SOUNDPROOFING SOLUTIONS

TECHNICAL MANUAL

- XYLOFON
- PIANO
- ALADIN
- SILENT FLOOR PUR
- SILENT FLOOR PE

rothoblaas

Solutions for Building Technology

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XYLOFON

TECHNICAL MANUAL

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LCA EPD FLANKSOUND EN ISO 10848 ETA-23/0061

XYLOFON

HIGH PERFORMANCE RESILIENT SOUNDPROOFING PROFILE

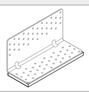
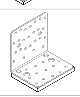





CODES AND DIMENSIONS

CODE	Shore	B [mm]	L [m]	s [mm]	B [in]	L [ft]	s [in]	pcs
XYL20050		50	3,66	6,0	2	12	1/4	1
XYL20080		80	3,66	6,0	3 1/8	12	1/4	1
XYL20090		90	3,66	6,0	3 1/2	12	1/4	1
XYL20100	20	100	3,66	6,0	4	12	1/4	1
XYL20120		120	3,66	6,0	4 3/4	12	1/4	1
XYL20140		140	3,66	6,0	5 1/2	12	1/4	1
XYL20160		160	3,66	6,0	6 1/4	12	1/4	1
XYL35080		80	3,66	6,0	3 1/8	12	1/4	1
XYL35090		90	3,66	6,0	3 1/2	12	1/4	1
XYL35100	35	100	3,66	6,0	4	12	1/4	1
XYL35120		120	3,66	6,0	4 3/4	12	1/4	1
XYL35140		140	3,66	6,0	5 1/2	12	1/4	1
XYL35160		160	3,66	6,0	6 1/4	12	1/4	1
XYL50080		80	3,66	6,0	3 1/8	12	1/4	1
XYL50090		90	3,66	6,0	3 1/2	12	1/4	1
XYL50100	50	100	3,66	6,0	4	12	1/4	1
XYL50120		120	3,66	6,0	4 3/4	12	1/4	1
XYL50140		140	3,66	6,0	5 1/2	12	1/4	1
XYL50160		160	3,66	6,0	6 1/4	12	1/4	1
XYL70080		80	3,66	6,0	3 1/8	12	1/4	1
XYL70090		90	3,66	6,0	3 1/2	12	1/4	1
XYL70100	70	100	3,66	6,0	4	12	1/4	1
XYL70120		120	3,66	6,0	4 3/4	12	1/4	1
XYL70140		140	3,66	6,0	5 1/2	12	1/4	1
XYL70160		160	3,66	6,0	6 1/4	12	1/4	1
XYL80080		80	3,66	6,0	3 1/8	12	1/4	1
XYL80090		90	3,66	6,0	3 1/2	12	1/4	1
XYL80100	80	100	3,66	6,0	4	12	1/4	1
XYL80120		120	3,66	6,0	4 3/4	12	1/4	1
XYL80140		140	3,66	6,0	5 1/2	12	1/4	1
XYL80160		160	3,66	6,0	6 1/4	12	1/4	1
XYL90080		80	3,66	6,0	3 1/8	12	1/4	1
XYL90090		90	3,66	6,0	3 1/2	12	1/4	1
XYL90100	90	100	3,66	6,0	4	12	1/4	1
XYL90120		120	3,66	6,0	4 3/4	12	1/4	1
XYL90140		140	3,66	6,0	5 1/2	12	1/4	1
XYL90160		160	3,66	6,0	6 1/4	12	1/4	1

SEPARATING PROFILE FOR TITAN AND NINO

CODE			pcs
XYL3570200		TTF200	10
XYL35120240		TTN240 - TTS240	10
XYL35100200		TCF200 - TCN200	10
XYL3580105		NINO100100	10
XYL3555150		NINO15080	10
XYL35120105		NINO100200	10

SEPARATING PROFILE FOR WHT AND SCREWS

CODE			pcs
XYLW806060		WHT340 | WHT440 | WHT540	10
XYLW808080		-	10
XYLW8080140		-	1
XYLW803811		-	50

K_{ij} values entered in ETA

K_{ij} tested for all hardness values and with appropriate fastening system

$\Delta_{l,ij} >$ **7 dB**

from page 8

Mechanical performance and elastic behaviour **tested** according to **ETA**

- elastic response of the profile applied in buildings
- elastic response of the profile as vibration damping

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EPD LCA

Sustainability

possibility of knowing the impact of the product thanks to **EPD**s evaluated from **LCA**s

page 12

Sound reduction measurements

measured effectiveness in reducing flanking sound transmission through soundproofing power measures

$\Delta R_{Df+Ff,situ}$ = **10 dB**

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FLANKSOUND PROJECT

K_{ij} for **15 different** types of joint

page 48

Impact noise level measurements

measured effectiveness in reducing flanking sound transmission through impact sound measures

$\Delta L_{n,Df+Ff,situ}$ = **8 dB**

page 61

On site measurements

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

page 71

Static to acoustic interaction

experimental investigations and tests on different configurations up to **34,6 kN** shear strength with **NINO** with **XYLOFON PLATE**

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Influence of friction

experimental investigations for timber-to-timber shear connections

page 90

Fire safety in buildings

Study of compartmentalisation of timber buildings temperatures below 300°C after 4 hours and without secondary flashover after 3 hours

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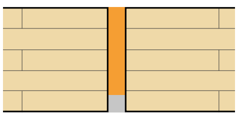
XYLOFON + FIRE SEALING



Fire resistance

experimental test **EI 60**

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PRODUCT COMPARISON

products		thickness	acoustic improvement $\Delta_{l,ij}$ (1)	elastic modulus in compression E_c
XYLOFON 20		**6** mm *1/4 in*	**> 7** dB	**1,45** N/mm² *210 psi*
XYLOFON 35		**6** mm *1/4 in*	**7,4** dB	**3,22** N/mm² *467 psi*
XYLOFON 50		**6** mm *1/4 in*	**10,6** dB	**7,11** N/mm² *1031 psi*
XYLOFON 70		**6** mm *1/4 in*	**7,8** dB	**14,18** N/mm² *2057 psi*
XYLOFON 80		**6** mm *1/4 in*	**> 7** dB	**25,39** N/mm² *3683 psi*
XYLOFON 90		**6** mm *1/4 in*	**> 7** dB	**36,56** N/mm² *5303 psi*

LEGEND:

load for acoustic optimisation

compression at 3 mm deformation (ultimate limit state)

dynamic elastic modulus E'_{5Hz} - E'_{50Hz}	damping factor $\tan\delta_{5Hz}$ - $\tan\delta_{50Hz}$	acoustic load / maximum applied load
-	-	acoustic load [N/mm²]: **0,016 – 0,14** maximum applied load [N/mm²]: 0,016 – 1,25
3,10 N/mm² - **3,60** N/mm² *450 psi - 522 psi*	**0,321 - 0,382**	acoustic load [N/mm²]: **0,038 – 0,32** maximum applied load [N/mm²]: 0,038 – 3,61
3,93 N/mm² - **4,36** N/mm² *570 psi - 632 psi*	**0,173 - 0,225**	acoustic load [N/mm²]: **0,22 – 0,68** maximum applied load [N/mm²]: 0,22 – 8,59
6,44 N/mm² - **7,87** N/mm² *934 psi - 1141 psi*	**0,118 - 0,282**	acoustic load [N/mm²]: **0,49 – 1,5** maximum applied load [N/mm²]: 0,49 – 11,1
16,90 N/mm² - **21,81** N/mm² *2451 psi - 3163 psi*	**0,150 - 0,185**	acoustic load [N/mm²]: **1,3 – 2,4** maximum applied load [N/mm²]: 1,3 – 19,51
39,89 N/mm² - **65,72** N/mm² *5786 psi - 9532 psi*	**0,307 - 0,453**	acoustic load [N/mm²]: **2,2 – 4,5** maximum applied load [N/mm²]: 2,2 – 28,97

0 5 10 15 20 25 30 35

(1) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

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.

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

$$Q_{linear} = DL + 0,5\, LL$$

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 XYLOFON 35).

TABLE OF USE[1]

CODE	load for acoustic optimisation[2] [kN/m] *[lbf/ft]* min		max		compression for acoustic optimisation[2] [N/mm²] *[psi]* min	max	reduction [mm] *[mil]* min	max	*compressive stress at 3 mm (ultimate limit state)* [N/mm²] *[psi]*
XYL35080	3,04	*2242*	25,6	*18882*	0,038 *5.5*	0,32 *46.4*	0,05 *2*	0,5 *20*	3,61 *524*
XYL35090	3,42	*2522*	28,8	*21242*					
XYL35100	3.8	*2803*	32	*23602*					
XYL35120	4,56	*3363*	38,4	*28322*					
XYL35140	5,32	*3924*	44,8	*33043*					
XYL35160	6,08	*4484*	51,2	*37763*					

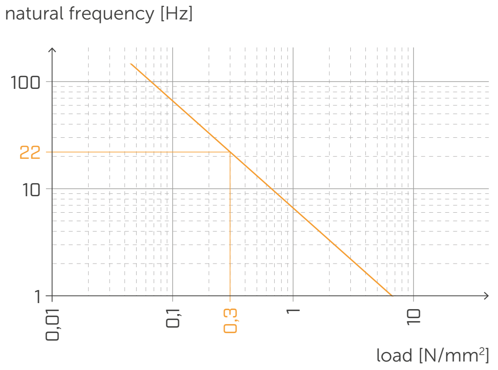
To properly evaluate the product using MyProject, simply follow the step-by-step instructions provided by the software.

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 0,3 N/mm² acting on the profile. In this case, we used the XYLOFON 35 product, because the load is not particularly high. Reading the graph, it can be seen that the profile has a resonance frequency of around 22 Hz.

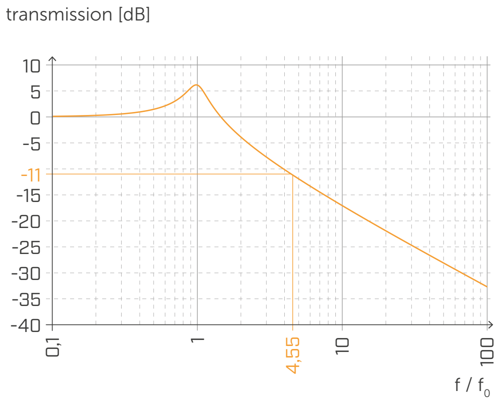


At this point, the degree of transmission for the product under these load conditions can be calculated, referring to the design frequency of 100 Hz.

$$\text{transmission} = f/f_0 = 4{,}55$$

Then the transmission graph is used, placing the value 4,55 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.

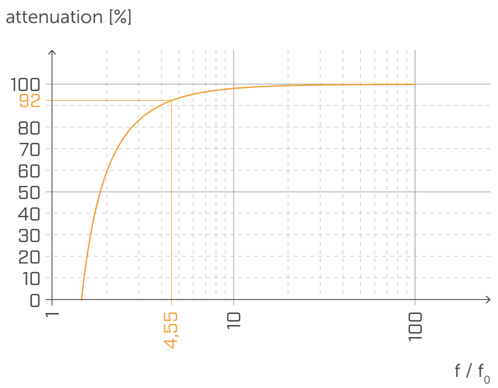
TRANSMISSION IS POSITIVE WHEN THE MATERIAL TRANSMITS AND IS NEGATIVE WHEN THE PROFILE BEGINS TO INSULATE. This means this figure shows that the product, loaded in this way, insulates 11 dB at a reference frequency of 100 Hz.



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.

$$\text{attenuation} = f/f_0 = 4{,}55$$

The graph is used by placing the calculated value of 4.55 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 92 % 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.

EUROPEAN TECHNICAL ASSESSMENT (ETA)

The European Technical Assessment (ETA) provides an **independent procedure at European level** for assessing the essential performance characteristics of non-standard construction products.

