FLANKSOUND

EN ISO 10848

ALADIN

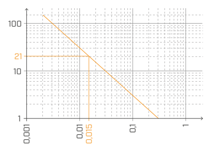
RESILIENT SOUNDPROOFING PROFILE

CODES AND DIMENSIONS

CODE	version	B [mm]	L [m]	s [mm]	pcs
ALADIN115	EXTRA SOFT	115	50	7	1
ALADIN95	SOFT	95	50	5	1

PRODUCT COMPARISON

	acoustic load [N/mm2] (scale 0 – 1)
ALADIN EXTRA SOFT	0,035 – 0,157
ALADIN SOFT	0,189 – 0,316



Anti-vibration

ALADIN dampens vibrations due to its ability to absorb and dissipate the energy of the system

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FLANKSOUND PROJECT

K_{ij} measured according to ISO EN 10848

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On site measurements

effectiveness verified through the measurement of passive acoustic requirements in constructed buildings

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Static to acoustic interaction

Experimental data on the static performance of a timber-to-steel connection with ALADIN interposed

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PRODUCT CHOICE AND DETERMINATION OF K_{IJ}

DESIGNING THE CORRECT PROFILE ACCORDING TO THE LOAD

Resilient profiles must be correctly loaded in order to isolate the low to medium frequencies of structurally transmitted vibrations: guidance on how to proceed with the evaluation of the product are given below.

It is advisable to add the permanent load value at 50% of the characteristic value of the accidental load.

$$Q_{linear} = q_{gk} + 0,5\ q_{vk}$$

It is necessary to focus on the operating conditions and not the ultimate limit state conditions. This is because the goal is to insulate the building from noise during normal operating conditions and not during design limit states.

PRODUCT SELECTION

The product can also be selected using the application tables (see for example the following table for ALADIN EXTRA SOFT).

TABLE OF USE[1]

CODE	B [mm]	B [in]	load for acoustic optimisation[2] [kN/m] from	[lbf/ft] from	[kN/m] a	[lbf/ft] a	compression for acoustic optimisation[2] [N/mm²] [psi] from	a	reduction [mm] [mil] from	a
ALADIN115	115	4 1/2	4	2969	18	13317	0,035 5.1	0,157 22.8	0,7 28	2 79
	57,5 (divided)	2 1/4	2	1484	9	6658				

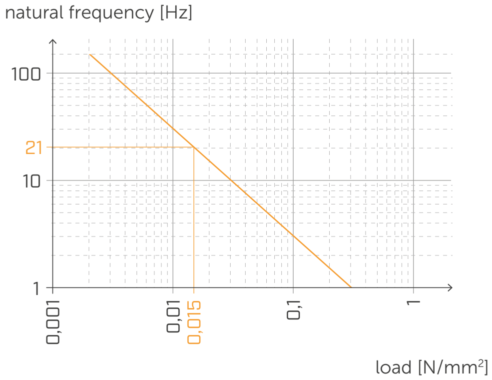
To properly evaluate the product using MyProject, simply follow the step-by-step instructions provided by the software.

Note: The static behaviour of the material in compression is evaluated, considering that the deformations due to the loads are static. This is because a building is not affected by significant movement phenomena, nor dynamic deformation.
Rothoblaas has chosen to define a load range that allows good acoustic performance and avoids excessive deformation and differential movements in the materials, including the building's final architectural finishes. It is possible to use profiles with loads outside the indicated range if the resonance frequency of the system and the deformation of the profile at the ultimate limit state are assessed.

DETERMINATION OF PERFORMANCE

Once the loads have been identified, it is necessary to determine the design frequency - that is the stimulating frequency for the element from which the structure needs to be isolated. Below is an example, to make the explanation easier and simple to understand.

Suppose there is a load of 0,015 N/mm² acting on the profile. In this case, we used the ALADIN EXTRA SOFT product, because the load is not particularly high. Reading the graph, it can be seen that the profile has a resonance frequency of around 21 Hz.

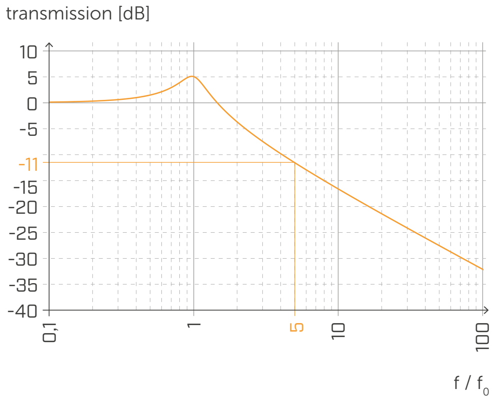


At this point, the degree of transmission for the product under these load conditions can be calculated, referring to the design frequency of 100 Hz.

$$\text{transmission} = f/f_0 = 5$$

Then the transmission graph is used, placing the value 5 obtained on the x-axis and intersecting the degree of the transmission curve.
It follows that the transmission of the material is negative i.e. that the material is able to insulate around -11 dB.

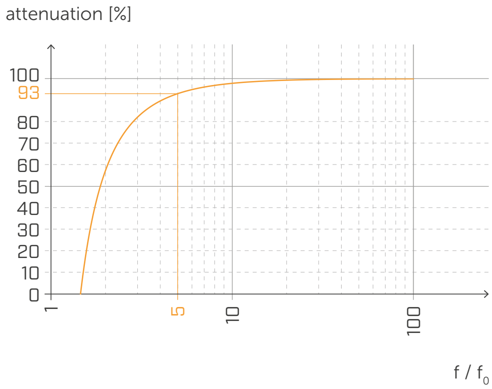
TRANSMISSION IS POSITIVE WHEN THE MATERIAL TRANSMITS AND IS NEGATIVE WHEN THE PROFILE BEGINS TO INSULATE. This means this figure shows that the product, loaded in this way, insulates 11 dB at a reference frequency of 100 Hz.



The same thing can be done using the attenuation graph. The percentage of vibration attenuated at the initial design frequency is obtained.
The attenuation is also calculated with the load conditions referring to the design frequency of 100 Hz.

$$\text{attenuation} = f/f_0 = 5$$

The graph is used by placing the calculated value of 5 on the x-axis and intersecting the attenuation curve.
It follows that the material's attenuation is optimal, i.e., the material can isolate more than 93 % of the transmission.



Essentially, the same result is obtained with two different inputs, but when deformation is set, the starting point is the mechanical performance, not the acoustic one.
In the light of this fact, Rothoblaas always recommends starting with the design frequency and the loads to optimise the material based on the real conditions.

ALADIN EXTRA SOFT

TABLE OF USE

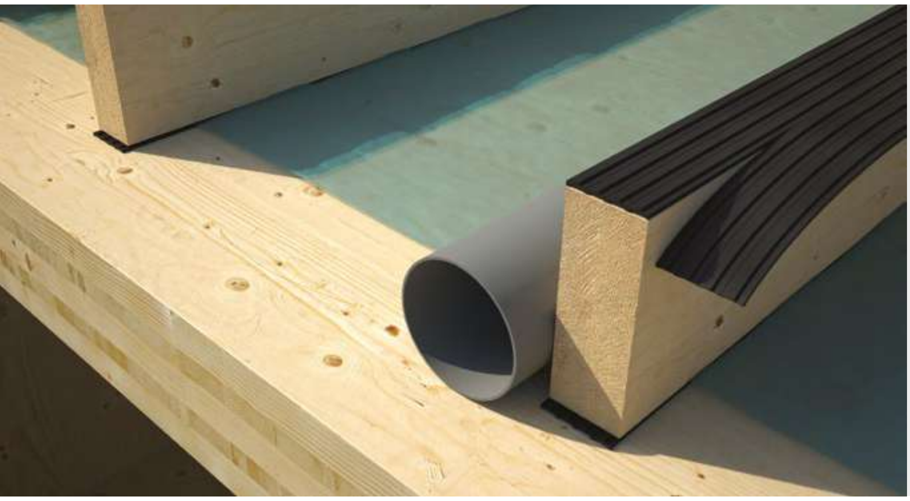
CODE	B [mm]	load for acoustic optimisation[1] [kN/m]		compression for acoustic optimisation[1] [N/mm^2]		deformation [mm]	
		from	to	from	to	from	to
ALADIN115	115	4	18	0,035	0,157	0,7	2
	57,5 (divided)	2	9				

[1]Resilient profiles must be properly loaded in order to isolate medium/low frequency vibrations transmitted structurally. It is advisable to assess the load according to the operating conditions because the building must be acoustically insulated under everyday load conditions (add the value of the permanent load to 50 per cent of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0{,}5\ q_{vk}$).

TECHNICAL DATA

Properties	standard	value
Acoustic improvement $\Delta L'_{nT,w}$	ISO 10848	4 dB
Dynamic stiffness s' (airtight condition)[2]	UNI 29052	76 MN/m^3
Dynamic stiffness s' (non-airtight condition)[2]	UNI 29052	23 MN/m^3
Density	ASTM D 297	0,50 g/cm^3
Compression set 50% (22h, 23°C)	EN ISO 815	≤ 25%
Compression set 50% (22h, 40°C)	EN ISO 815	≤ 35%
Water absorption 48h	-	3%
Reaction to fire	EN 13501-1	class E
Max processing temperature	-	100°C

[2]ISO standards require for measurement with loads between 0.4 and 4 kPa and not with the product operating load. The contribution of air is not calculated because the product is extremely impermeable to air (extremely high flow resistance figures).

