,k}$	
	Qty	Qty		4.0 x 50	4.0 x 60	4.0 x 50	4.0 x 60	4.0 x 50	4.0 x 60	4.0 x 50	4.0 x 60
ABR255	24	21	CNA	min (15,6/ kmod^ 0,4 ; 26,2 / kmod)	min (18,1/ kmod^ 0,4 ; 26,2 / kmod)	28.6	31.4	15.9	18.3	10.8/ kmod^ 0.3	min (12.7/ kmod^ 0,3 ; 12.8 / kmod)

3. Suitable products

D - Acoustic angle bracket - ABAI

The ABAI acoustic angle bracket breaks new ground by combining a conventional angle bracket with an acoustic insulating material. It can be used to join CLT wall and floor elements together, while guaranteeing sound insulation with the pre-installed 12 mm strip beneath the bracket.

Material

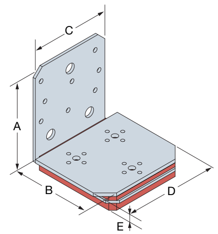
- Galvanised steel S250GD + Z275 according to EN 10346
- Thickness: 3 mm

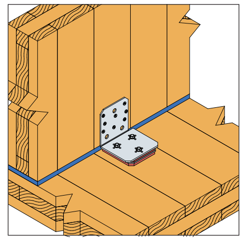
Advantages

- Reduced sound transfer between structural components
- Improved draught sealing
- Fast installation

Dimensions and drill holes

Item code	Dimensions [mm]						Holes Flange A		Holes Flange B
	A	B	C	D	E	t	Ø5	Ø11	Ø7
ABAI105	113	103	90	106	18	3	8	3	3



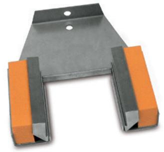


Characteristic values - Timber to timber - Full nailing

Item code	Fastenings				Characteristic values - C24 graded timber - One bracket [kN]			
	Flange A		Flange B		$R_{1,k}$	$R_{2,k} = R_{3,k}$	$R_{4,k}$	$R_{5,k}$
	Qty	Type	Qty	Type				
ABAI105	8	CNA4.0x60	3	SDS25600	7.9/kmod	5.9/kmod	7.3/kmod	5.4/kmod

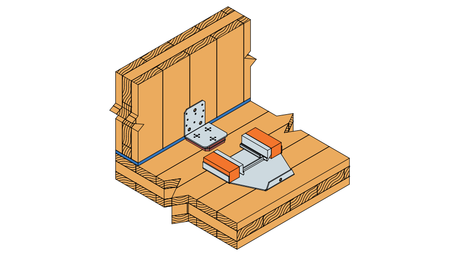
3. Suitable products

E - ABAI mounting template - MOABAI

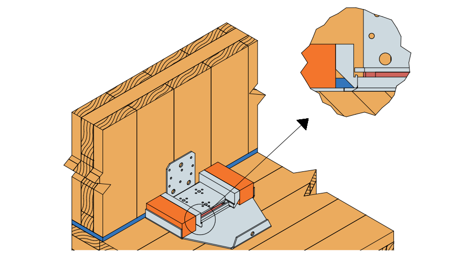


This template is used to fit ABAI acoustic angle brackets. It prevents the acoustic strip from being crushed when fixing the bracket.

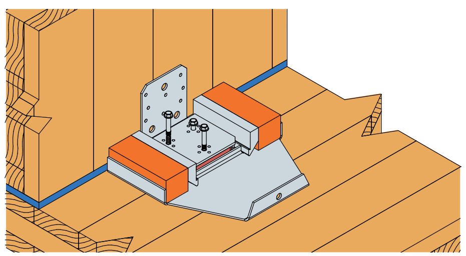
MOABAI MOUNTING TEMPLATE



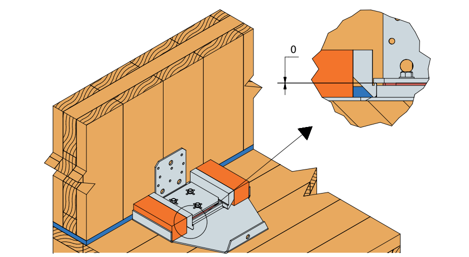
1 Position the ABAI bracket.



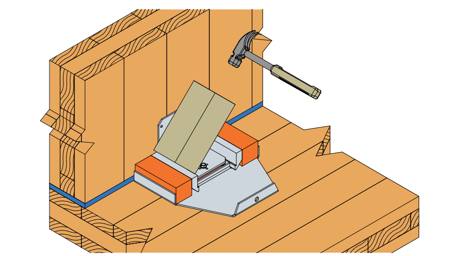
2 Place the MOABAI template beneath the upper plate of the bracket.



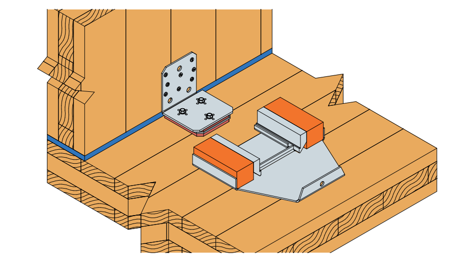
3 Drive in the special screws (SDS25600) using the bit provided...



4 ...until the upper plate of the bracket is touching the edges of the spacer blocks.