OBJECTIVITY AND INDEPENDENCE

Only independent Technical Assessment Bodies (TAB) can issue ETAs. Third-party evaluation enhances the credibility of product performance information, improves **market transparency**, and ensures that the stated values are tested to **precise standards** appropriate for the intended use of the product.

TRANSPARENCY

ETAs provide **reliable product performance information** that can be compared across Europe on the basis of harmonised technical specifications, the European Assessment Documents (EADs).
ETAs have made construction products **comparable throughout the European Economic Area** through the provision of detailed product performance information.

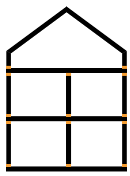
PARAMETERS TESTED ACCORDING TO ETA

STATIC AND DYNAMIC MODULUS OF ELASTICITY

Many products on the market have been tested to determine the dynamic elastic modulus and damping factor in order to provide transmissibility graphs according to the natural frequency of the resilient profile.

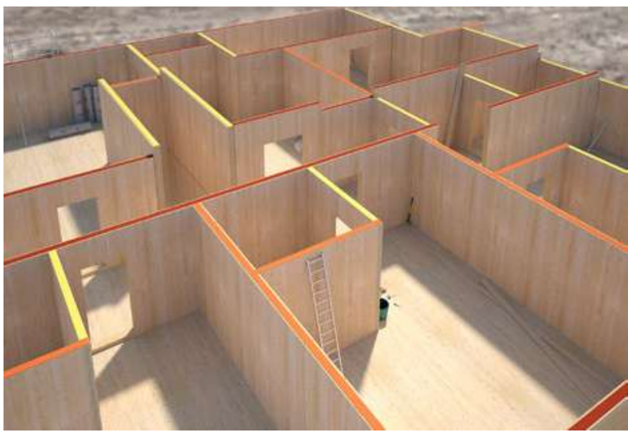
Since there is no common standard, each manufacturer follows a different procedure, and often the standard used and the test setup are not stated.

Considering the intended use of **XYLOFON**, the dynamic elastic modulus and damping factor must be determined in compression (there would be no point in defining them according to other deformation methods).
Dynamic elastic modulus and damping factor are measured under dynamic conditions and are relevant for vibration reduction in service equipment or other vibration sources.



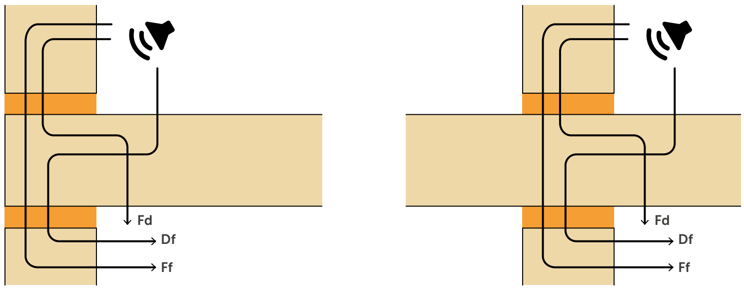
In buildings, **XYLOFON** is subject to static and quasi-static loading, so the dynamic elastic modulus is not as representative of the product's actual behaviour.

Tests show that profile friction could affect the elastic modulus value, and that is why it is necessary to always perform measurements with and without a lubricant to have a value that is independent of boundary conditions (without friction) and a value that is representative of the in situ operating conditions (with friction).



VIBRATION REDUCTION INDEX - $\mathbf{K_{ij}}$

Due to the lack of a common standard, each manufacturer provides K_{ij} values tested in a different configuration (type of joint, number of fastening systems, etc.). Clarifying the test setup and boundary conditions being used is important because the result is strongly influenced by the many variables that define the joint.



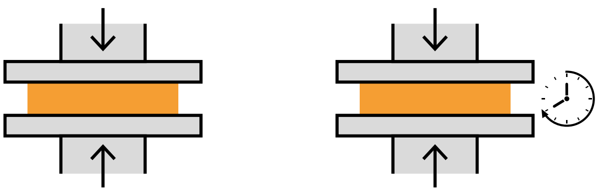
In the European Technical Assessment, the results are expressed clearly to avoid ambiguity in the configuration.

STRESS AND DEFORMATION IN COMPRESSION

XYLOFON has been tested under significant compressive stresses, demonstrating linear behaviour even under high loads.

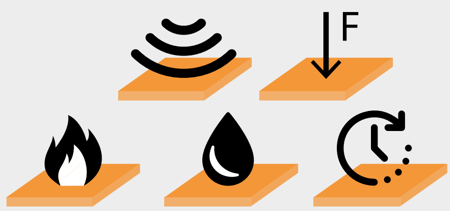
From a static point of view, it is important to provide the **compressive stress according to the deformation** (e.g., 1 mm, 2 mm and 3 mm compression) so as to limit the maximum deformation and possible structural failure.

Resilient profiles are subjected to constant loading during their working life, so it is important to estimate the **long-term behaviour** for both static reasons (to avoid differential failure in the structure) and acoustic reasons (a flattened resilient strip does not have the same elastic response and consequently the acoustic performance declines).



For the same reason, it is important to assess the **final thickness of the product** after compression for a given time and after a recovery period.

Rothoblaas has invested in the development of solutions that follow a multidisciplinary approach and take into account the real conditions of the construction site. Laboratory measurements, static tests, durability tests, moisture control and fire performance studies allow the designer to benefit from real performance data and not just theoretical values that have limited practical applications.



SUSTAINABILITY

Environmental sustainability is an increasingly central issue in the construction sector and it has been taken into account in our company for a long time.

Although timber construction is in many respects more sustainable than other building systems, an assessment of the impacts linked to the entire life cycle of the products is still necessary in order to make an objective comparison between different building systems.

A suitable tool for this is the **EPD** (**Environmental Product Declaration**). This is a type III environmental declaration in accordance with EN ISO 14025 which, based on specific parameters, makes it possible to produce a technical document to use in order to make an objective comparison of the environmental impact of various products.

The EPD is a declaration based on **LCA** (**Life Cycle Assessment)** for which the study of all aspects related to the production, use and disposal of the product is required.

This is a voluntary initiative, not obligatory by law, which we have decided to implement to know the environmental impact of our products, and to allow the designer to have an accurate idea of the ecological footprint of the building he or she is designing.

XYLOFON 20

CODES AND DIMENSIONS

CODE	Shore	B [mm]	L [m]	s [mm]	*B [in]*	*L [ft]*	*s [in]*	pcs
XYL20050		50	3,66	6,0	*2*	*12*	*1/4*	1
XYL20080		80	3,66	6,0	*3 1/8*	*12*	*1/4*	1
XYL20090		90	3,66	6,0	*3 1/2*	*12*	*1/4*	1
XYL20100	20	100	3,66	6,0	*4*	*12*	*1/4*	1
XYL20120		120	3,66	6,0	*4 3/4*	*12*	*1/4*	1
XYL20140		140	3,66	6,0	*5 1/2*	*12*	*1/4*	1
XYL20160		160	3,66	6,0	*6 1/4*	*12*	*1/4*	1

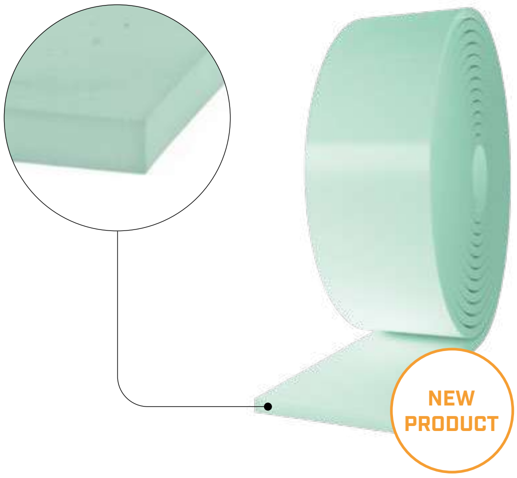


TABLE OF USE[1]

CODE	**load for acoustic optimisation(2)** [kN/m] *[lbf/ft]* min		max		**compression for acoustic optimisation(2)** [N/mm²] *[psi]* min	max	**reduction** [mm] *[mil]* min	max	***compressive stress at 3 mm (ultimate limit state)*** [N/mm²] *[psi]*
XYL20050	0,7	*590*	8	*5163*					
XYL20080	1,12	*944*	12,8	*8261*					
XYL20090	1,26	*1062*	14,4	*9293*					
XYL20100	1,4	*1180*	16	*10326*	0,016 *2.32*	0,14 *20.3*	0,06 *2*	0,6 *24*	***1,25*** *181*
XYL20120	1,68	*1416*	19,2	*12391*					
XYL20140	1,96	*1652*	22,4	*14456*					
XYL20160	2,24	*1888*	25,6	*16521*					

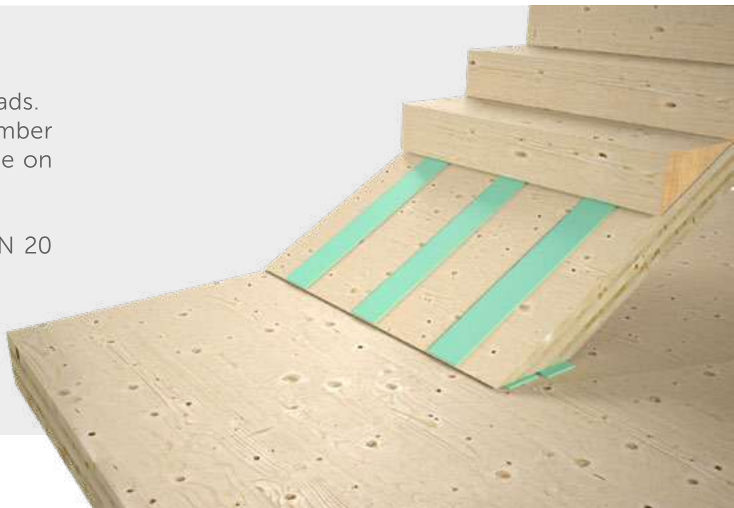
(1) The load ranges reported are optimised with respect to the static behaviour of the material assessed under compression, considering the effect of friction and the system resonance frequency, which falls between 20 and 30 Hz, with a maximum deformation of 12%. See the manual or use MyProject to view transmissibility and attenuation graphs.

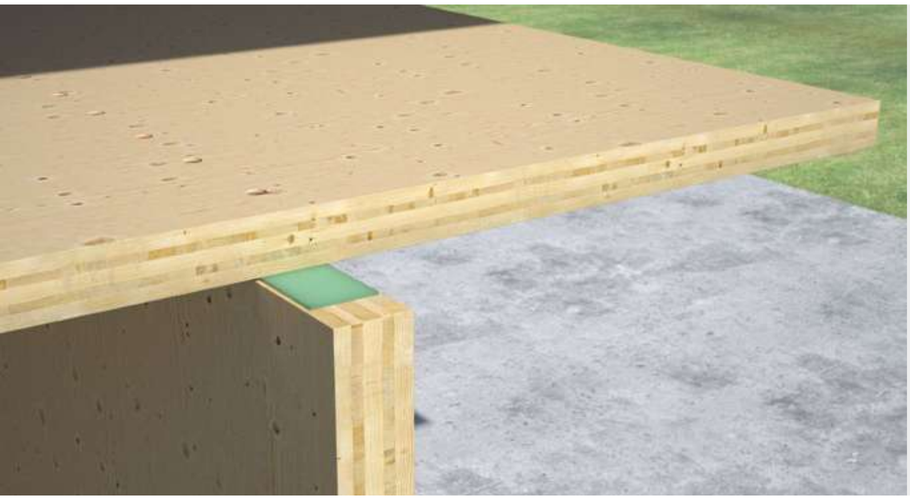
(2) Resilient profiles must be properly loaded in order to isolate medium/low frequency vibrations transmitted structurally. It is advisable to assess the load according to the operating conditions because the building must be acoustically insulated under everyday load conditions (add the value of the permanent load to 50% of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0.5\ q_{vk}$).