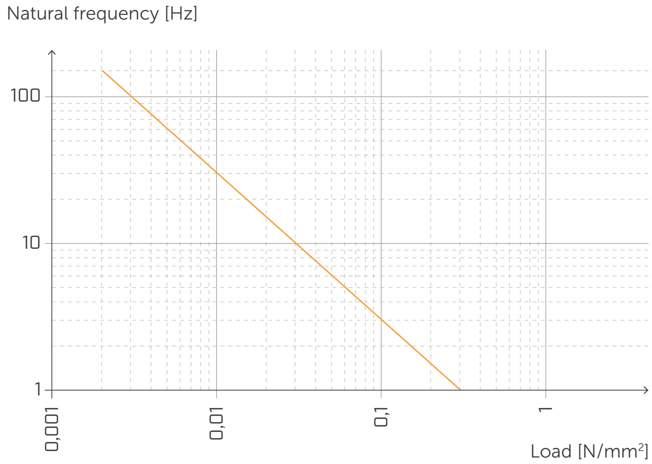


HIGH PERFORMANCE

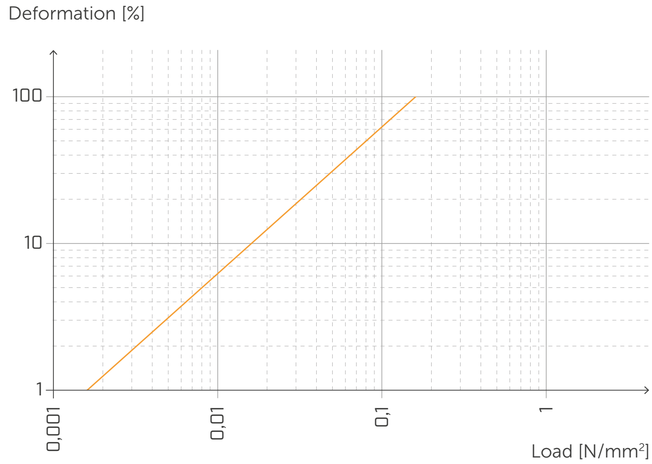
Soundproofing up to 4 dB in accordance with EN ISO 140-7, thanks to the innovative composition of the mixture; reduced application thickness.

STATIC LOAD
(buildings)

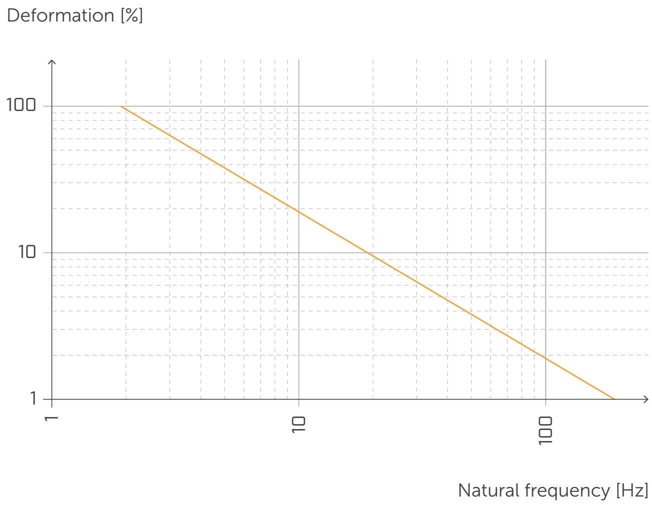
NATURAL FREQUENCY AND LOAD



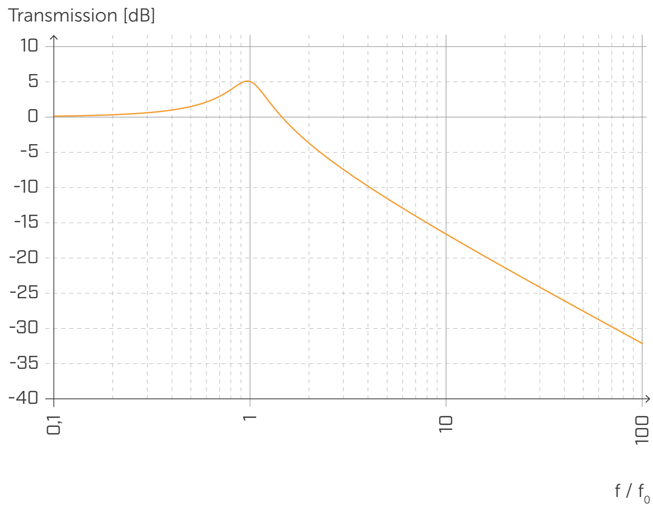
DEFORMATION AND LOAD



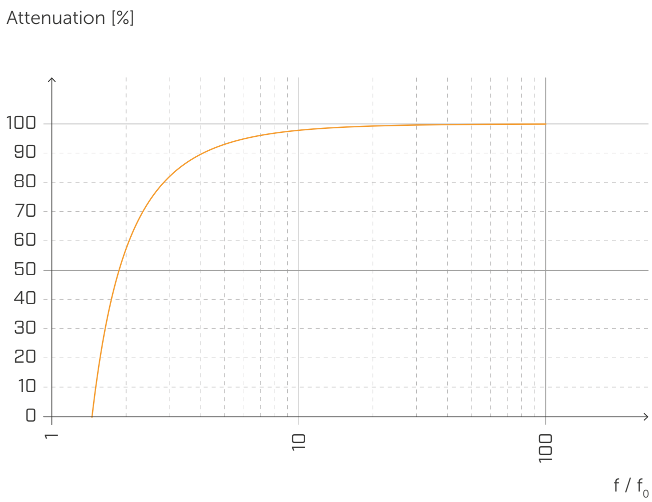
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 20 Hz.

ALADIN SOFT

TABLE OF USE

CODE	B	load for acoustic optimisation[1] [kN/m]		compression for acoustic optimisation[1] [N/mm²]		deformation [mm]	
	[mm]	from	to	from	to	from	to
ALADIN95	95	18	30	0,189	0,316	0,5	1,5
	47,5 (divided)	9	15				

[1] Resilient profiles must be properly loaded in order to isolate medium/low frequency vibrations transmitted structurally. It is advisable to assess the load according to the operating conditions because the building must be acoustically insulated under everyday load conditions (add the value of the permanent load to 50 per cent of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0,5\ q_{vk}$).

TECHNICAL DATA

Properties	standard	value
Acoustic improvement $\Delta L'_{nT,w}$	ISO 10848	3 dB
Dynamic stiffness s' (airtight condition)[2]	UNI 29052	221 MN/m^3
Dynamic stiffness s' (non-airtight condition)[2]	UNI 29052	115 MN/m^3
Density	ASTM D 297	1,1 g/cm^3
Compression set 50% (22h, 70°C)	EN ISO 815	50%
Tensile strength	EN ISO 37	≥ 9 N/mm^2
Elongation at failure	EN ISO 37	≥ 500%
Water absorption 48h	-	< 1 %
Reaction to fire	EN 13501-1	class E
Max processing temperature	-	100°C

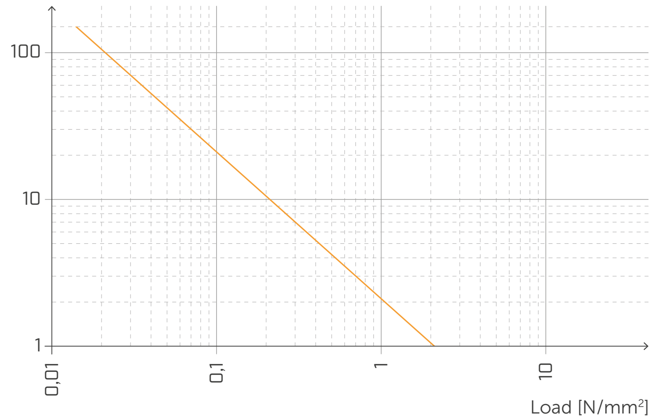
[2] ISO standards require for measurement with loads between 0,4 and 4 kPa and not with the product operating load. The contribution of air is not calculated because the product is extremely impermeable to air (extremely high flow resistance figures).

RELIABLE

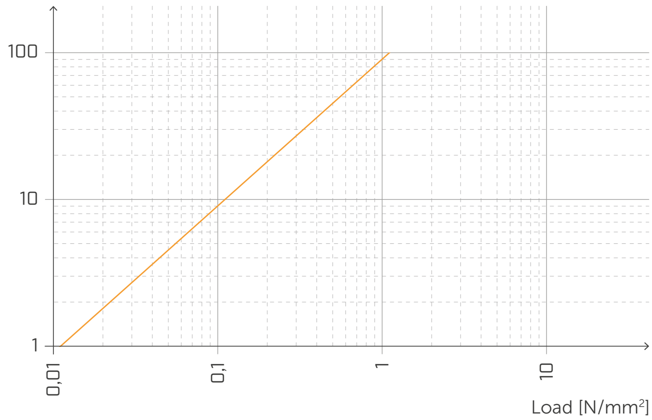
Extruded EPDM compound to optimise sound absorption. It also offers high chemical stability and is VOC-frees.