5 Remove the spacer blocks by tapping gently with a hammer against a wood block.



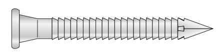
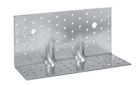
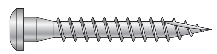
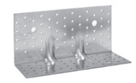
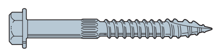
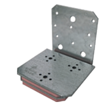
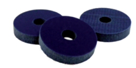
6 Pull the MOABAI template towards you and nail the ABAI bracket to the wall using CNA 4.0x60 connector nails.

Simpson Strong-Tie® - ACOUSTICS & TIMBER - Recommendations guide

3. Suitable products

F - Additional fastenings

Timber-to-timber connections

CNA		CNA annular ring-shank nails are traditionally used for timber-to-timber connections.		p. 22
				p. 23
CSA		CSA screws can be used instead of CNA nails for easier fitting.		p. 22
SDS		SDS structural timber screws are ideal for fitting acoustic angle brackets.		p. 23
ESCR		The ESCR screw is used for a wide range of applications in the timber construction industry.		p. 21

Check out the catalogues for all our solutions at:

strongtie.eu

4. Acoustic solutions

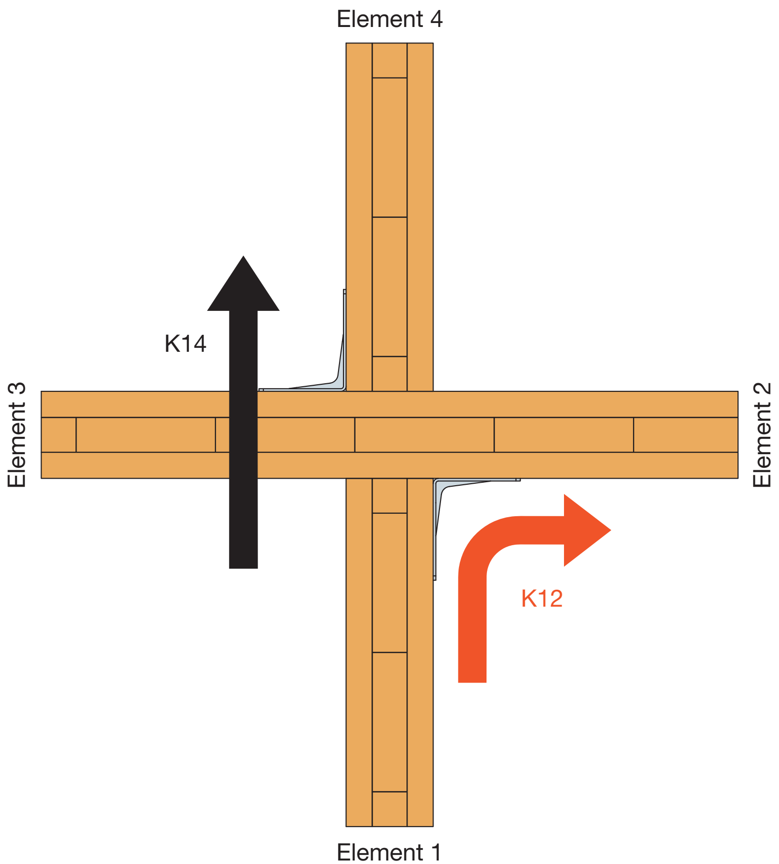
4. Acoustic solutions

A - The different acoustic solutions

The acoustic performance of the Simpson Strong-Tie range of products has been assessed by the BOIS HD laboratory (owned by the ESB Group). The results are available in report BHD18705 (version of 21/10/2019).

The values of the vibration reduction indices K_{ij} have been determined through testing in accordance with EN ISO10848-1:2017 and EN ISO 10848-4:2017, which specify the calculation methods for the vibration reduction index and the test methods respectively.

The configuration for this example shows an X-shaped junction with a dividing floor, and bare floors and walls. Two vibration transmission paths are identified in the following diagram: from element 1 to element 2, which represents the junction between the lower wall and the floor, and from element 1 to element 4, which shows the transmission path between two walls through the floor.