LIGHTNESS AND HEIGHT

XYLOFON 20 is the range innovation for light structures and low loads. The acoustic insulation performance is the same as for Mass Timber products, but the 20 shore polyurethane compound allows for use on frame structures, roofs and floors with small dimensions.

In the construction of multi-storey buildings, the use of XYLOFON 20 ensures soundproofing of the highest floors.





PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}^{(3)}$: **> 7** dB

Maximum applied load
(3 mm deformation):

1,25 N/mm²

Acoustic service load:

from **0,014** to **0,16** N/mm²

XYLOFON 35

TABLE OF USE[(1)]

CODE	load for acoustic optimisation[(2)] [kN/m] *[lbf/ft]*				compression for acoustic optimisation[(2)] [N/mm²] *[psi]*		reduction [mm] *[mil]*		*compressive stress at 3 mm (ultimate limit state)* [N/mm²] *[psi]*
	min		max		min	max	min	max	
XYL35080	3,04	*2242*	25,6	*18882*	0,038 *5.5*	0,32 *46.4*	0,05 *2*	0,5 *20*	***3,61*** *524*
XYL35090	3,42	*2522*	28,8	*21242*					
XYL35100	3,8	*2803*	32	*23602*					
XYL35120	4,56	*3363*	38,4	*28322*					
XYL35140	5,32	*3924*	44,8	*33043*					
XYL35160	6,08	*4484*	51,2	*37763*					

(1) The load ranges reported here are optimised with respect to the acoustic and static behaviour of the material in compression. However, 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. See the manual for transmissibility and attenuation graphs.

(2) 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% of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0.5\ q_{vk}$).

TECHNICAL DATA

Properties	standard	value	*USC conversion*
Acoustic improvement $\Delta_{l,ij}$[(3)]	ISO 10848	7,4 dB	-
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	3,22 MPa (1,74 MPa)	*467 psi (252 psi)*
Dynamic elastic modulus evaluated at 1 Hz E'_{1Hz} - E''_{1Hz}	ISO 4664-1	2,79 - 0,77 MPa	*405 - 112 psi*
Dynamic elastic modulus evaluated at 5 Hz E'_{5Hz} - E''_{5Hz}	ISO 4664-1	3,10 - 1,00 MPa	*450 psi - 145 psi*
Dynamic elastic modulus evaluated at 10 Hz E'_{10Hz} - E''_{10Hz}	ISO 4664-1	3,28 - 1,09 MPa	*476 - 158 psi*
Dynamic elastic modulus evaluated at 50 Hz E'_{50Hz} - E''_{50Hz}	ISO 4664-1	3,60 - 1,38 MPa	*522 - 200 psi*
Damping factor evaluated at 1 Hz $\tan\delta_{1Hz}$	ISO 4664-1	0,276	-
Damping factor evaluated at 5 Hz $\tan\delta_{5Hz}$	ISO 4664-1	0,321	-
Damping factor evaluated at 10 Hz $\tan\delta_{10Hz}$	ISO 4664-1	0,332	-
Damping factor evaluated at 50 Hz $\tan\delta_{50Hz}$	ISO 4664-1	0,382	-
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,54	-
Compression set c.s.	ISO 1856	0,72%	-
Compression at 1 mm deformation σ_{1mm}	ISO 844	0,5 N/mm²	*73 psi*
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	1,54 N/mm²	*223 psi*
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	3,61 N/mm²	*524 psi*
Dynamic stiffness s'[(4)]	ISO 9052	1262 MN/m³	
Max processing temperature (TGA)	-	200 °C	*392 °F*
Reaction to fire	EN 13501-1	class E	-
Water absorption after 48h	ISO 62	< 1 %	-

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

(4) ISO standards require for measurement with loads between 0.4 and 4 kPa and not with the product operating load.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[(3)] : **7,4** dB

Maximum applied load (3 mm deformation):

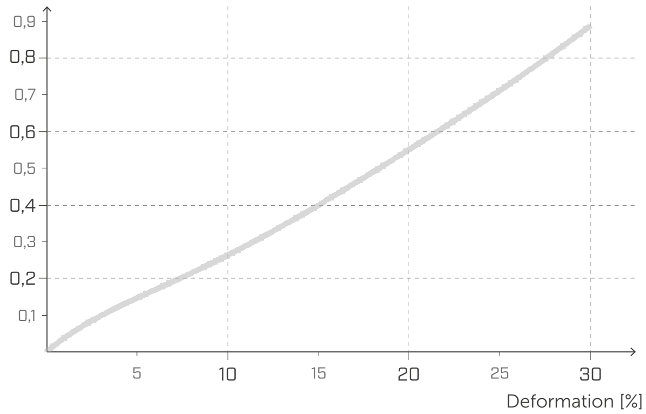
3,61 N/mm²

Acoustic service load:

from **0,038** to **0,32** N/mm²

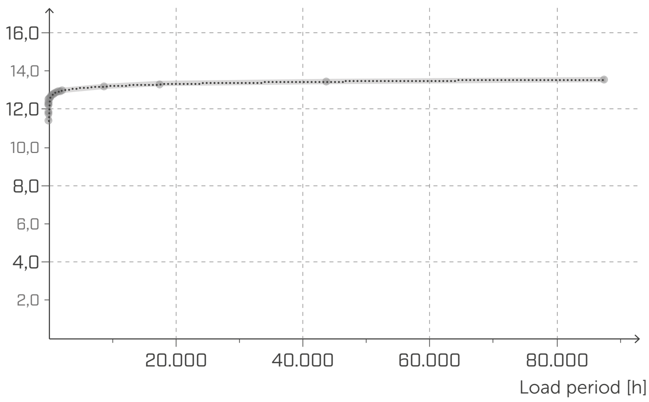
STRESS | DEFORMATION
COMPRESSION

Stress [MPa]



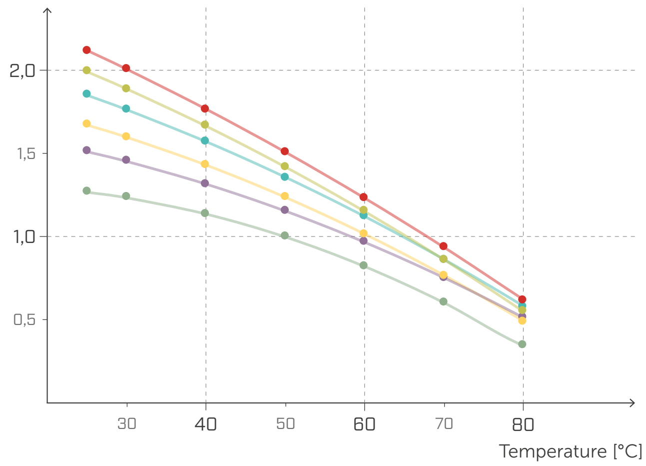
CREEP
COMPRESSION

Relative deformation
[% reduction in sample thickness]



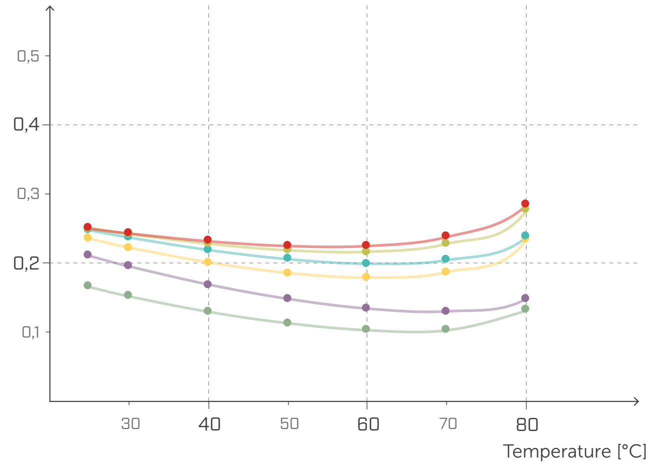
DYNAMIC ELASTIC MODULUS E'
DMTA

E' [MPa]



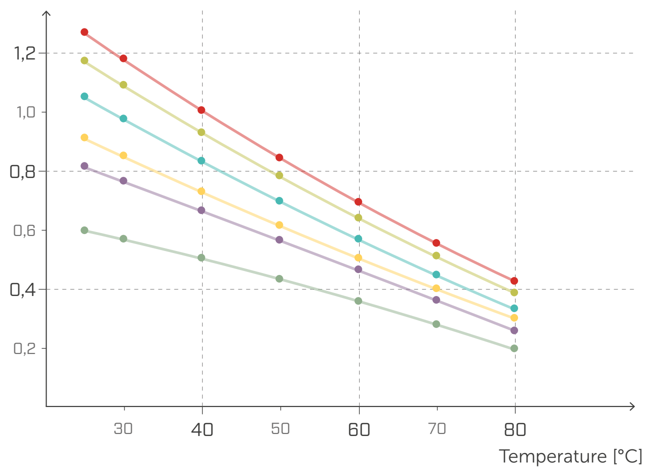
TAN δ UNDER STRESS
DMTA

Loss factor



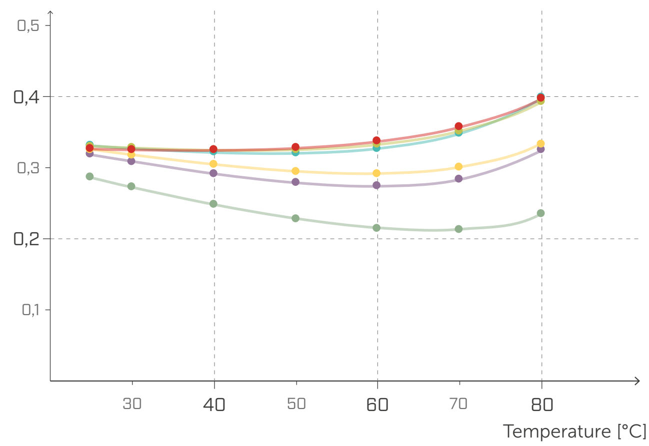
DYNAMIC ELASTIC MODULUS G'
DMTA

G' [MPa]



TAN δ SHEAR
DMTA

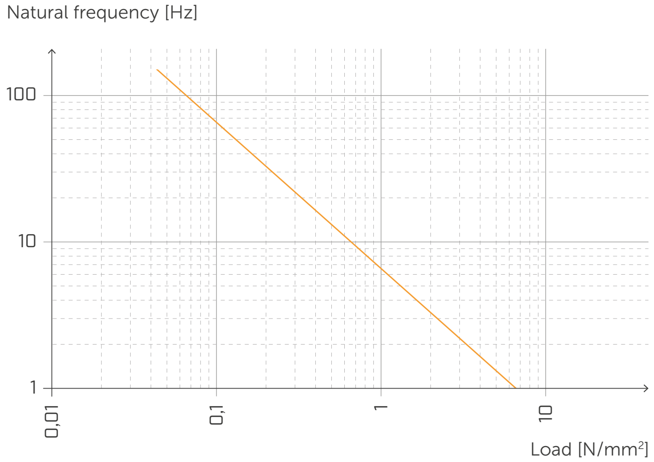
Loss factor



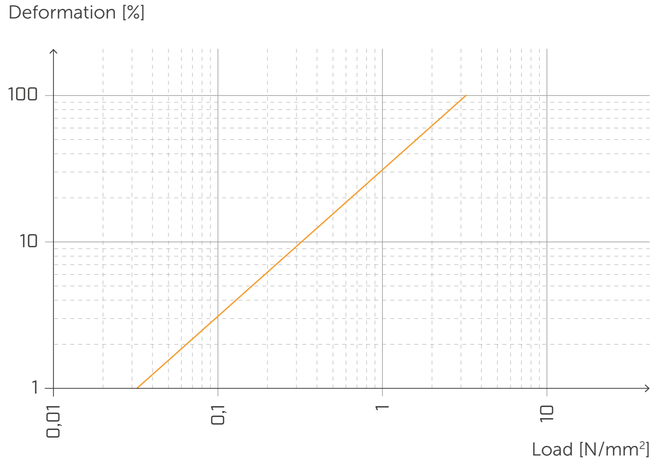
1,0 Hz/MPa 5,0 Hz/MPa 10,0 Hz/MPa 20,0 Hz/MPa 33,3 Hz/MPa 50,0 Hz/MPa