STATIC LOAD
(buildings)

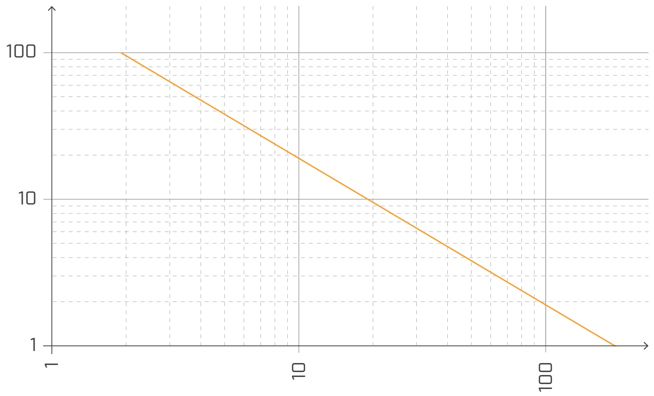
NATURAL FREQUENCY AND LOAD



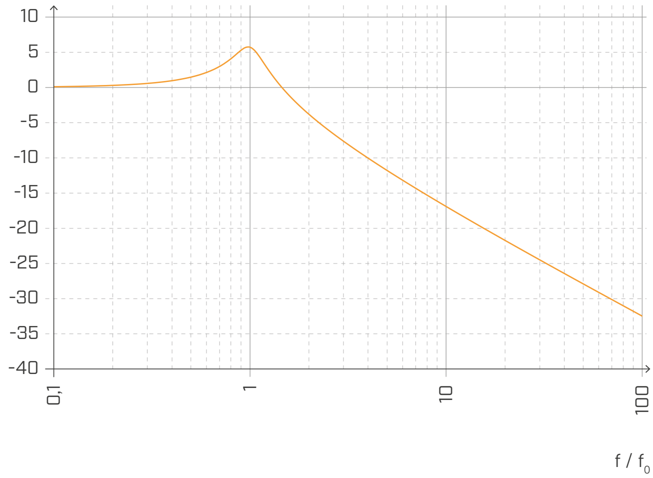
DEFORMATION AND LOAD



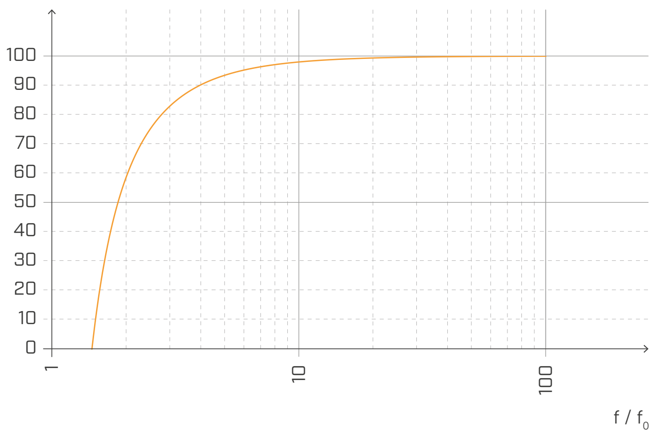
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 20 Hz.

THE CEN MODEL (EN ISO 12354)

The CEN model proposed in the EN ISO 12354 series of standards provides a powerful tool to predict the acoustic performance of a partition from the characteristics of the construction elements. The EN ISO 12354 series has been expanded to provide more specific information regarding timber frame and CLT structures.

EN ISO 12354-1:2017
Airborne sound insulation between rooms.

EN ISO 12354-2:2017
Impact sound soundproofing between rooms.

APPARENT SOUND REDUCTION INDEX

EN ISO 12354 norms provide two methods to calculate the acoustic performance of a partition: a detailed method and the simplified method. When using the simplified calculation model, disregarding the presence of small penetrations and airborne transmission paths $D_{n,j,w}$, the apparent sound reduction index R'_w can be calculated as the logarithmic sum of the direct component $R_{Dd,w}$ and the flanking transmission components $R_{ij,w}$.

$$R'_w = -10\log\left[10^{-\frac{R_{Dd,w}}{10}} + \sum_{i,j=1}^{n} 10^{-\frac{R_{ij,w}}{10}} + \frac{A_0}{S_s}\sum_{j=1}^{n} 10^{-\frac{D_{n,j,w}}{10}}\right] (dB)$$

The sound reduction index for flanking transmission paths $R_{ij,w}$ can be estimated as:

$$R_{ij,w} = \frac{R_{i,w}+R_{j,w}}{2} + \Delta R_{ij,w} + K_{ij} + 10\log\frac{S}{l_0 l_{ij}} \ (dB)$$

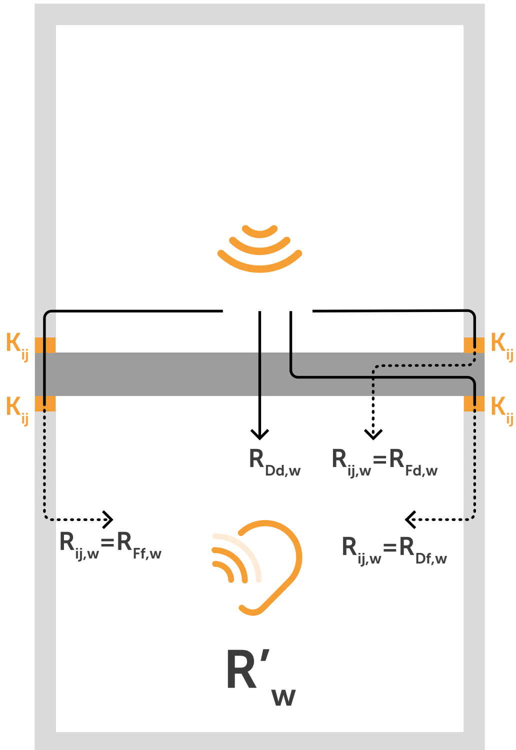
where:

$R_{i,w}$ e $R_{j,w}$ are sound reduction evaluation indices of flanking elements i and j respectively;

ΔR_i, ΔR_j are sound reduction index increases due to the installation of architectural finishes for element i in the source environment and/or element j in the receiving environment;

K_{ij} vibration reduction index through the joint

S is the area of the separating element and l_{ij} is the length of the joint between the separating wall and the flanking elements i and j, l_0 being a reference length of 1 m.



Among the input parameters required by the calculation model, the sound reduction indices can be obtained from accredited laboratory measurements or from the manufacturers of construction elements. Additionally, a number of open-access databases offer data for frequently used construction solutions. The ΔR_w can be estimated by modelling the wall assembly in terms of a mass-spring-mass system (EN ISO 12354 Annex D).

The most critical parameter to estimate is the **VIBRATION REDUCTION INDEX** K_{ij}. This quantity represents the vibration energy dissipating into the junction, and is associated with the structural coupling of the elements. High values of K_{ij} generate the best junction performance. Standard EN ISO 12354 provides some predictive estimates of two standard T and X-shaped joints for CLT structures, which are shown on the right, but the experimental data available is still limited. This is why Rothoblaas has invested in several measurement campaigns to provide usable data with this calculation model.

ASTM & K_{ij}

The ASTM standards currently do not provide a predictive model for the evaluation of flanking sound transmission, so the ISO 12354 and ISO 10848 standards are used and "translated" into the ASTM metric.

$$STC_{ij} = \frac{STC_i}{2} + \frac{STC_j}{2} + \boldsymbol{K_{ij}} + max(\Delta STC_i, \Delta STC_j) + \frac{min(\Delta STC_i, \Delta STC_j)}{2} + 10log\frac{S_S}{l_0 l_{ij}}$$

DETERMINING THE VIBRATION REDUCTION INDEX K_{IJ} IN TIMBER STRUCTURES

INCORPORATING OF RESILIENT LAYERS LIKE XYLOFON, PIANO, CORK AND ALADIN

The MyProject software can be used during design, or follow one of the methods below, extrapolated from internationally valid standards.

METHOD 1 BASED ON EN ISO 12354:2017 FOR HOMOGENEOUS STRUCTURES

Typically, this formula has been considered for lightweight wood structures, i.e. considering the connections between elements, which are considered rigid and homogeneous. For CLT structures this is certainly an approximation.

K_{ij} depends on the shape of the junction and the type of elements composing it, especially their surface mass. In case of T- or X-joints, use the following expressions, shown aside.

For both cases:

$$K_{ij} = K_{ijrigid} + \Delta L$$

if the flanking transmission path passes through a junction

$$K_{ij} = K_{ijrigid} + 2\Delta L$$

if the flanking transmission path passes through two joints

$$M=10\log(mi_{\perp}/mi)$$

where:

$mi_{\perp}$ is the mass of one of the elements, the one placed perpendicular to the other.