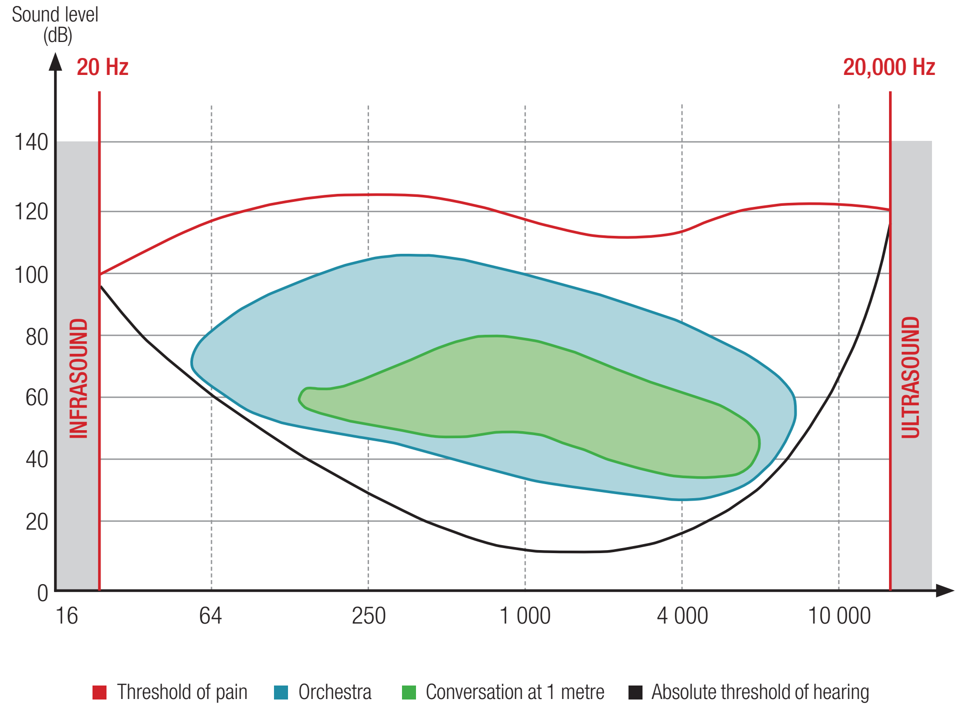


4. Acoustic solutions

To ensure that the results in this guide are easier to understand, we are going to take a closer look at the concept of sound level perception with the associated hearing sensations.

Increasing the sound level by:	Multiplies the sound energy by:	Has the following influence on what we are hearing
3 dB	2	Slight change
5 dB	3	Significant change
10 dB	10	As if the sound were two times louder
20 dB	100	As if the sound were four times louder
50 dB	100,000	As if the sound were thirty times louder

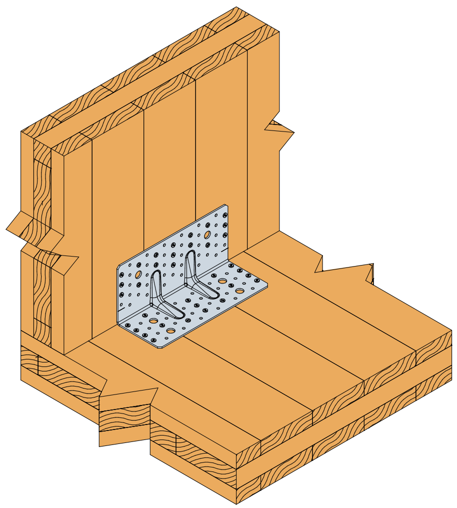
Note that the sensitivity of the human ear to different frequencies also depends on the amplitude of that frequency.



B - Installation without an SIT isolating strip

Fitting an ABR255 bracket without an acoustic strip

The CLT wall and floor are in direct contact. An ABR255 reinforced angle bracket is used to join the two CLT panels. This configuration does not use any acoustic solutions.



Bass frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
40	10.5	13.7
50	11.0	10.9
63	9.6	9.3
80	11.1	16.9
100	11.6	14.4
125	15.1	15.2
160	13.2	14.6

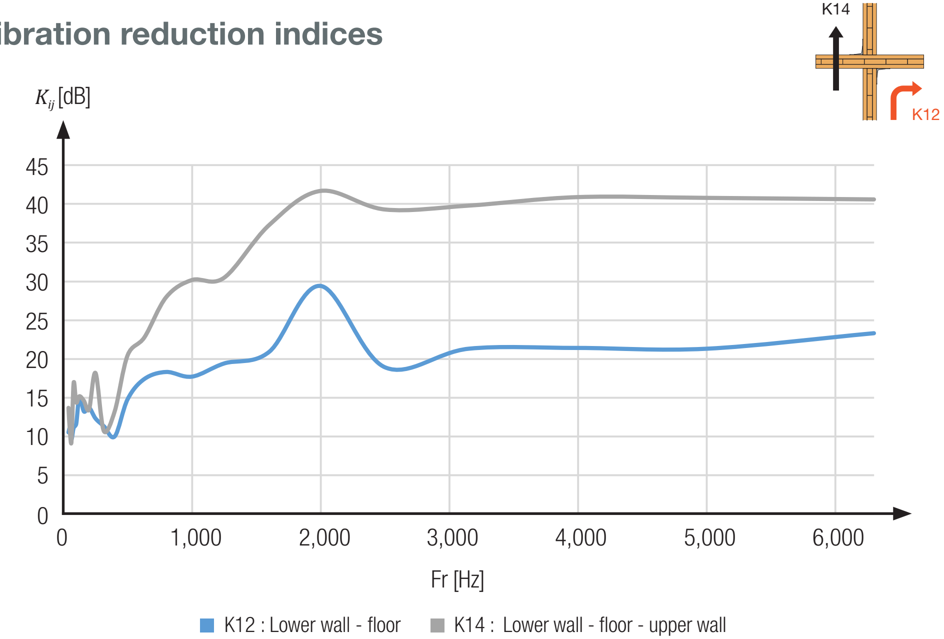
Midrange frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
200	13.7	13.5
250	12.3	18.2
315	11.3	10.7
400	10.0	13.3
500	14.8	20.5
630	17.4	22.8
800	18.3	28.8
1000	17.7	30.2

High frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
1250	19.4	30.5
1600	20.9	37.3
2000	29.4	41.7
2500	18.9	39.3
3150	21.3	39.8
4000	21.4	40.9
5000	21.3	40.8
6300	23.3	40.6