STATIC LOAD
(buildings)

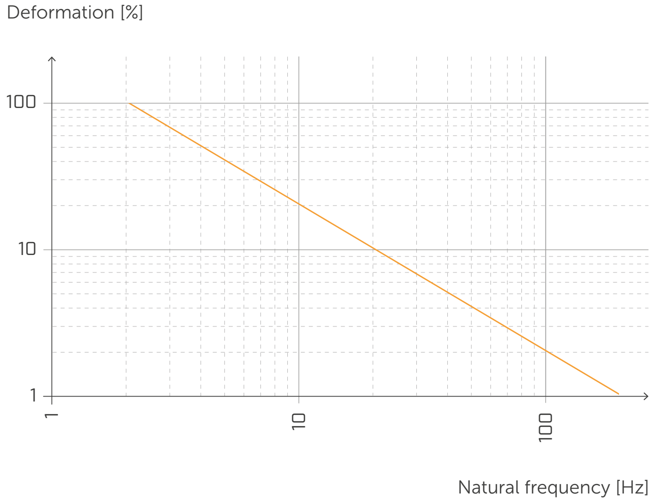
NATURAL FREQUENCY AND LOAD



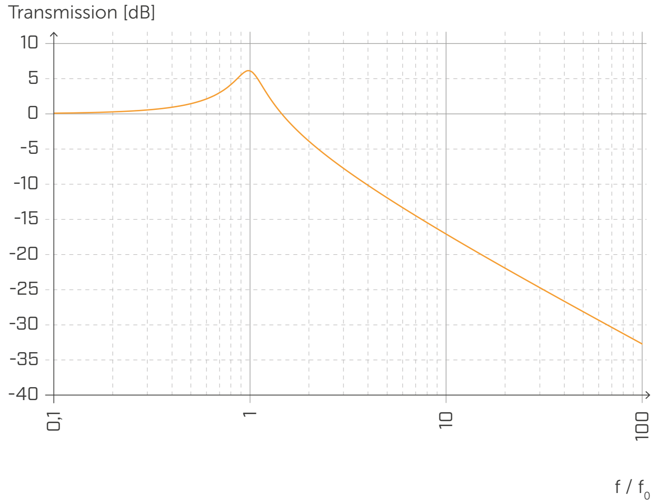
DEFORMATION AND LOAD



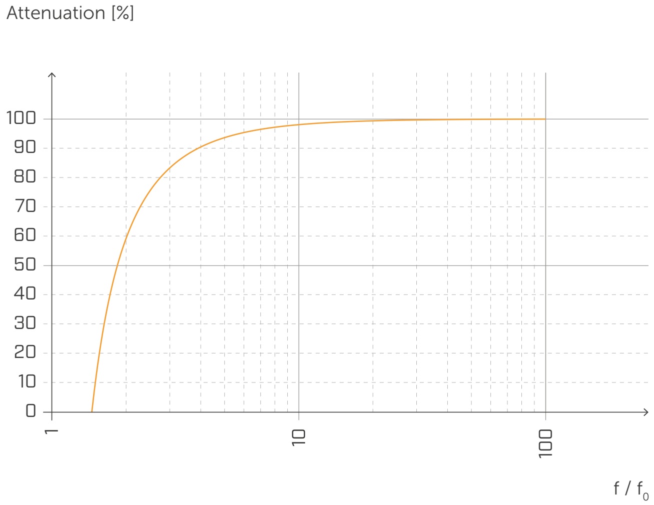
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

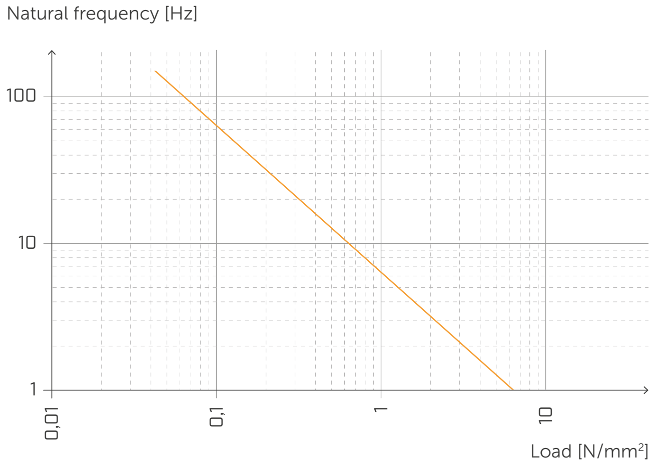


Normalised with respect to the resonance frequency with f = 20 Hz.

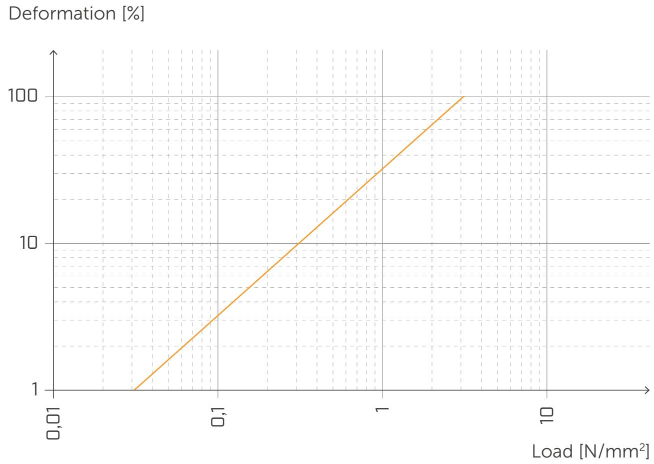
DYNAMIC LOAD
(machines and vibration)

5 Hz

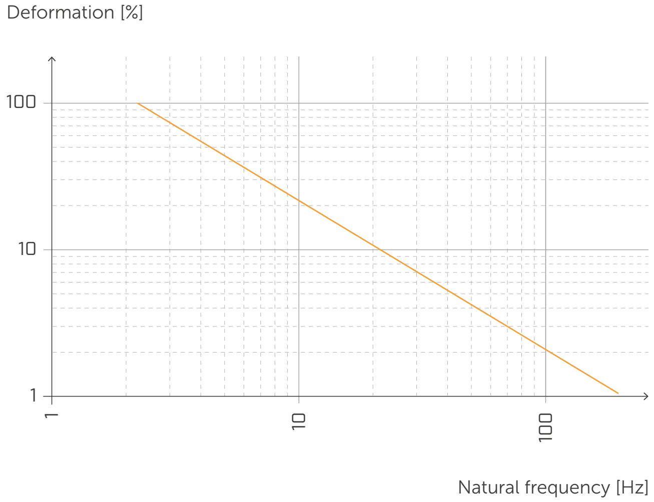
NATURAL FREQUENCY AND LOAD



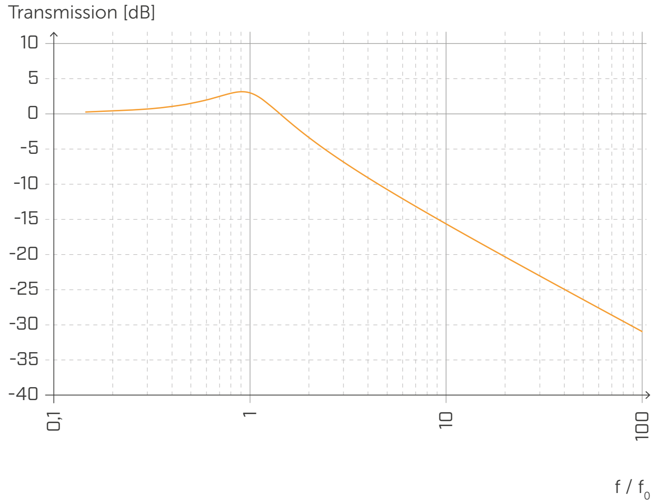
DEFORMATION AND LOAD



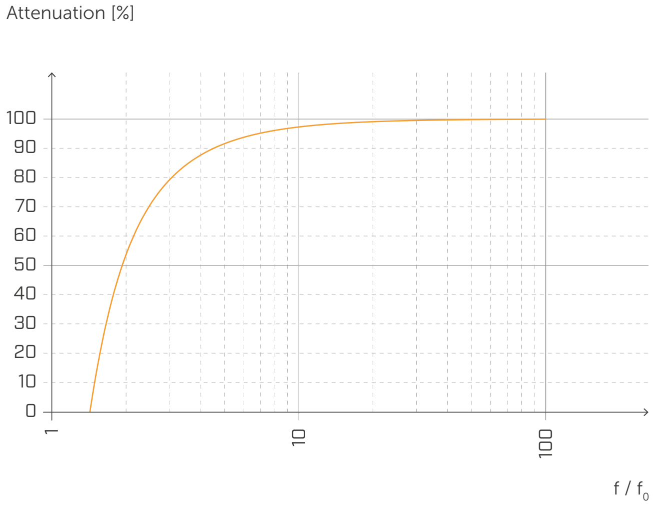
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



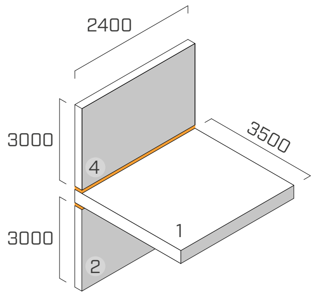
ATTENUATION



Normalised with respect to the resonance frequency with f = 5 Hz.

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

FASTENING SYSTEM

6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm (*17 1/4 in*)
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm (*69 5/16 in*)
fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE

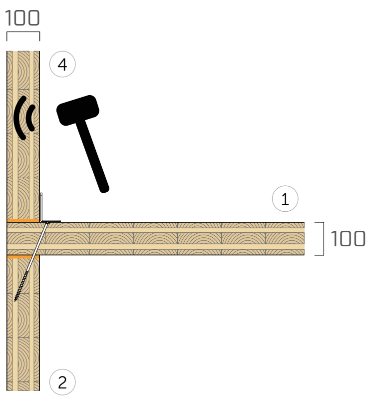
XYLOFON 35 + **XYLOFON PLATE**

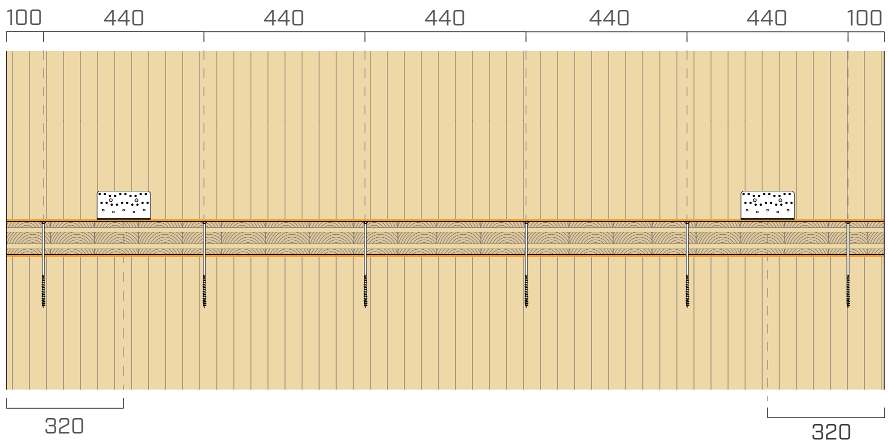
position: between the upper wall and the floor + between the floor and the lower wall.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	12,5	19,6	10,5	13,7	14,8	16,7	19,0	17,6	16,7	18,5	21,3	22,8	23,2	18,8	19,8	20,5