Therefore, the transmitted vibration reduction value is:

$$\Delta Lw = 10\log(1/ft)$$

for loads exceeding 750 kN/m² on a resilient layer with ΔL_{min} = 5 dB

$$f_t = ((G/t_i)(\sqrt{\rho_1\,\rho_2}))^{1,5}$$

where:

G is the Young tangential module (MN/m²)

t_i is the thickness of the resilient material (m)

ρ_1 and ρ_2 are, respectively, the density of connected elements 1 and 2

METHOD 2 F.3 EMPIRICAL DATA FOR JUNCTIONS CHARACTERIZED BY K_{ij} ISO 12354-1:2017

CLT construction elements are elements in which the structural reverberation time is, in most cases, mainly

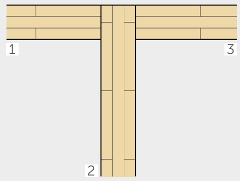
determined by the connecting elements.
In the case of CLT structures weakly bound together, the side transmission contribution can be determined according to the following relations, valid if $0,5 < (m_1/m_2) < 2$.

METHOD 1 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

K_{13}= 5,7 + 14,1 M + 5,7 M² dB

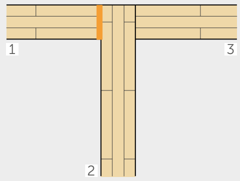
K_{12}= 5,7 + 5,7 M² = K_{23} dB



Solution 2 - T-SHAPED JOINT with resilient layer

K_{23}= 5,7 + 14,1 M + 5,7 M² dB

K_{12}= 5,7 + 5,7 M² = K_{23} dB



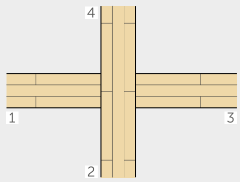
Solution 3 - X-SHAPED JOINT

K_{13}= 8,7 + 17,1 M + 5,7 M² dB

K_{12}= 8,7 + 5,7 M² = K_{23} dB

K_{24}= 3,7 + 14,1 M + 5,7 M² dB

$0 \leq K_{24} \leq -4$ dB



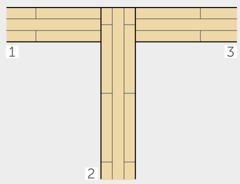
METHOD 2 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

K_{13}= 22 + 3,3log(f/f_k)

f_k=500 Hz

K_{23}= 15 + 3,3log(f/f_k)



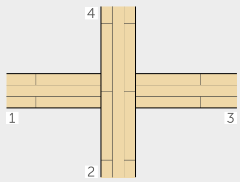
Solution 1 - X-SHAPED JOINT

K_{13}= 10 - 3,3log(f/f_k) + 10 M

K_{24}= 23 - 3,3log(f/f_k)

f_k=500 Hz

K_{14}= 18 - 3,3log(f/f_k)



THE SIMPLIFIED METHOD

A CALCULATION EXAMPLE USING EN ISO 12354

INPUT DATA

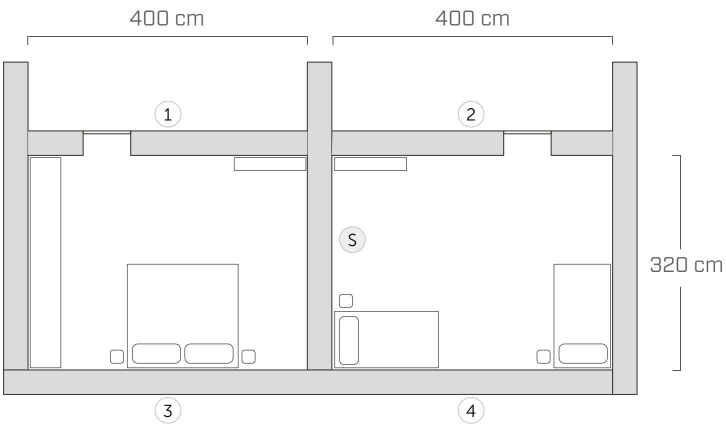
The EN ISO 12354 norms provide two methods to calculate the acoustic performance of a partition: a detailed method and the simplified method.

Regarding airborne sound insulation, the simplified calculation model predicts the apparent sound energy as a single value based on the acoustic performance of the elements involved in the junction. Below is an example of a calculation evaluating the apparent sound reduction index between two adjacent rooms.

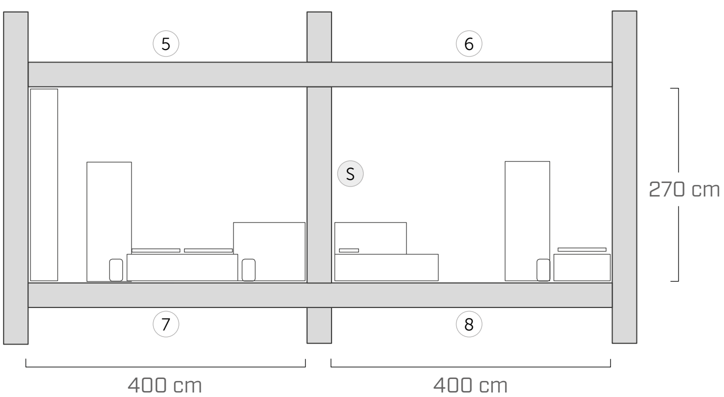
In order to determine the acoustic performance of assembly from the acoustic performance of its components, it is important to determine for every junction element:

- the geometry of the partition (S)
- the acoustic properties of the assembly (R_w)
- the connection between structural elements (K_{ij})
- the characteristics of each layer composing the assembly

PLAN



SECTION



PARTITION CHARACTERISTICS

SEPARATING WALL (S)

25 mm	plasterboard
50 mm	mineral wool
75 mm	CLT
50 mm	mineral wool
25 mm	plasterboard

INTERNAL WALLS (1)

12,5 mm	gypsum fibreboard
78 mm	CLT
12,5 mm	gypsum fibreboard

INTERNAL WALLS (2)

75 mm	CLT
50 mm	mineral wool
25 mm	plasterboard

EXTERNAL WALLS (3) (4)

6 mm	plaster
60 mm	wood fibre panel
160 mm	mineral wool
90 mm	CLT
70 mm	fir panels
50 mm	mineral wool
15 mm	plasterboard
25 mm	plasterboard

FLOORS (5) (6) (7) (8)

70 mm	concrete screed
0,2 mm	PE membrane
30 mm	under floor membrane
50 mm	backfill (loose)
140 mm	CLT
60 mm	mineral wool
15 mm	plasterboard

Data for acoustic characterisation of the assemblies was taken from DataHolz.

www.dataholz.com

CALCULATION OF DIRECT AND FLANKING TRANSMISSION COMPONENTS

The apparent sound reduction index is obtained from the contribution of the direct component and the flanking transmission paths, based on the following equation:

$$R'_w = -10\log\left[10^{-\frac{R_{Dd,w}}{10}} + \sum_{i,j=1}^{n} 10^{-\frac{R_{ij,w}}{10}} + \frac{A_0}{S_s}\sum_{j=1}^{n} 10^{-\frac{D_{n,j,w}}{10}}\right] (dB)$$

Considering only the first order transmission, there are three flanking transmission paths for each combination of partitions i-j, for a total of 12 R_{ij} calculated using the equation:

$$R_{ij,w} = \frac{R_{i,w}+R_{j,w}}{2} + \Delta R_{ij,w} + K_{ij} + 10\log\frac{S}{l_0 l_{ij}} \ (dB)$$

DETERMINING THE APPARENT SOUND REDUCTION INDEX

The simplified calculation model has the unquestioned advantage of providing an easy-to-use tool to predict sound insulation.

On the other hand, its application is quite delicate for CLT structures because the damping of each structural element is strongly affected by the assembly. It really deserves a dedicated modelling approach. Moreover, CLT panels provide poor insulation at low frequencies, thus the use of frequency weighted indices might return results which do not provide an accurate representation of actual behaviour in the low frequency region. Therefore the use of the detailed method is advised for accurate predictive analysis.

In the example provided, sound insulation for direct transmission gives R_w of 53 dB, if the contributions of flanking transmission are considered, R'_w decreases to 51 dB.

R'_w = 51 dB **R_w = 53 dB**

ACOUSTIC CHARACTERISTICS OF THE ASSEMBLIES

Path of transmission	S [m²]	R_w [dB]	m' [kg/m²]
S	8,64	53	69
1	10,8	38	68
2	10,8	49	57
3	10,8	55	94
4	10,8	55	94
5	12,8	63	268
6	12,8	63	268
7	12,8	63	268
8	12,8	63	268

CALCULATING R_{ij}

Path of transmission	R_{ij} [dB]	Path of transmission	R_{ij} [dB]
1-S	60	S-6	83
3-S	68	S-8	75
5-S	83	1-2	64
7-S	75	3-4	77
S-2	66	5-6	75
S-4	68	7-8	75

CHARACTERISATION OF THE JOINTS

JUNCTION 1-2-S
X-shaped joint
detail 12

JOINT 3-4-S
T-shaped joint,
detail 5

JOINT 5-6-S
X-shaped joint with resilient profile
detail 43

JOINT 7-8-S
X-shaped joint with resilient profile
detail 43

Download all the documentation about the project from www.rothoblaas.com

FLANKSOUND PROJECT

EXPERIMENTAL MEASUREMENTS OF K_{ij} FOR CLT JOINTS

Rothoblaas has therefore promoted research aimed at measuring the K_{ij} vibration reduction index for a variety of CLT panel joints, with the dual objective of providing specific experimental data for the acoustic design of CLT buildings and contributing to the development of calculation methods.