Vibration reduction indices



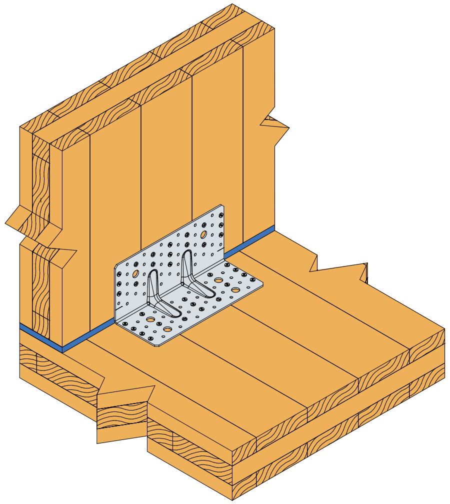
The results obtained for the ABR255 solution alone will be used as a baseline for assessing the acoustic performance of the alternative solutions featured on the following pages. We are going to introduce three quantities to calculate the associated performance gains for bass frequencies (BF), midrange frequencies (MF) and high frequencies (HF):

- $K_{ij,BF}$: arithmetic mean of the K_{ij} values for Fr < 200Hz
- $K_{ij,MF}$: arithmetic mean of the K_{ij} values for 200 Hz < Fr < 1,250Hz
- $K_{ij,HF}$: arithmetic mean of the K_{ij} values for Fr > 1,250 Hz

C - Fitting an SIT isolating strip beneath the wall

Fitting an ABR255 bracket with an acoustic strip between the wall and the floor

The SIT isolating strip is made from polyurethane with a closed cell structure. It is capable of filtering frequencies down to 15 Hz. The type of strip depends on the load to be supported.



Bass frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
40	12.3	22.6
50	14.4	19.0
63	12.4	17.0
80	11.8	10.0
100	11.3	9.1
125	9.3	13.7
160	12.2	13.0

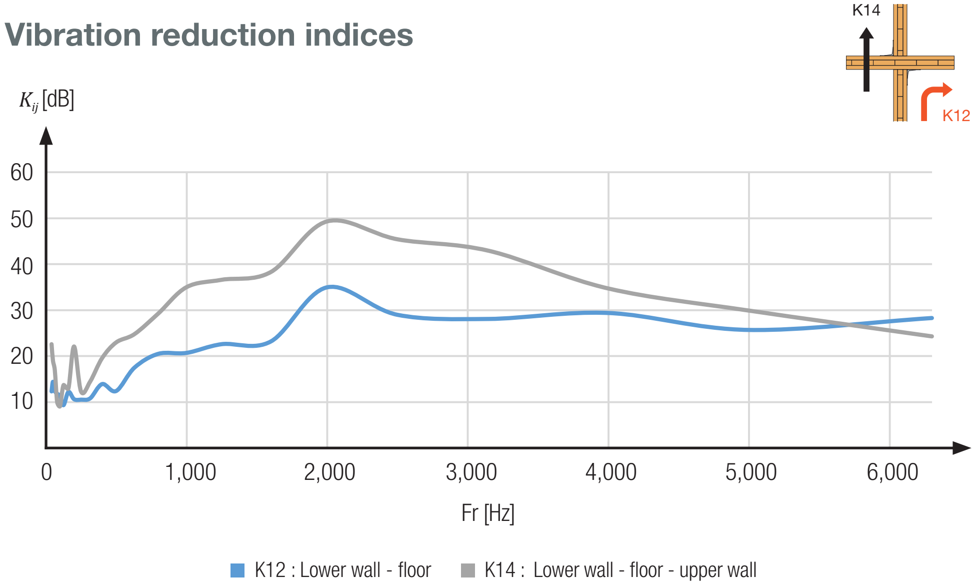
High frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
1250	22.6	36.6
1600	23.2	38.3
2000	35.0	49.3
2500	29.0	45.4
3150	28.1	42.9
4000	29.4	34.7
5000	25.7	29.9
6300	28.3	24.3

Midrange frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
200	10.6	22.1
250	10.5	12.3
315	10.8	14.5
400	13.9	19.6
500	12.4	23.0
630	17.5	24.8
800	20.5	29.3
1000	20.7	35.0

Vibration reduction indices



Calculated gains compared to an ABR255 bracket without an isolating strip

	K12 [dB]	Gain12 [dB]	K14 [dB]	Gain14 [dB]
BF	12.0	0.2	15.0	1.4
MF	14.7	0.2	22.6	2.9
HP	27.7	5.7	37.7	-1.2

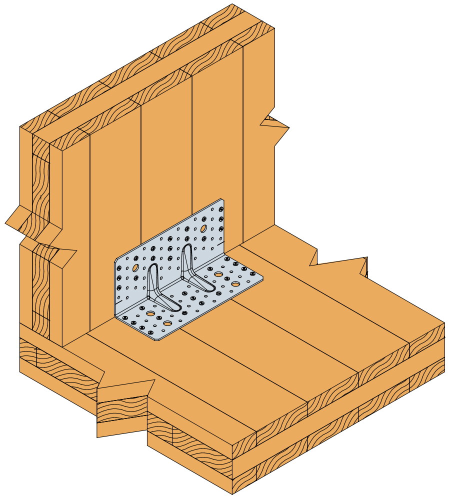
In terms of sound transmission between the wall and floor, the highest gains compared to a bracket without an isolating strip are achieved in the high frequency band. When it comes to sound transmission between levels, the change in hearing perception is barely audible in the midrange frequency band and even inaudible in the low and high frequency bands.