$\overline{K_{14}}$ = **17,9 dB** $\overline{K_{14,0}}$ = **14,4 dB** $\Delta_{l,14}$ = **3,5 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	18,2	21,3	12,3	15,3	17,3	17,6	20,7	20,1	23,6	22,3	23,2	24,0	24,3	22,0	24,1	20,3

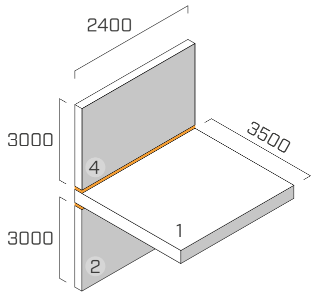
$\overline{K_{12}}$ = **20,3 dB** $\overline{K_{12,0}}$ = **14,6 dB** $\Delta_{l,12}$ = **5,7 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	11,8	25,9	16,1	23,5	21,1	25,4	23,9	23,6	26,2	27,5	32,6	34,1	33,2	35,0	34,7	32,0

$\overline{K_{24}}$ = **26,8 dB** $\overline{K_{24,0}}$ = **20,4 dB** $\Delta_{l,24}$ = **6,4 dB**

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

FASTENING SYSTEM

6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm (*17 1/4 in*)
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm (*69 5/16 in*)
fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE

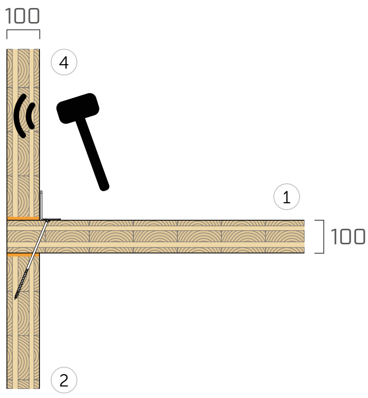
XYLOFON 35 + **XYLOFON PLATE**

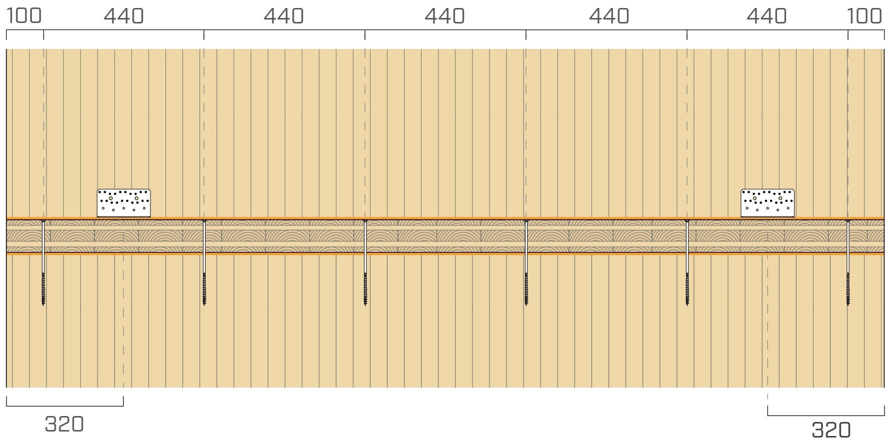
position: between the upper wall and the floor + between the floor and the lower wall.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)

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

applied load [N/m²]: 210000





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	21,0	20,1	16,1	19,9	17,5	21,4	24,4	17,7	20,9	17,6	17,9	19,2	20,7	18,2	18,5	21,7

$\overline{K_{14}}$ = **19,4 dB** $\overline{K_{14,0}}$ = **13,3 dB** $\Delta_{l,14}$ = **6,1 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	21,7	24,6	17,2	20,0	21,1	20,5	20,0	20,9	21,8	22,6	20,7	22,4	27,0	21,8	22,3	27,4

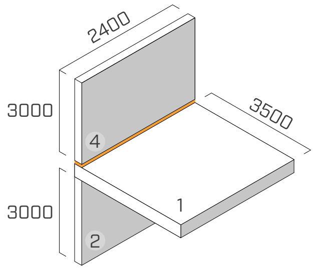
$\overline{K_{12}}$ = **21,6 dB** $\overline{K_{12,0}}$ = **14,5 dB** $\Delta_{l,12}$ = **7,1 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	18,9	29,2	23,3	22,6	24,2	22,5	22,0	20,2	22,6	22,0	24,7	25,8	32,0	29,9	28,5	29,6

$\overline{K_{24}}$ = **24,7 dB** $\overline{K_{24,0}}$ = **17,3 dB** $\Delta_{l,24}$ = **7,4 dB**

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

FASTENING SYSTEM

6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm (*17 1/4 in*)
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm (*69 5/16 in*)
fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE

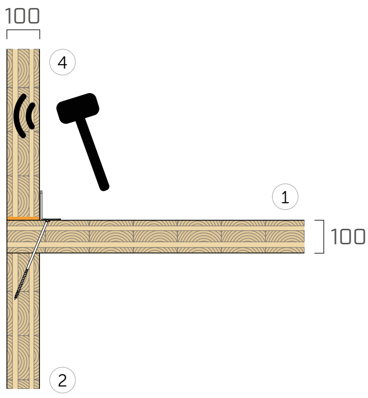
XYLOFON 35 + **XYLOFON PLATE**

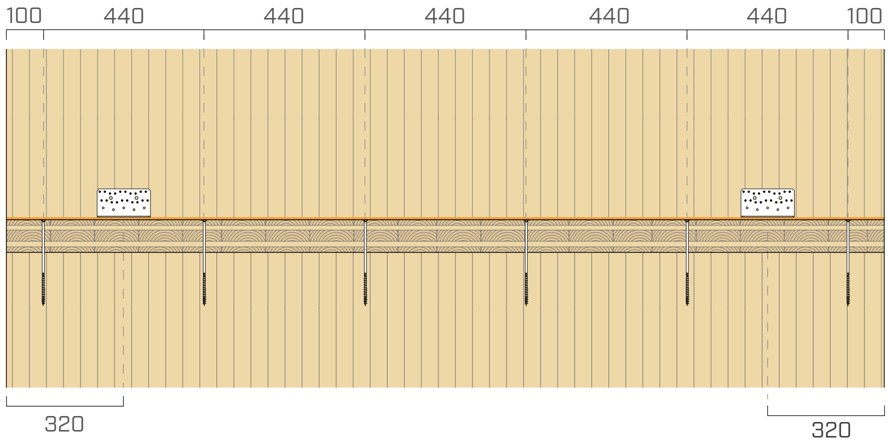
position: between the upper wall and the floor

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)

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

applied load [N/m²]: 210000





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	20,9	19,3	20,5	20,4	16,4	21,4	26,2	19,1	21,6	17,7	18,9	21,6	20,1	17,7	18,3	20,1

$\overline{K_{14}}$ = **20,1 dB** $\overline{K_{14,0}}$ = **13,3 dB** $\Delta_{l,14}$ = **6,8 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	20,1	18,3	12,5	10,2	13,3	10,6	13,9	10,7	14,6	11,1	9,6	13,2	17,3	14,8	17,9	21,1

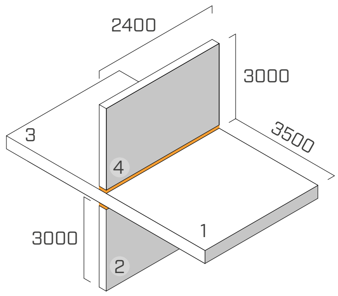
$\overline{K_{12}}$ = **13,1 dB** $\overline{K_{12,0}}$ = **14,5 dB** $\Delta_{l,12}$ = **-1,4 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	20,4	25,7	23,2	20,7	22,1	24,3	24,6	20,5	22,5	20,9	22,2	23,9	27,5	27,8	28,3	28,1

$\overline{K_{24}}$ = **23,5 dB** $\overline{K_{24,0}}$ = **17,3 dB** $\Delta_{l,24}$ = **6,2 dB**

X-JOINT | INTERNAL WALLS

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 7,1 m - *7.8 ft x 23.3 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

FASTENING SYSTEM

6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm (*17 1/4 in*)
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm (*69 5/16 in*)
fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE

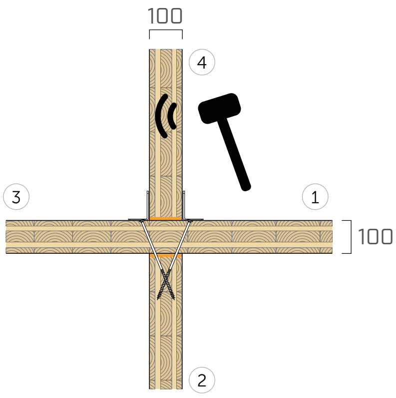
XYLOFON 35 + **XYLOFON PLATE**

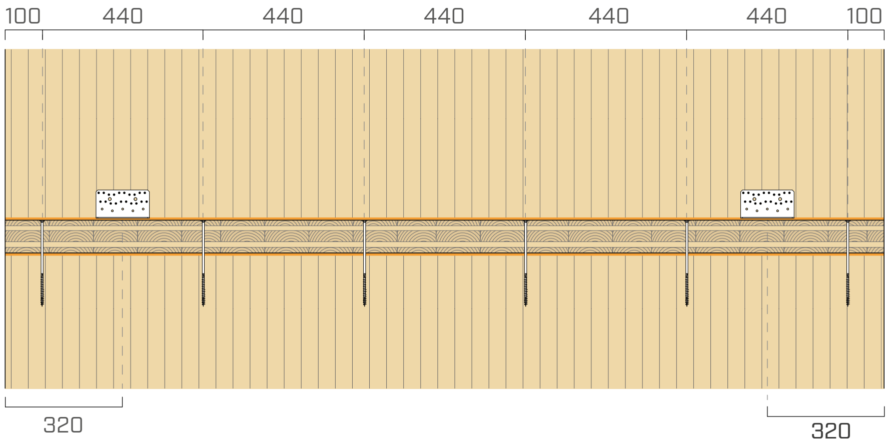
position: between the upper wall and the floor + between the floor and the lower wall

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	19,5	21,5	19,6	17,0	17,5	14,7	19,1	21,0	20,8	19,3	22,2	23,2	22,6	20,4	19,8	19,9

$\overline{K_{14}}$ = **19,9 dB** $\overline{K_{14,0}}$ = **17,0 dB** $\Delta_{l,14}$ = **2,9 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	16,7	15,6	12,0	17,4	17,7	16,1	21,0	20,2	23,1	19,1	23,4	22,4	24,2	23,9	24,7	24,0

$\overline{K_{12}}$ = **19,7 dB** $\overline{K_{12,0}}$ = **15,9 dB** $\Delta_{l,12}$ = **3,8 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	17,1	26,2	25,2	26,9	23,2	25,9	28,2	24,6	26,6	30,2	32,2	33,5	31,4	37,0	36,3	32,8

$\overline{K_{24}}$ = **28,6 dB** $\overline{K_{24,0}}$ = **23,2 dB** $\Delta_{l,24}$ = **5,4 dB**

XYLOFON 50

TABLE OF USE[1]

CODE	load for acoustic optimisation[2] [kN/m] *[lbf/ft]*				compression for acoustic optimisation[2] [N/mm²] *[psi]*		reduction [mm] *[mil]*		*compressive stress at 3 mm (ultimate limit state)* [N/mm²] *[psi]*
	min		max		min	max	min	max	
XYL50080	17,6	*12981*	54,4	*40123*	0,22 *31.9*	0,68 *98.6*	0,07 *3*	0,6 *24*	*8,59* *1246*
XYL50090	19,8	*14604*	61,2	*45139*					
XYL50100	22	*16226*	68	*50154*					
XYL50120	26,4	*19472*	81.6	*60185*					
XYL50140	30,8	*22717*	95,2	*70216*					
XYL50160	35,2	*25962*	108,8	*80247*					

(1) The load ranges reported here are optimised with respect to the acoustic and static behaviour of the material in compression. However, 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. See the manual for transmissibility and attenuation graphs.