L, T and X-shaped joints were tested during the measurement project.

CLT panels were provided by seven different manufacturers and therefore underwent different production processes, showing different characteristics such as the number and thickness of lamellas, side gluing of layers, and anti-shrinkage kerf cuts in the core. Different kinds of screws and connectors were tested, as well as different resilient layers at the wall-floor junction.

The test set-up was arranged in the warehouse at Rothoblaas headquarters in Cortaccia (prov. Bolzano).

The vibration reduction index measurements were carried out in compliance with EN ISO 10848.

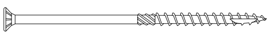
EN ISO 10848

K_{ij} for different types of joint

- 7 different CLT manufacturers
- L, T, X-shaped vertical and horizontal joints
- influence of type and number of screws
- influence of type and number of angle brackets
- influence of type and number of hold-downs
- use of resilient layers

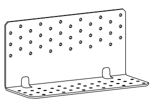
FASTENING

HBS
countersunk screw

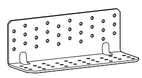


VGZ
fully threaded screw
with cylindrical head

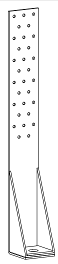
TITAN N
angle bracket for shear loads in solid walls



TITAN F
angle bracket for shear loads on frame walls

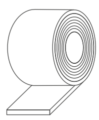


WHT
angle bracket for tensile loads

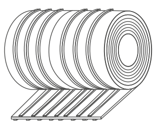


SOUNDPROOFING

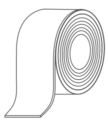
XYLOFON
high performance
resilient profile



ALADIN
resilient profile

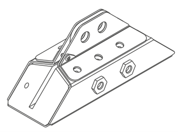


CONSTRUCTION SEALING
airtight profile

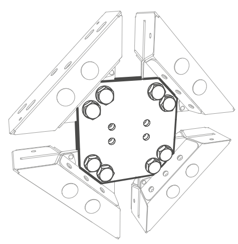


X-RAD

X-ONE
universal connector
for CLT panel



X-PLATE
complete range
of connection plates



MEASUREMENT CONFIGURATION

MEASUREMENT SETUP: EQUIPMENT AND DATA PROCESSING

The vibration reduction index K_{ij} is calculated as:

$$K_{ij} = \frac{D_{v,ij} + D_{v,\,ji}}{2} + 10\log \frac{l_{ij}}{\sqrt{a_i\, a_j}}\ (dB)$$

where:

$D_{v,ij}$ ($D_{v,ji}$) is the difference in vibration velocity between the elements i and j (j and i) when element i (j) is excited (dB)

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

a are the equivalent absorption lengths elements of i and j

$$a = \frac{2.2\pi^2 S}{c_0\, T_s}\sqrt{\frac{f_{ref}}{f}}\ (m)$$

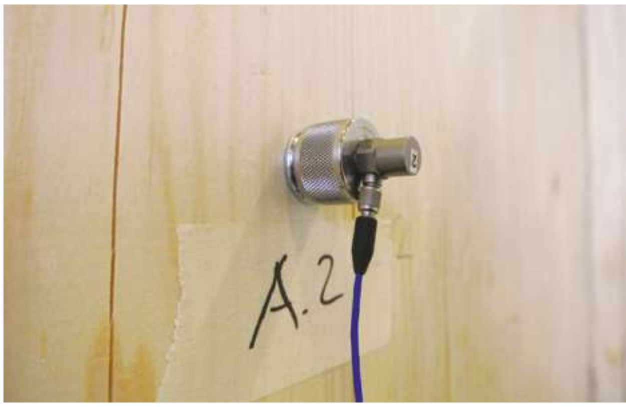
S is the panel surface

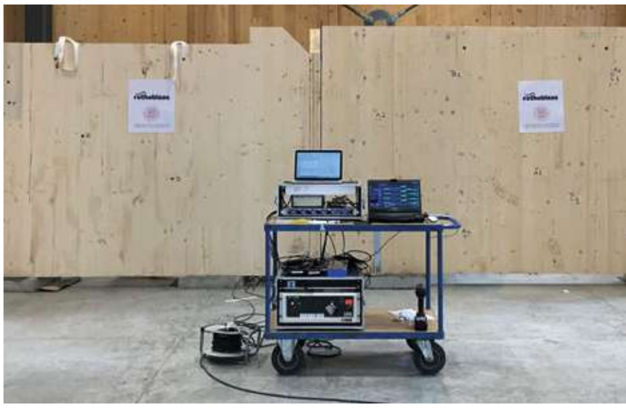
f is the frequency

T_s is the structural reverberation time

The sound source consisted of an electrodynamic shaker with sinusoidal peak force of 200 N, which was mounted on a heavyweight base and screwed to the CLT panels using a plate.

The velocity levels were measured using a pink noise source signal, filtered at 30 Hz in order to get reliable results from 50 Hz onwards. Structural reverberation times were calculated from impulse responses acquired using ESS test signals. The accelerometers were fixed to the panels using magnets. Eyelets were screwed to the panels with screws whose length was at least half of the thickness of the panels, in order to reach the innermost layer of the panel. The vibration reduction indices are reported in the one-third octave bands ranging from 100 to 3150 Hz, together with the value averaged over the one-third octave bands from 200 to 1250 Hz.





A. Speranza, L. Barbaresi, F. Morandi, " **Experimental analysis of flanking transmission of different connection systems for CLT panels** " in Proceedings of the World Conference on Timber Engineering 2016, Vienna, August 2016.

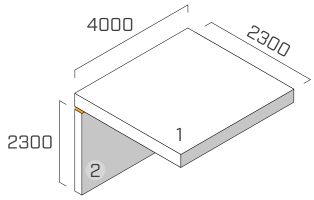
L. Barbaresi, F. Morandi, M. Garai, A. Speranza, " **Experimental measurements of flanking transmission in CLT structures** " in Proceedings of the International Congress on Acoustics 2016, Buenos Aires, September 2016.

L. Barbaresi, F. Morandi, M. Garai, A. Speranza, "**Experimental analysis of flankng transmission in CLT structures**" of Meetings on Acoustics (POMA), a serial publication of the Acoustical Society of America - POMA-D-17-00015.

L. Barbaresi, F. Morandi, J. Belcari, A. Zucchelli, Alice Speranza, "**Optimising the mechanical characterisation of a resilient interlayer for the use in timber construction**" in Proceedings of the International congress on sound and vibration 2017, London, July 2017.

L-SHAPED JOINT

EN ISO 10848-1/4



STRUCTURE

floor: CLT 5 layers (s: 160 mm) (2,3 m x 4,0 m)
lower wall: CLT 5 layers (s: 100 mm) (4,0 m x 2,3 m)

FASTENING SYSTEM

13 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm
5 angle brackets **TITAN** (TTN240) spacing 800 mm
fastening pattern: total nailing 72 screws 5 x 50
2 hold down **WHT** (WHT440)

RESILIENT PROFILE

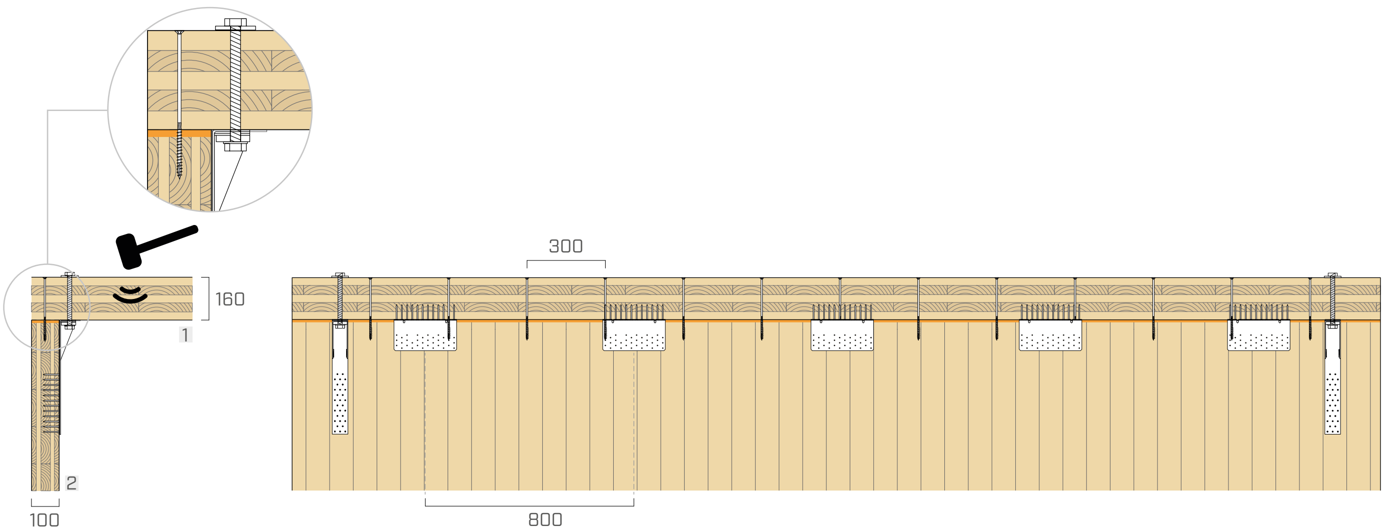
ALADIN SOFT

position: between the lower wall and the floor.