This is the most commonly used solution at construction sites. Acoustic strips are available in two-meter lengths, and the width can be cut on request to fit the CLT walls.

D - Fitting an SIT isolating strip beneath the wall and bracket

Fitting an ABR255 bracket with an acoustic strip beneath the bracket and between the wall and the floor

In addition to separating the CLT wall from the floor, a 6 mm-thick SIT1500 isolating strip is added to separate the connector from the CLT floor. This configuration is covered by European Technical Assessment ETA-06/0106 (nailing pattern 4, CNA 4.0 x 60 nails).



Bass frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
40	12.3	23.2
50	14.5	17.2
63	14.4	15.1
80	12.0	11.5
100	13.9	10.4
125	12.6	12.4
160	14.4	14.9

Midrange frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
200	13.8	21.9
250	11.5	10.0
315	3.9	13.4
400	12.2	13.2
500	11.3	19.1
630	16.7	22.7
800	20.4	27.8
1000	22.1	35.9

High frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
1250	22.2	34.1
1600	24.0	38.7
2000	35.0	41.7
2500	23.0	34.6
3150	31.6	47.0
4000	33.4	43.2
5000	33.5	41.0
6300	32.3	37.5

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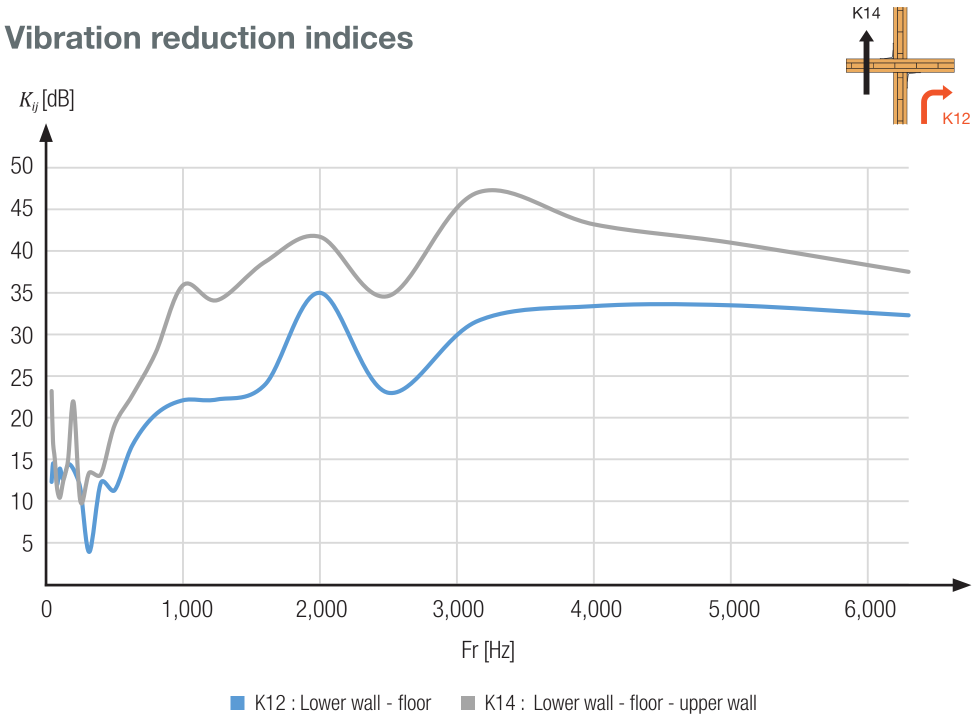
4. Acoustic solutions

Vibration reduction indices



Calculated gains compared to an ABR255 bracket without an isolating strip

	K12 [dB]	Gain12 [dB]	K14 [dB]	Gain14 [dB]
BF	13.5	1.7	15.0	1.4
MF	14.0	-0.5	20.5	0.8
HP	29.4	7.4	39.8	0.9

In terms of sound transmission between the wall and floor, high gains are achieved in the high frequency band. For transmission between levels, there is no significant change in hearing perception compared to a bracket without an isolating strip.

Note: adding an isolating strip beneath the bracket does not change the load-bearing capacities.

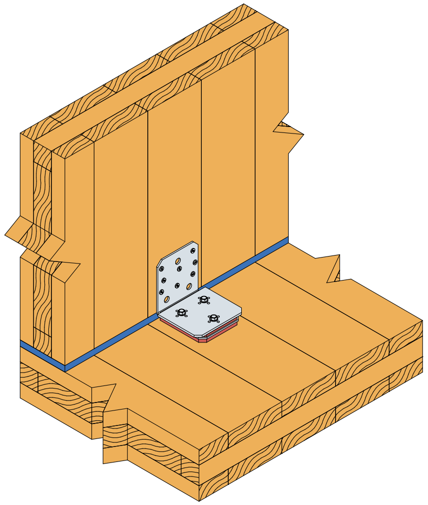
Adding an isolating strip beneath the bracket does not change the stiffness in direction R1.

The stiffness in direction R2 is 15% less when adding an isolating strip beneath the bracket.