(2) 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% of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0.5\ q_{vk}$).

TECHNICAL DATA

Properties	standard	value	*USC conversion*
Acoustic improvement Δ_{lij}[3]	ISO 10848	10,6 dB	-
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	7,11 MPa (2,89 MPa)	*1031 psi (419 psi)*
Dynamic elastic modulus evaluated at 1 Hz E'_{1Hz} - E''_{1Hz}	ISO 4664-1	4,64 - 0,55 MPa	*673 - 80 psi*
Dynamic elastic modulus evaluated at 5 Hz E'_{5Hz} - E''_{5Hz}	ISO 4664-1	3,93 - 0,68 MPa	*570 psi - 99 psi*
Dynamic elastic modulus evaluated at 10 Hz E'_{10Hz} - E''_{10Hz}	ISO 4664-1	4,09 - 0,73 MPa	*593 - 106 psi*
Dynamic elastic modulus evaluated at 50 Hz E'_{50Hz} - E''_{50Hz}	ISO 4664-1	4,36 - 0,98 MPa	*632 - 142 psi*
Damping factor evaluated at 1 Hz $\tan\delta_{1Hz}$	ISO 4664-1	0,153	-
Damping factor evaluated at 5 Hz $\tan\delta_{5Hz}$	ISO 4664-1	0,173	-
Damping factor evaluated at 10 Hz $\tan\delta_{10Hz}$	ISO 4664-1	0,178	-
Damping factor evaluated at 50 Hz $\tan\delta_{50Hz}$	ISO 4664-1	0,225	-
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,53	-
Compression set c.s.	ISO 1856	1,25%	-
Compression at 1 mm deformation σ_{1mm}	ISO 844	1,11 N/mm²	*161 psi*
Compression at 2 mm deformation σ_{2mm}	ISO 844	3,50 N/mm²	*508 psi*
Compression at 3 mm deformation σ_{3mm}	ISO 844	8,59 N/mm²	*1246 psi*
Dynamic stiffness s'[4]	ISO 9052	1455 MN/m³	-
Max processing temperature (TGA)	-	200 °C	*392 °F*
Reaction to fire	EN 13501-1	class E	-
Water absorption after 48h	ISO 62	< 1 %	-

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

(4) ISO standards require for measurement with loads between 0.4 and 4 kPa and not with the product operating load.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[3] : **10,6** dB

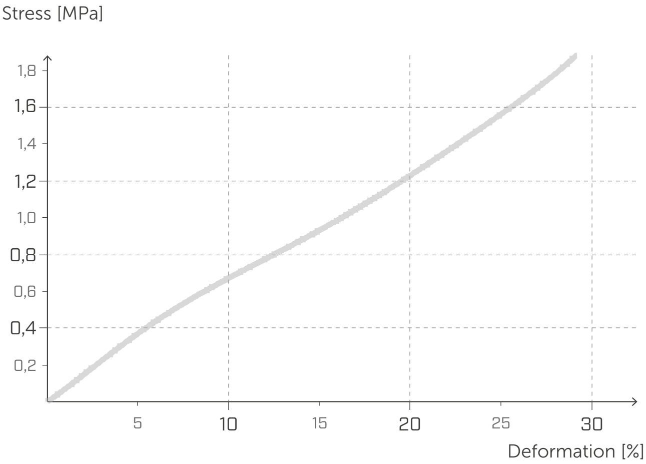
Maximum applied load (3 mm deformation):

8,59 N/mm²

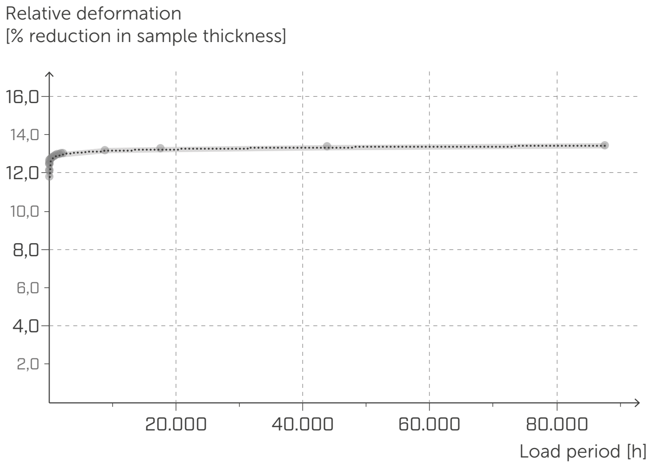
Acoustic service load:

from **0,22** to **0,68** N/mm²

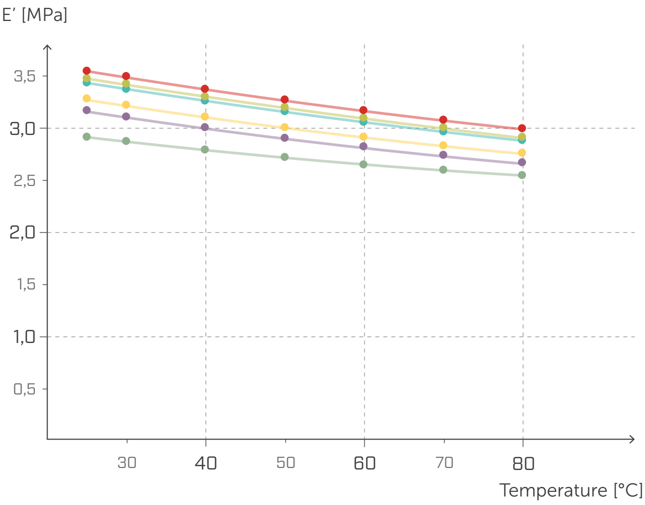
STRESS | DEFORMATION
COMPRESSION



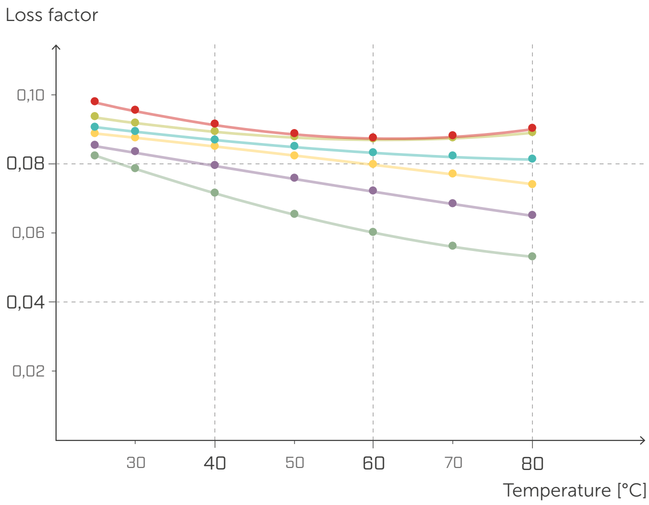
CREEP
COMPRESSION



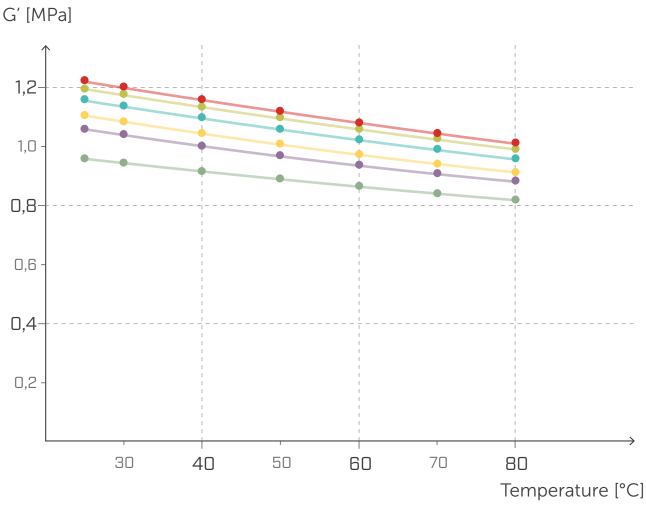
DYNAMIC ELASTIC MODULUS E'
DMTA



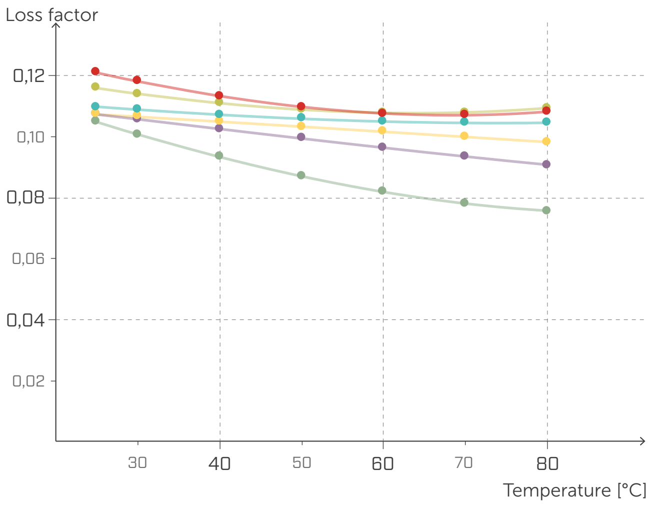
TAN δ UNDER STRESS
DMTA



DYNAMIC ELASTIC MODULUS G'
DMTA



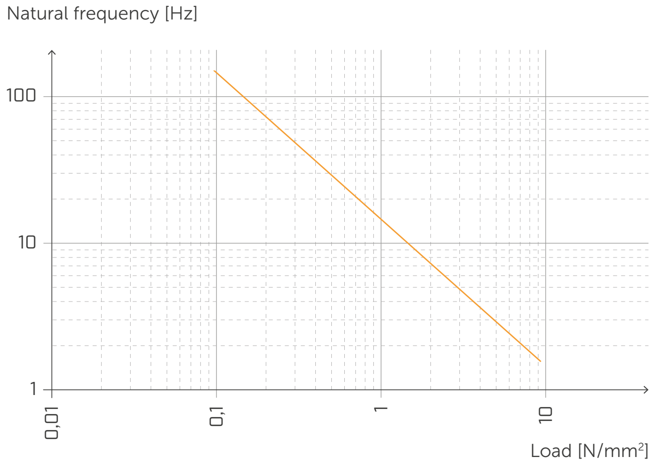
TAN δ SHEAR
DMTA



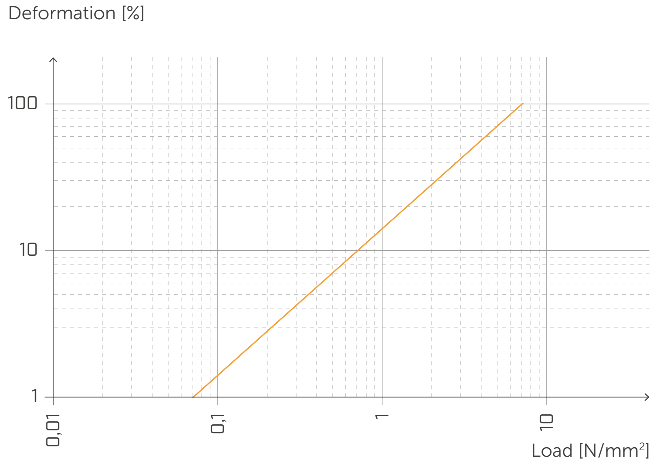
1,0 Hz/MPa — 5,0 Hz/MPa — 10,0 Hz/MPa — 20,0 Hz/MPa — 33,3 Hz/MPa — 50,0 Hz/MPa

STATIC LOAD
(buildings)