dimensions: width = 95 mm thickness = 6 mm length = 4,0 m

contact area: continuous strip (same width as the wall)

applied load [kN/m]: structure self weight



f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	8,7	14,4	8,7	10,0	10,7	9,5	6,1	9,8	9,4	14,1	16,1	18,1	18,1	17,8	21,3	19,1

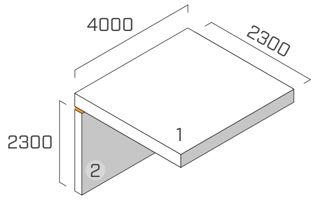
$\overline{K_{12}}$ = **11,5 dB**

L-SHAPED JOINT

EN ISO 10848-1/4

STRUCTURE

floor: CLT 5 layers (s: 160 mm) (2,3 m x 4,0 m)
lower wall: CLT 5 layers (s: 100 mm) (4,0 m x 2,3 m)



FASTENING SYSTEM

13 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm
5 angle brackets **TITAN** (TTN240) spacing 800 mm
fastening pattern: total nailing 72 screws 5 x 50
2 hold down **WHT** (WHT440)

RESILIENT PROFILE

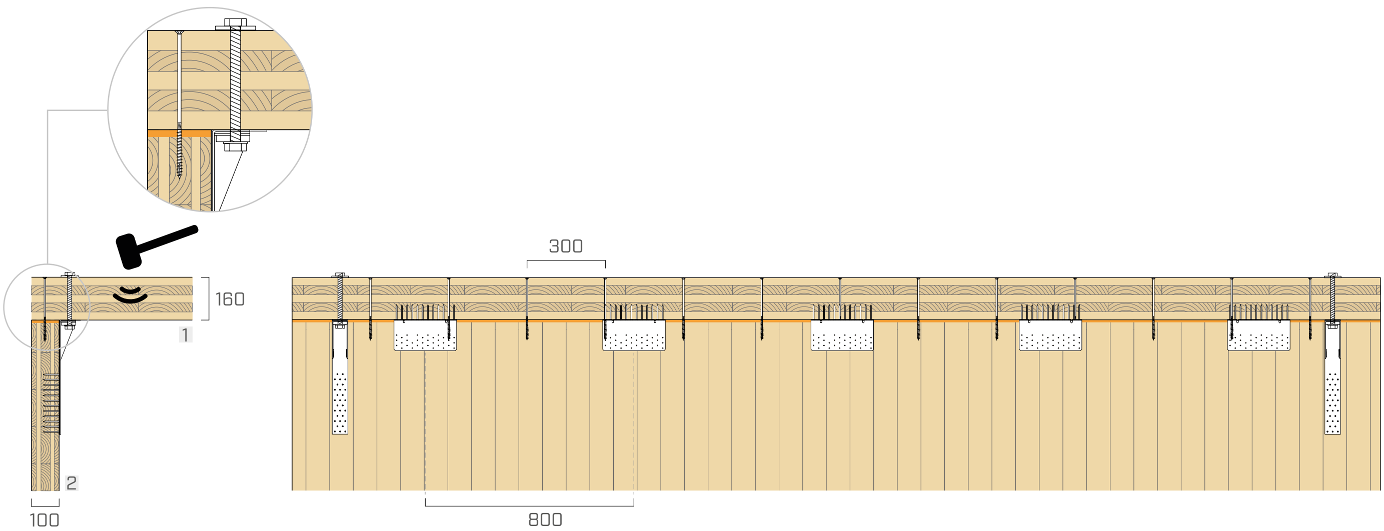
ALADIN SOFT

position: between the lower wall and the floor.

dimensions: width = 95 mm thickness = 6 mm length = 4,0 m

contact area: continuous strip (same width as the wall)

applied load [kN/m]: 2



f [Hz]	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**
K_{12} [dB]	9,5	13,6	8,7	11,8	9,0	10,1	7,2	8,7	10,4	14,2	17,0	16,5	18,4	20,0	23,1	19,7

$\overline{K_{12}}$ = **11,7 dB**

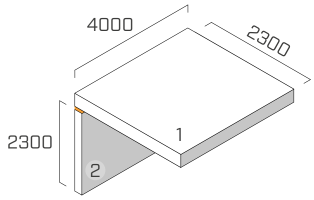
L-SHAPED JOINT

EN ISO 10848-1/4

STRUCTURE

floor: CLT 5 layers (s: 160 mm) (2,3 m x 4,0 m)

lower wall: CLT 5 layers (s: 100 mm) (4,0 m x 2,3 m)



FASTENING SYSTEM

13 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm

5 angle brackets **TITAN** (TTN240) with resilient profile **ALADIN** spacing 800 mm

fastening pattern: total nailing 72 screws 5 x 50

2 hold down **WHT** (WHT440)

RESILIENT PROFILE

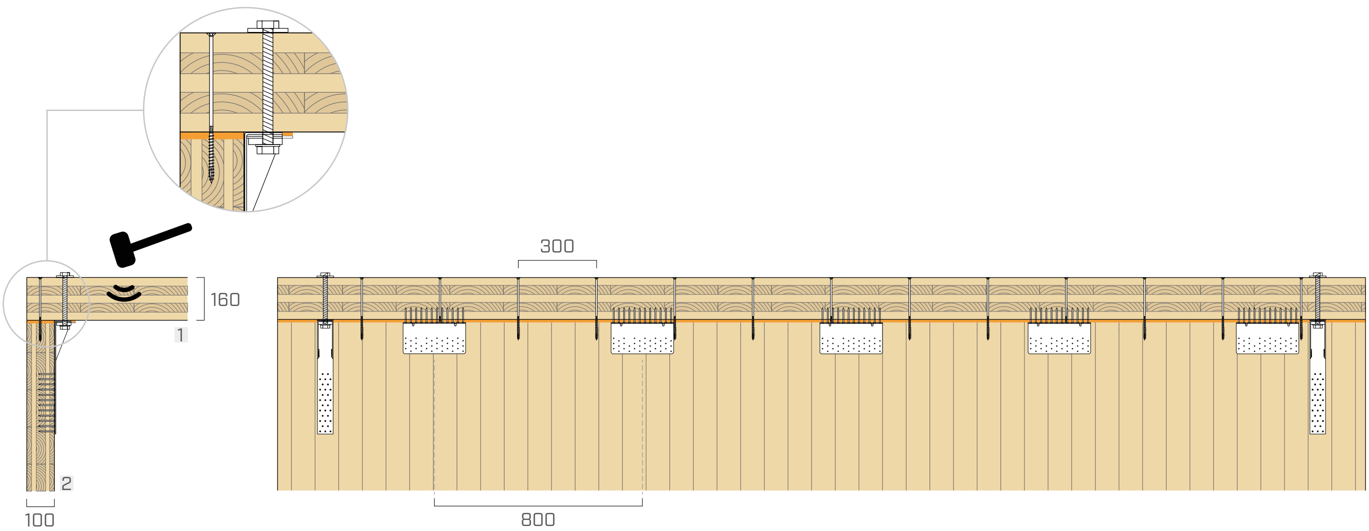
ALADIN SOFT

position: between the lower wall and the floor.

dimensions: width = 95 mm thickness = 6 mm length = 4,0 m

contact area: continuous strip (same width as the wall)

applied load [kN/m]: structure self weight



f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	9,7	15,3	9,0	11,2	9,2	9,3	6,6	10,6	9,7	14,0	16,3	15,8	16,7	17,8	22,1	21,8

$\overline{K_{12}}$ = **11,4 dB**

ON SITE MEASUREMENTS

The effectiveness of ALADIN was also verified by measuring passive acoustic requirements in constructed buildings.
ALADIN has been used in residential buildings, accommodation facilities, university campuses, schools, health centres and mixed-use multi-storey buildings.
The performance achieved did not disappoint expectations and ALADIN proved to be an excellent partner for reducing flanking sound transmission.