E - Fitting an SIT isolating strip beneath the wall with an ABAI angle bracket

Fitting an ABAI105 bracket with an acoustic strip between the wall and the floor

ABAI105 is an acoustic angle bracket developed by Simpson Strong-Tie. This bracket features two anti-vibration layers for the purpose of restricting the transmission of vibrations through the bracket and fastenings.



Bass frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
40	16.6	25.1
50	12.4	16.3
63	14.1	19.9
80	9.7	18.1
100	12.0	11.9
125	7.6	15.6
160	16.2	20.7

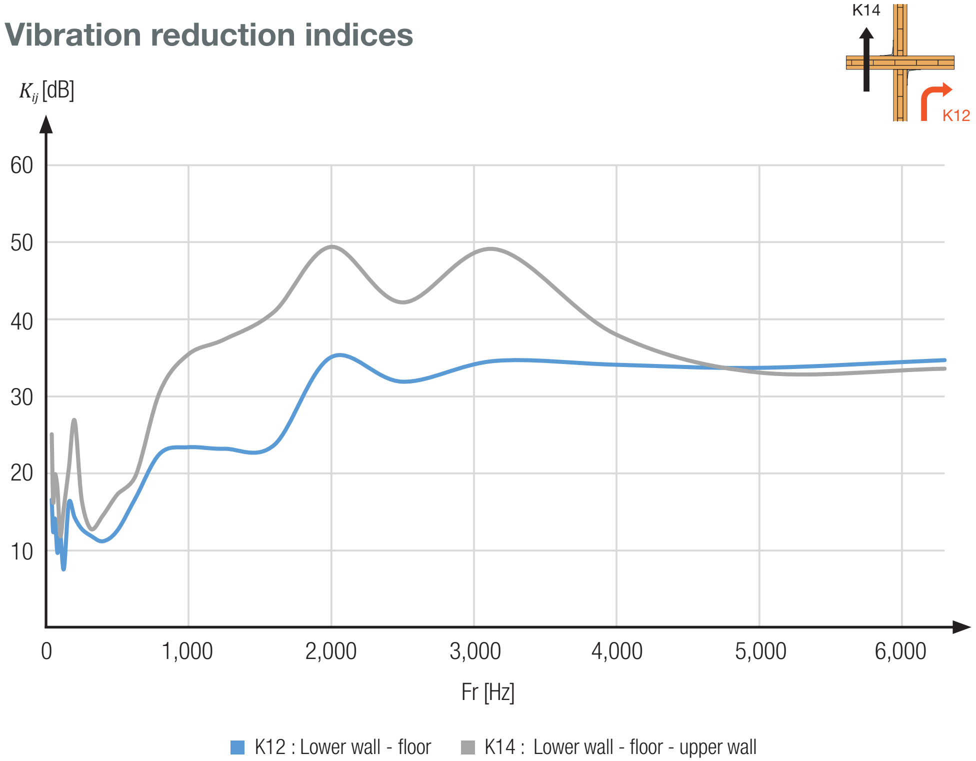
High frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
1250	23.2	37.4
1600	23.7	41.0
2000	35.1	49.4
2500	31.9	42.2
3150	34.6	49.1
4000	34.1	38.0
5000	33.7	33.1
6300	34.7	33.6

Midrange frequencies

Fr [Hz]	K12 [dB]	K14 [dB]
200	14.3	26.9
250	12.8	16.6
315	11.9	12.8
400	11.2	14.6
500	12.6	17.3
630	16.9	19.8
800	22.6	30.7
1000	23.4	35.5

Vibration reduction indices



Calculated gains compared to an ABR255 bracket without an isolating strip

	K12 [dB]	Gain12 [dB]	K14 [dB]	Gain14 [dB]
BF	12.7	0.9	18.3	4.7
MF	15.8	1.3	21.8	2.1
HP	31.4	9.4	40.5	1.6

In terms of sound transmission between the wall and floor, very high gains are achieved in the high frequency band. When it comes to transmission between levels, there is a significant increase in hearing perception for the low-frequency band compared to an ABR255 bracket without an isolating strip.

5. Real-life applications

5. Real-life applications

A - Case study: Gaité Montparnasse

Gaité Montparnasse is an eight-storey building comprising a CLT structure on a concrete core which is being developed as part of plans to modernise the Montparnasse district in Paris. Just a stone's throw from the station of the same name, this new building will feature residential accommodation and a nursery within a property complex including a shopping centre, offices and a hotel. With such a construction project, sound insulation is a major challenge that needs to be taken into account during the design process. That is why a comprehensive acoustic survey was carried out alongside Kraiburg. Simpson Strong-Tie supplied the angle brackets, plates, fastenings and acoustic strips for this project, which is being managed by Eiffage, implemented by Cuiller Frères and designed by construction consultancy Oregon.

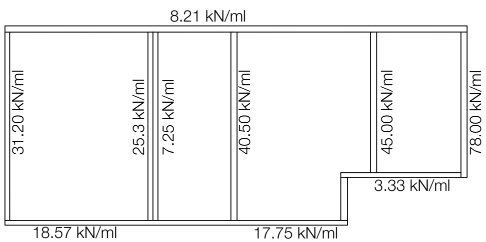
Objective: 15 Hz filter

Design principle

The strips were designed using the permanent loads (G) and working loads (Q), and the following load combination: G+0.3Q.

The resulting linear load was programmed into the Kraiburg software.