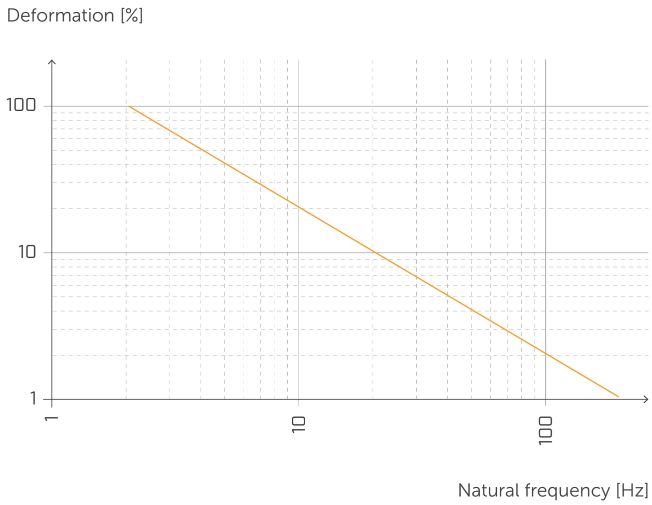
NATURAL FREQUENCY AND LOAD



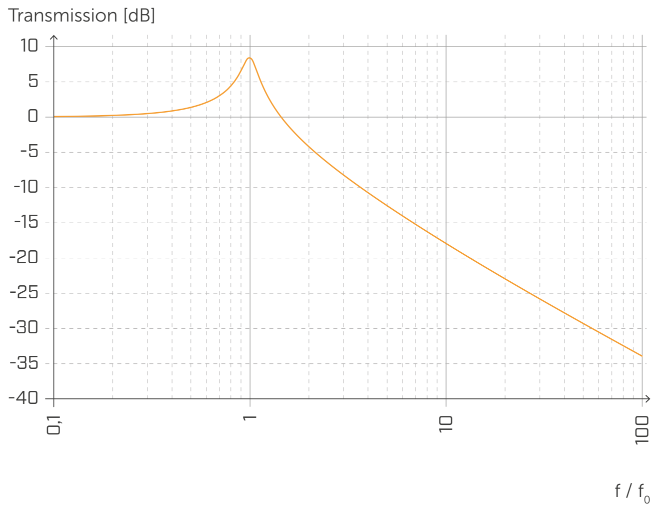
DEFORMATION AND LOAD



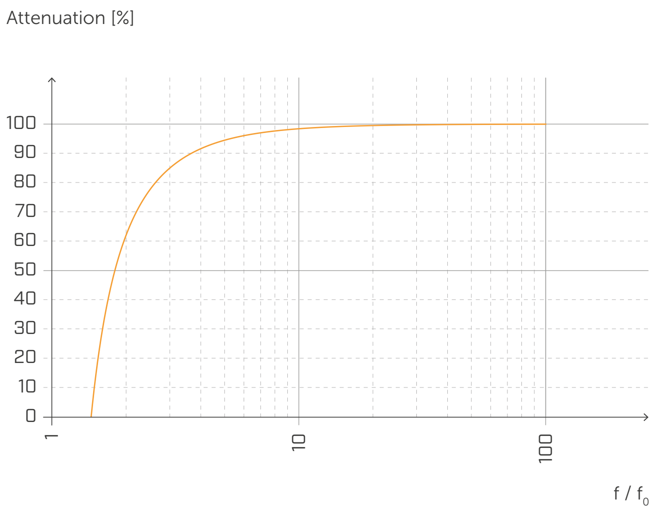
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



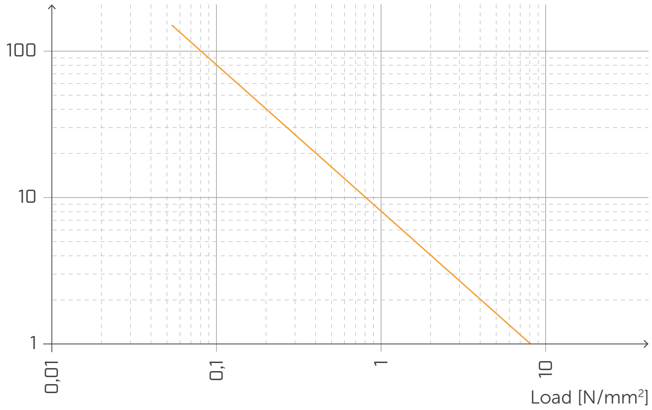
Normalised with respect to the resonance frequency with f = 20 Hz.

DYNAMIC LOAD
(machines and vibration)

5 Hz

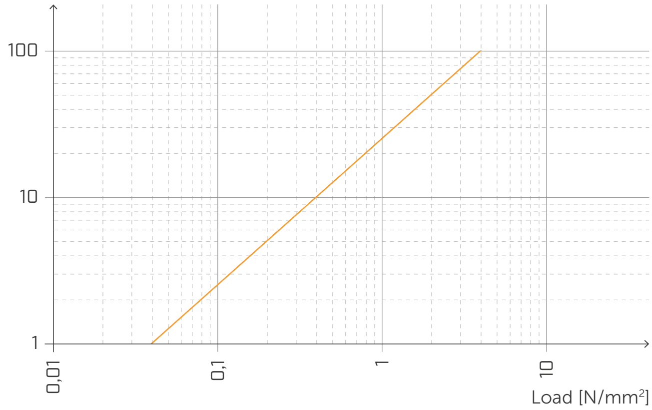
NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



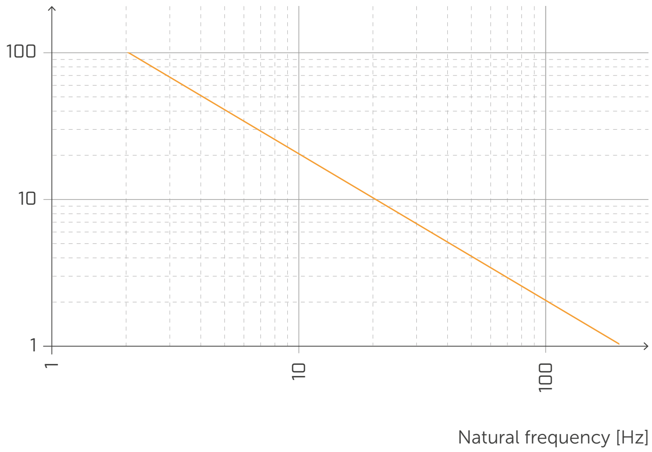
DEFORMATION AND LOAD

Deformation [%]



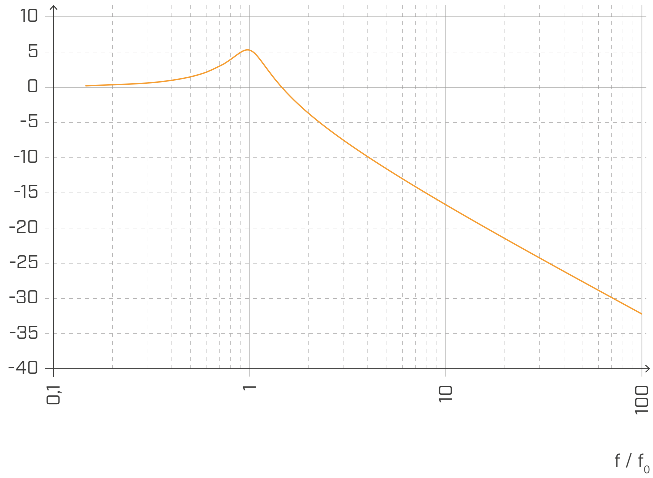
DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



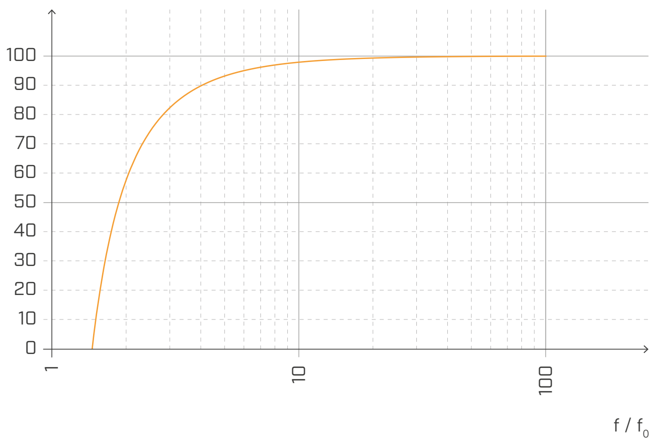
TRANSMISSIBILITY

Transmission [dB]



ATTENUATION

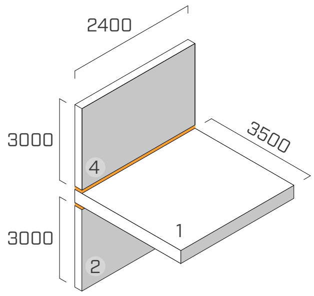
Attenuation [%]



Normalised with respect to the resonance frequency with f = 5 Hz.

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

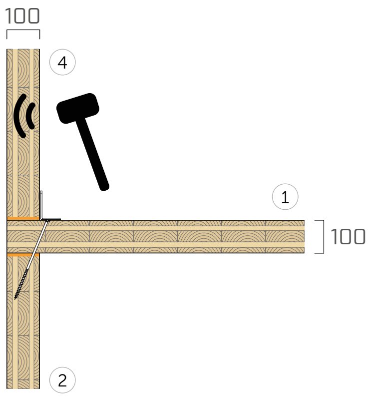
FASTENING SYSTEM

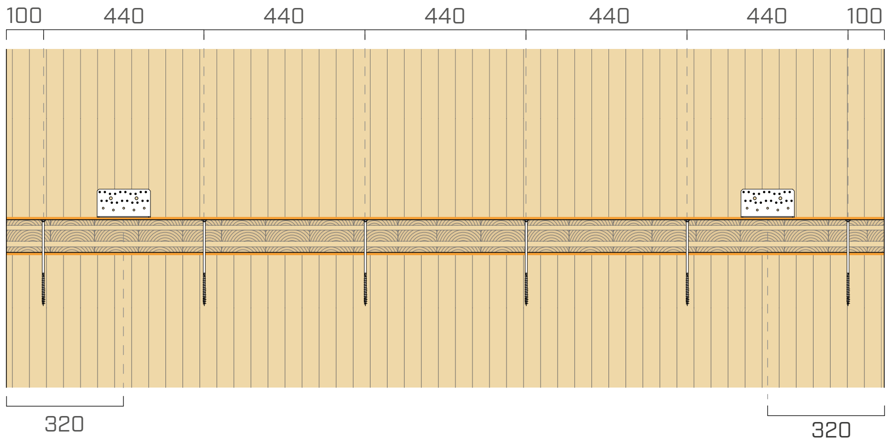
6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm (*17 1/4 in*)
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150), 146 x 55 x 77 x 2,5 mm, spacing 1760 mm (*69 5/16 in*)
fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE

XYLOFON 50 + **XYLOFON PLATE**

position: between the upper wall and the floor + between the floor and the lower wall.
dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)
contact area: continuous strip (same width as the wall)
applied load [N/m²]: 338000





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	17,6	17,7	20,5	21,3	18,4	21,9	24,3	16,9	20,5	21,0	18,6	19,7	21,9	16,1	16,3	20,7

$\overline{K_{14}}$ = **19,9 dB** $\overline{K_{14,0}}$ = **13,3 dB** $\Delta_{l,14}$ = **6,6 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	22,1	19,2	15,9	21,0	20,5	21,5	24,0	21,2	19,8	23,0	23,7	23,6	26,8	23,2	24,3	28,3

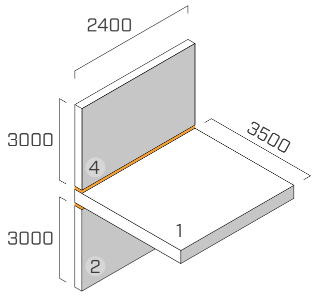
$\overline{K_{12}}$ = **21,8 dB** $\overline{K_{12,0}}$ = **14,5 dB** $\Delta_{l,12}$ = **7,3 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	18,7	26,7	26,6	31,1	24,4	27,8	26,6	25,3	22,5	27,8	28,6	33,2	28,6	33,3	34,0	31,6