UNIVERSITY CAMPUS

Victoria (AU)

description	university student residence with 150 beds
type of structure	CLT panels
location	Victoria (Australia)
products	ALADIN, XYLOFON

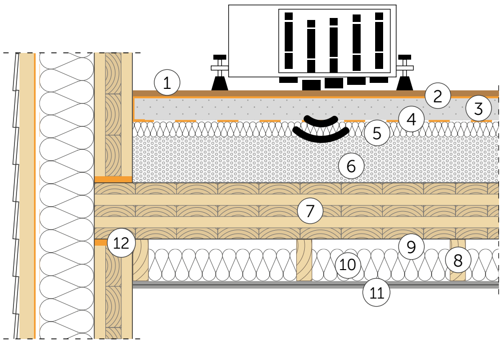
MULTI-STOREY BUILDING

Toronto (CA)

description	6-storey building for residential use
type of structure	CLT panels
location	Toronto (Canada)
products	ALADIN, XYLOFON

ON-SITE MEASUREMENT | CLT FLOOR

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARDS: ISO 140-7



FLOOR SLAB

Surface = 31 m^2
Receiving room volume = 75 m^3

1. Timber floor (thickness: 15 mm)
2. **SILENT STEP** (thickness: 2 mm)
3. Concrete screed (thickness: 70 mm)
4. **BARRIER 100**
5. Mineral wool insulation (thickness: 30 mm) s′ ≤ 10 MN/m^3
6. Gravel fill (thickness: 80 mm) (1600 kg/m^3)
7. CLT (thickness: 146 mm)
8. Solid wood batten (thickness: 50 mm base: 150 mm)
9. Air chamber
10. Low density mineral wool insulation (thickness: 120 mm)
11. Plasterboard panel x2 (thickness: 25 mm)
12. **ALADIN EXTRA SOFT**

IMPACT SOUND INSULATION

f [Hz]	$L'_{nT,w}$ [dB]
50	-
63	-
80	-
100	44,6
125	40,6
160	41,4
200	40,6
250	37,7
315	33,6
400	35,1
500	35,2
630	32,2
800	27,6
1000	24,7
1250	22,2
1600	18,3
2000	13,2
2500	8,0
3150	7,3
4000	-
5000	-

without ALADIN EXTRA SOFT

$L'_{nT,w,0}$ (C_I) = 38 (1) dB

$NISR_{ASTM}$ = 73

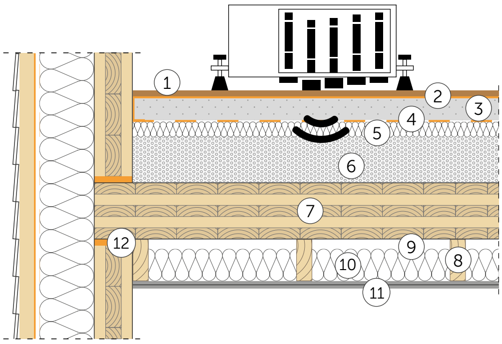
with ALADIN EXTRA SOFT

$L'_{nT,w,ALADIN}$ (C_I) = **34 (0) dB**

$NISR_{ASTM}$ = 75

ON-SITE MEASUREMENT | CLT FLOOR

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARDS: ISO 140-7

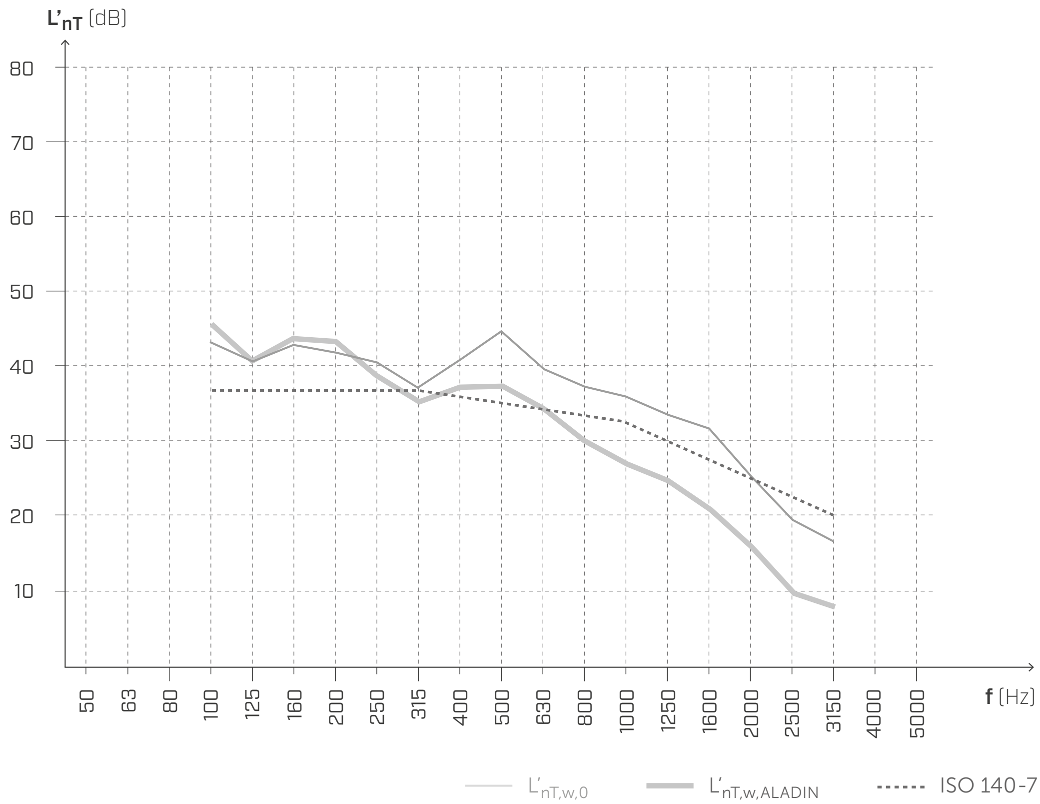


FLOOR SLAB

Surface = 31 m^2
Receiving room volume = 75 m^3

1. Timber floor (thickness: 15 mm)
2. **SILENT STEP** (thickness: 2 mm)
3. Concrete screed (thickness: 70 mm)
4. **BARRIER 100**
5. Mineral wool insulation (thickness: 30 mm) $s' \leq 10$ MN/m^3
6. Gravel fill (thickness: 80 mm) (1600 kg/m^3)
7. CLT (thickness: 146 mm)
8. Solid wood batten (thickness: 50 mm base: 150 mm)
9. Air chamber
10. Low density mineral wool insulation (thickness: 120 mm)
11. Plasterboard panel x2 (thickness: 25 mm)
12. **ALADIN SOFT**

IMPACT SOUND INSULATION



f [Hz]	$L'_{nT,w}$ [dB]
50	-
63	-
80	-
100	45,7
125	40,7
160	43,8
200	43,3
250	38,8
315	35,3
400	37,3
500	37,4
630	34,4
800	30,1
1000	27,0
1250	24,8
1600	20,9
2000	16,0
2500	9,8
3150	7,9
4000	-
5000	-

without ALADIN EXTRA SOFT

$L'_{nT,w,0}$ (C_I) = 38 (1) dB

$NISR_{ASTM}$ = 73

with ALADIN EXTRA SOFT

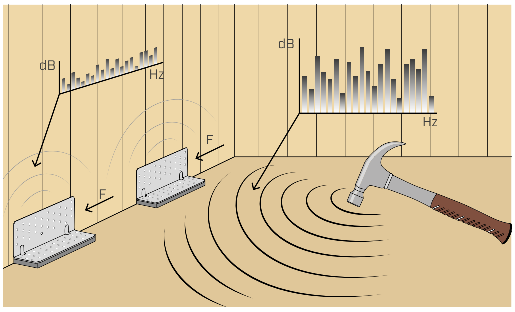
$L'_{nT,w,ALADIN}$ (C_I) = **35 (0) dB**

$NISR_{ASTM}$ = 74

ACOUSTIC AND MECHANICAL INTERACTION

ACOUSTIC - MECHANICAL BEHAVIOR OF TITAN + ALADIN

The TITAN + ALADIN system has been tested in order to determine its mechanical and acoustic behaviour. The experimental campaigns carried out within the Seismic-Rev project and in collaboration with multiple research institutes, have shown how the characteristics of the resilient profile influence the mechanical performance of the connection. From an acoustic point of view, with the Flanksound project, it has been demonstrated that the ability to dampen vibrations through the joint is strongly influenced by the type and number of connections.



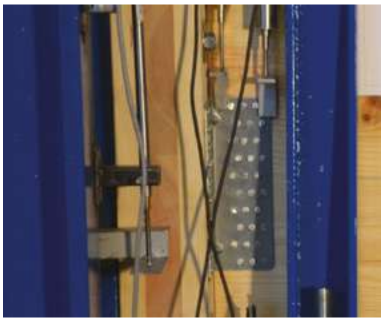
EXPERIMENTAL INVESTIGATION: MECHANICAL BEHAVIOUR

Within the Seismic-Rev project, in collaboration with the University of Trento and the Institute for BioEconomy (IBE - San Michele all'Adige), an investigation project was launched to evaluate the mechanical behaviour of TITAN angle brackets used in combination with different soundproofing profiles.

FIRST LABORATORY PHASE

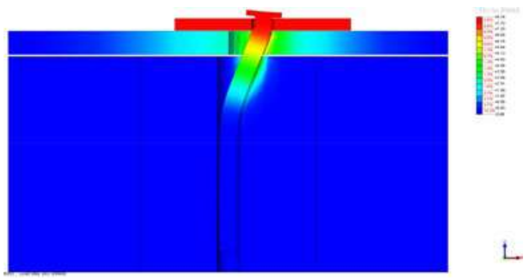
Monotonic shear tests were carried out, in the first experimental phase, using linear loading procedures in displacement control, aimed at evaluating the variation in ultimate strength and stiffness offered by the TTF200 connection with LBA Ø4 x 60 mm nails.