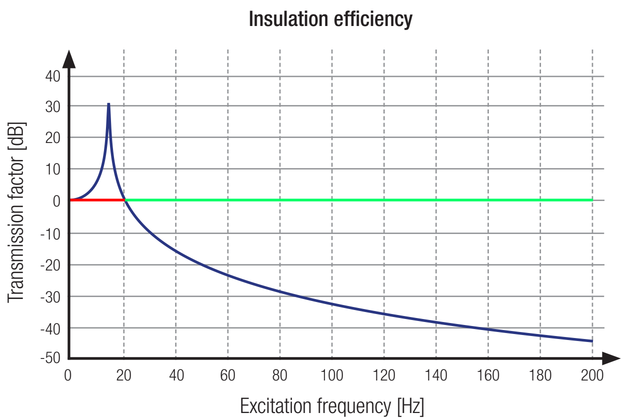
The following diagram is an extract of the building (aerial view) with the corresponding loads.



The example is based on the wall with a 17.75 kN/m load. Once the load is entered, the software specifies a SIT350/60/12.5 isolating strip, meaning a 60 mm-wide strip with a thickness of 12.5 mm.

The calculated performance levels are as follows:

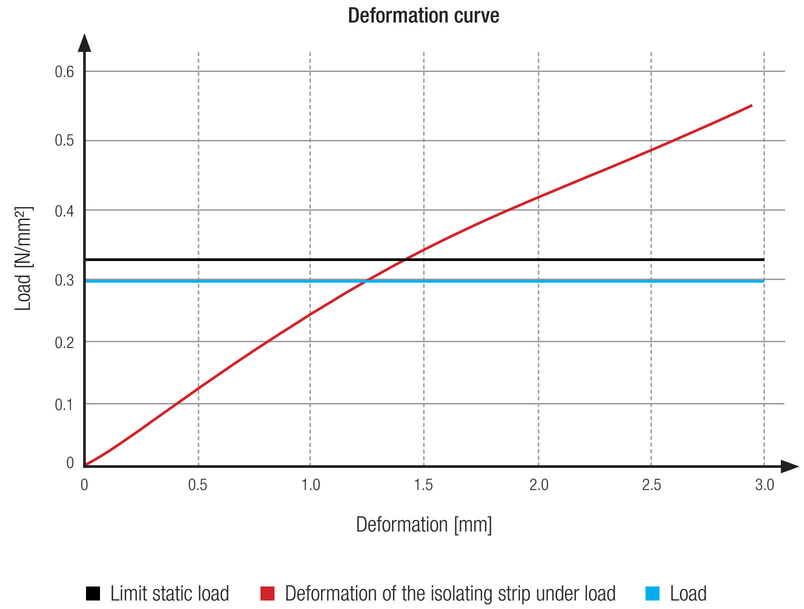
- Working stress ratio 89.5%
- Compression 1.24 mm
- Filter frequency 15 Hz



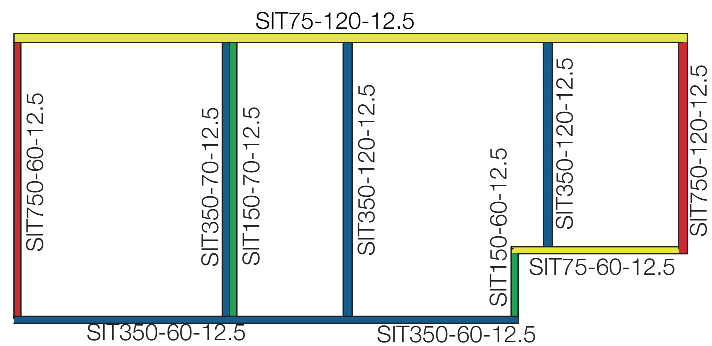
Frequency	Insulation efficiency
4 Hz	0.6 dB / -8 %
5 Hz	1.0 dB / -12 %
6.3 Hz	1.7 dB / -21 %
8 Hz	2.9 dB / -40 %
10 Hz	5.1 dB / -80 %
12.5 Hz	10.3 dB / -226 %
15 Hz	30.5 dB / -3235 %
16 Hz	17.0 dB / -607 %
20 Hz	2.2 dB / -29 %
25 Hz	-5.0 dB / 44 %
31.5 Hz	-10.6 dB / 71 %
40 Hz	-15.7 dB / 84 %
50 Hz	-20.1 dB / 90 %
63 Hz	-24.4 dB / 94 %
80 Hz	-28.7 dB / 96 %
100 Hz	-32.6 dB / 98 %
125 Hz	-36.4 dB / 98 %
160 Hz	-40.6 dB / 99 %
200 Hz	-44.3 dB / 99 %

5. Real-life applications

Compression is an important factor. In addition to the filter frequency, steps must be taken to ensure that there is no load-induced differential movement between the different walls. If necessary, the type of isolating strip may need to be modified on site to reduce deformation under load.



The calculation is then used for the rest of the building to produce the installation diagrams, such as shown below:

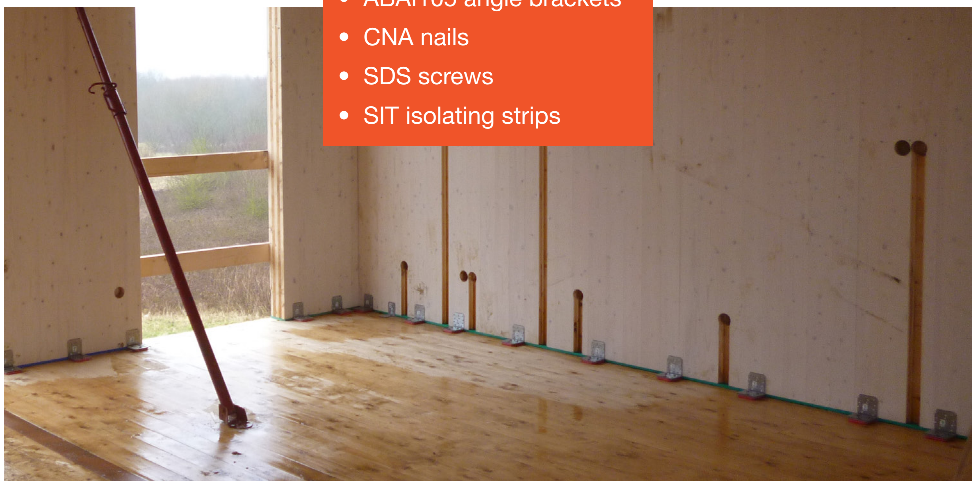


B - Construction of a rental apartment building in Belgium

100% CLT structure

Simpson Strong-Tie products and supplies:

- ABAI105 angle brackets
- CNA nails
- SDS screws
- SIT isolating strips



Laminated Timber Solutions

C - Construction of a rental apartment building in the UK

Mixed structure: timber and CLT frame

Simpson Strong-Tie products and supplies:

Isolating strips

5. Real-life applications

D - Construction of a university hall of residence in France

Mixed structure: timber and CLT frame

Simpson Strong-Tie products and supplies:

- Structural screws and brackets
- Timber panel anchors
- SIT isolating strips
- Wall plugs
- Perforated plates

Denis Aubineau

5. Real-life applications

E - Construction of a mixed-use property in France

Mixed structure: Concrete core + CLT floors and walls

Simpson Strong-Tie products and supplies:

- Structural screws and brackets
- SIT isolating strips
- Perforated plates

Cuiller Frères

6. Reference documents

Simpson Strong-Tie uses applicable standards for support and guidance when developing each of its products. The reference documents used for this guide are listed below.

Regulations

Regulation of 30 June 1999 for the Housing and Construction Code, Article R.111-4, relating to the Regulation of 30 May 1996.

Standards

EN ISO 717-2:2013: Acoustics - Rating of sound insulation in buildings and of building elements - Part 2: Impact sound insulation.

EN ISO 10140-1:2016: Acoustics - Laboratory measurement of sound insulation of building elements - Part 1: Application rules for specific products.

EN ISO 10140-3:2013: Acoustics - Laboratory measurement of sound insulation of building elements - Part 3: Measurement of impact sound insulation.

EN 12354-1: 2017: Building acoustics - Estimation of acoustic performance of buildings from the performance of elements - Part 1: Airborne sound insulation between rooms.

EN ISO 10848-1:2017: Acoustics - Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms - Part 1: Frame document.

EN ISO 10848-4:2017: Acoustics - Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms - Part 4: Application to junctions with at least one Type A element.

Additional studies

Acoubois report (https://www.codifab.fr/actions-collectives/bois/acoubois-performance-acoustique-des-constructions-ossature-bois-1310): French study comparing different timber wall designs (timber frame buildings and CLT), specifying their performance levels and the influence of change on those levels.

https://www.dataholz.eu/en.htm: website (English and German) showing the acoustic performance levels (also fire and other parameters) for different wall designs.

Deckenkonstruktionen für den mehrgeschossigen Holzbau: document published by the Austrian Institute of Timber Engineering and Wood Technology, specifying combinations of vertical and horizontal dividing elements and their associated performance levels: https://www.irbnet.de/daten/rswb/15049000686.pdf

7. Glossary

Amplitude: characterises the extent of the variations in a given quantity. In acoustics, amplitude refers to the variations in pressure of the sound wave.

Decibel: a unit defined as being 10 times the logarithm in base 10 of the ratio between two powers [dB].

Discontinuous construction: a technique that involves insulating or separating elements to prevent the transmission of vibrations between those elements.

Filter frequency: the critical frequency where vibrations are the most amplified. In a building, this frequency needs to be outside the audible frequency scale.

Flanking transmission: sound that is transmitted through the elements that are adjacent to the element separating two rooms (walls, ceiling or floor).

Frequency: the number of oscillations of a repeating event per unit of time, expressed in hertz [Hz].

Gain: used to quantify the advantage that one system has over another.

Incident wave: a sound wave that comes into contact with the dividing element.

Noise pollution: the concept of what constitutes noise pollution is subjective and represents the way that we perceive the sounds around us. Noise pollution does not have any effect on our hearing acuity, but on our quality of life (fatigue, stress, etc.).

Pressure: the force exerted by a fluid per unit area, expressed in pascals [Pa].

Reverberation: the persistence of a sound in a room after the sound source has been stopped.

Sound: a wave that propagates through a transmission medium by causing the molecules to vibrate.

Sound reduction index: characterises the extent to which a physical quantity is reduced when passing through a material. In acoustics, it refers to the amount of sound that is stopped by a material or product.

Vibration reduction factor: the ability of a junction to attenuate the vibrations passing through it.

Notes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in France and
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