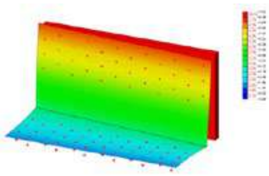
Test samples:
CLT panels
TITAN TTF200 angle bracket



NUMERIC MODELLING

The results of the preliminary investigation campaign highlighted the importance of carrying out more accurate analyses of the influence of acoustic profiles on the mechanical behaviour of TTF200 and TTN240 metal angle brackets in terms of overall strength and stiffness. For this reason it was decided to carry out further evaluations by means of finite element numerical modelling, starting from the behaviour of the individual nail. In the case under study, the influence of three different resilient profiles were analysed: XYLOFON 35 (6 mm), ALADIN SOFT (5 mm) and ALADIN EXTRA SOFT (7 mm).





Tx deformation [mm]
for induced displacement 8 mm

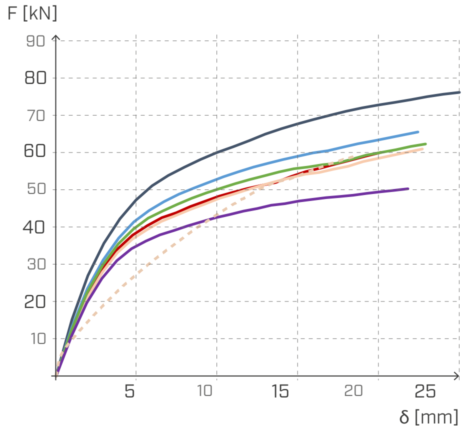
VARIATION OF MECHANICAL SHEAR STRENGTH AS A FUNCTION OF SOUNDPROOFING PROFILE

The comparison of the results between the different configurations analysed is reported in terms of load variation at 15 mm displacement ($F_{15\,mm}$) and elastic stiffness at 5 mm ($K_{s,5\,mm}$).

TITAN TTF200

configurations	sp [mm]	$F_{15\,mm}$ [kN]	$\Delta F_{15\,mm}$	$K_{5\,mm}$ [kN/mm]	$\Delta K_{5\,mm}$
TTF200	-	68,4	-	9,55	-
TTF200 + ALADIN SOFT red.*	3	59,0	-14 %	8.58	-10 %
TTF200 + ALADIN EXTRA SOFT red.*	4	56,4	-18 %	8.25	-14 %
TTF200 + ALADIN SOFT	5	55,0	-20 %	7.98	-16 %
TTF200 + XYLOFON PLATE	6	54,3	-21 %	7,79	-18 %
TTF200 + ALADIN EXTRA SOFT	7	47,0	-31 %	7,30	-24 %

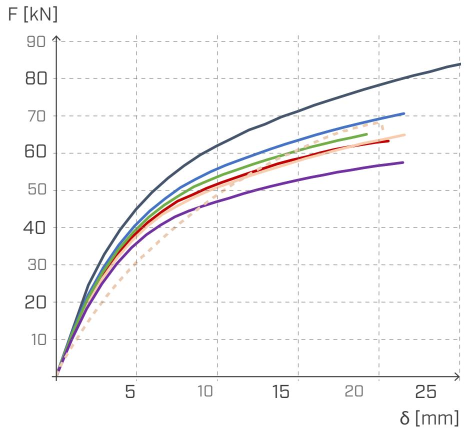
* Reduced thickness: reduced profile height due to the trapezoidal section and consequent crushing induced by the head of the nail during operation.



TITAN TTN240

configurations	sp [mm]	$F_{15\,mm}$ [kN]	$\Delta F_{15\,mm}$	$K_{5\,mm}$ [kN/mm]	$\Delta K_{5\,mm}$
TTN240	-	71,9	-	9,16	-
TTN2400 + ALADIN SOFT red.*	3	64,0	-11 %	8,40	-8 %
TTN240 + ALADIN EXTRA SOFT red.*	4	61,0	-15 %	8.17	-11 %
TTN240 + ALADIN SOFT	5	59,0	-18 %	8,00	-13 %
TTN240 + XYLOFON PLATE	6	58,0	-19 %	7,81	-15 %
TTN240 + ALADIN EXTRA SOFT	7	53,5	-26 %	7.47	-18 %

* Reduced thickness: reduced profile height due to the trapezoidal section and consequent crushing induced by the head of the nail during operation.



EXPERIMENTAL RESULTS

The results obtained show a reduction in the strength and stiffness of the devices following the interposition of the soundproofing profiles. This variation is highly dependent on the thickness of the profile. In order to limit the reduction of strength it is necessary to adopt profiles with real thickness of approximately 6 mm or less.

SHEAR AND TENSILE STRENGTH TITAN + ALADIN CERTIFIED IN ETA

Not only experimental tests, but also values certified by independent assessment bodies that certify the performance characteristics of non-standard construction products.

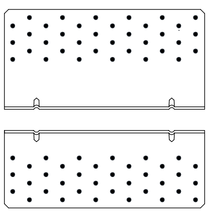
TITAN

The strength of TITAN coupled with ALADIN below the horizontal flange was calculated from the load-carrying capacity of nails or screws according to "Blaß, H.J. und Laskewitz, B. (2000); Load-Carrying Capacity of Joints with Dowel-Type fasteners and Interlayers.", conservatively neglecting the profile stiffness.
Being an innovative angle bracket and one of the first certified on the market, a highly conservative approach was chosen and ALADIN was simulated as an equivalent air layer. The angular capacity is therefore largely underestimated.

ANGLE BRACKET	fastening				$F_{2/3,Rk}$
	type	Ø x L	n_V	n_H	
		[mm]	[pcs]	[pcs]	[kN]
TTN240 + ALADIN SOFT	LBA nails	4 x 60	36	36	28,9
	LBS screws	5 x 50	36	36	27,5
TTS240 + ALADIN EXTRA SOFT	HBS PLATE screws	8 x 80	14	14	27,5
	LBS screws	5 x 50	36	36	25,8

TIMBER-TO-TIMBER FASTENING PATTERN

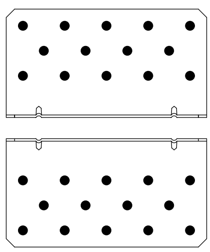
TTN240



36 LBA nails/LBS screws

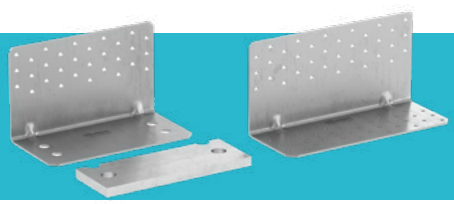
36 LBA nails/LBS screws

TTS240



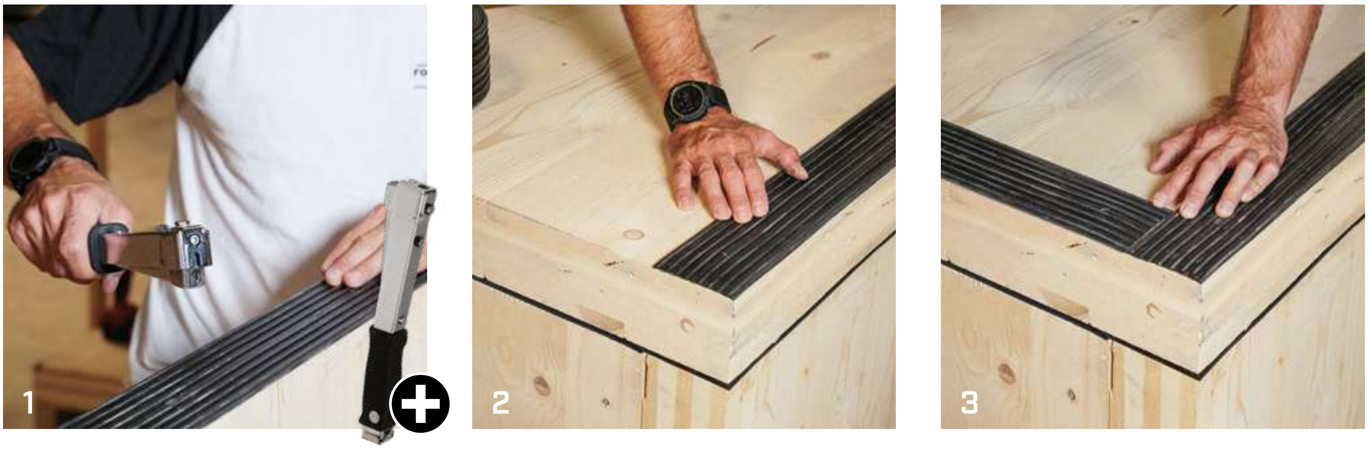
14 LBA nails/LBS screws

14 LBA nails/LBS screws



ALADIN | RECOMMENDATIONS FOR INSTALLATION

APPLICATION WITH STAPLES



APPLICATION WITH PRIMER SPRAY

APPLICATION WITH DOUBLE BAND