$\overline{K_{24}}$ = **27,9 dB** $\overline{K_{24,0}}$ = **17,3 dB** $\Delta_{l,24}$ = **10,6 dB**

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

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floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

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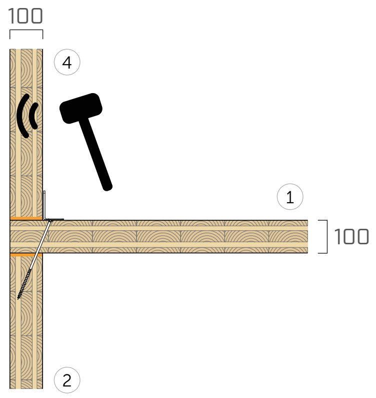
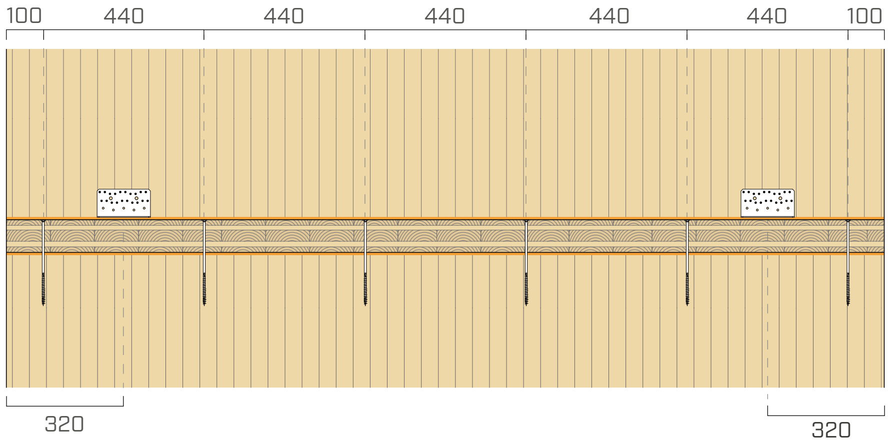
dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	12,3	18,4	17,0	19,7	15,3	19,3	23,6	20,5	22,2	19,9	23,6	24,5	24,6	22,4	21,8	20,5

$\overline{K_{14}}$ = **20,8 dB** $\overline{K_{14,0}}$ = **14,4 dB** $\Delta_{l,14}$ = **6,4 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	15,5	19,2	15,8	18,1	19,0	19,4	20,9	18,3	18,8	20,3	20,4	23,7	25,0	24,1	21,3	23,5

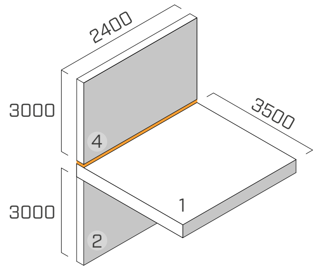
$\overline{K_{12}}$ = **20,2 dB** $\overline{K_{12,0}}$ = **14,6 dB** $\Delta_{l,12}$ = **5,6 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	12,3	25,0	20,2	26,9	23,5	27,7	27,0	27,0	28,8	30,5	33,5	36,0	35,9	38,7	36,1	31,6

$\overline{K_{24}}$ = **29,3 dB** $\overline{K_{24,0}}$ = **20,4 dB** $\Delta_{l,24}$ = **8,9 dB**

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



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floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
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FASTENING SYSTEM

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RESILIENT PROFILE

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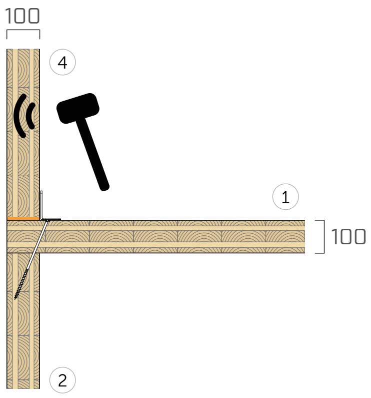
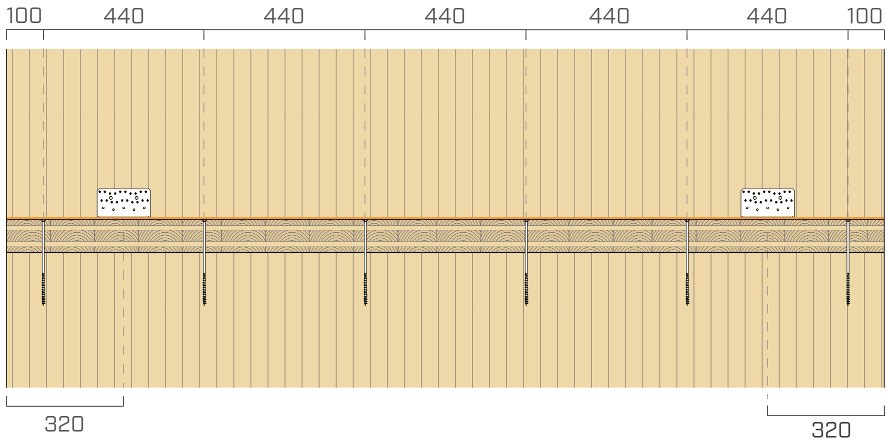
dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)

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

applied load [N/m²]: 338000





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	19,4	18,3	20,6	27,4	19,4	23,9	25,0	17,1	19,3	20,4	19,6	20,6	22,8	17,3	18,4	21,1

$\overline{K_{14}}$ = **20,9 dB** $\overline{K_{14,0}}$ = **13,3 dB** $\Delta_{l,14}$ = **7,6 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	15,8	13,8	8,9	9,4	13,8	10,5	13,8	10,2	11,7	11,0	10,1	13,0	15,9	14,9	16,8	19,9

$\overline{K_{12}}$ = **12,1 dB** $\overline{K_{12,0}}$ = **14,5 dB** $\Delta_{l,12}$ = **-2,4 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	18,2	23,7	23,2	28,0	26,4	24,5	24,4	19,6	20,2	23,0	21,0	25,7	26,4	29,3	30,3	28,2

$\overline{K_{24}}$ = **24,3 dB** $\overline{K_{24,0}}$ = **17,3 dB** $\Delta_{l,24}$ = **7 dB**

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4

STRUCTURE
upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
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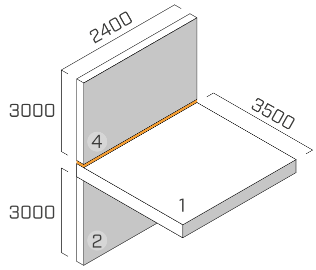

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fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE
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dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)
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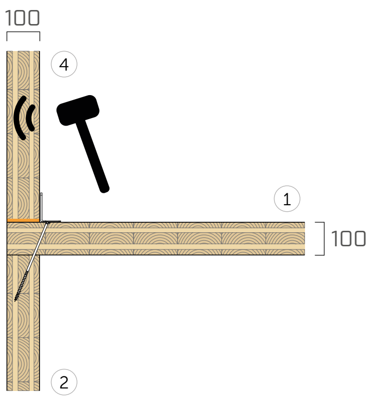
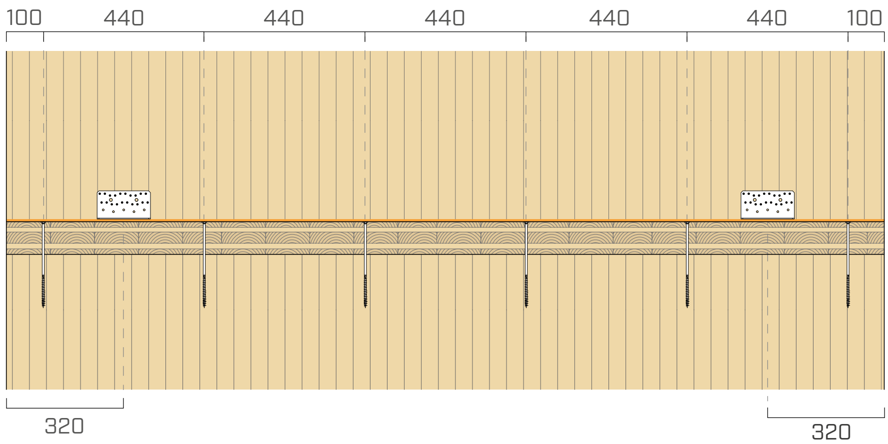
applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	11,0	14,4	16,0	17,2	17,3	19,8	23,1	20,1	23,5	21,7	26,9	26,6	24,5	24,6	24,1	22,0

$\overline{K_{14}}$ = **21,2 dB** $\overline{K_{14,0}}$ = **14,4 dB** $\Delta_{l,14}$ = **6,8 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	15,8	10,9	9,5	9,2	14,5	10,7	13,2	10,3	14,3	12,1	14,5	14,4	15,7	18,0	19,4	19,7

$\overline{K_{12}}$ = **12,9 dB** $\overline{K_{12,0}}$ = **14,6 dB** $\Delta_{l,12}$ = **-1,8 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	15,2	24,5	21,3	23,8	19,6	23,0	22,6	21,9	26,7	26,8	31,6	26,3	29,8	34,3	34,9	31,1

$\overline{K_{24}}$ = **25,5 dB** $\overline{K_{24,0}}$ = **20,4 dB** $\Delta_{l,24}$ = **5,1 dB**

XYLOFON 70

TABLE OF USE[1]

CODE	load for acoustic optimisation[2] [kN/m] *[lbf/ft]*				compression for acoustic optimisation[2] [N/mm²] *[psi]*		reduction [mm] *[mil]*		*compressive stress at 3 mm (ultimate limit state)* [N/mm²] *[psi]*
	min		max		min	max	min	max	
XYL70080	39,2	*28912*	120	*88507*	0,49 *71.1*	1,5 *218*	0,2 *8*	0,65 *26*	***11,1*** *1610*
XYL70090	44,1	*32526*	135	*99571*					
XYL70100	49	*36141*	150	*110634*					
XYL70120	58,8	*43369*	180	*132761*					
XYL70140	68.6	*50597*	210	*154888*					
XYL70160	78,4	*57825*	240	*177015*					

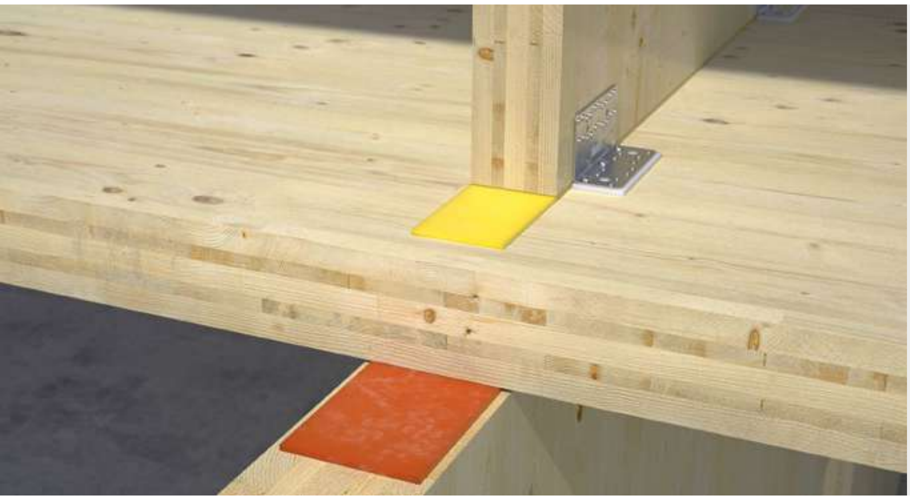
(1) The load ranges reported here are optimised with respect to the acoustic and static behaviour of the material in compression. However, it is possible to use profiles with loads outside the indicated range if the resonance frequency of the system and the deformation of the profile at the ultimate limit state are assessed. See the manual for transmissibility and attenuation graphs.

(2) 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% of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0.5\, q_{vk}$).

TECHNICAL DATA

Properties	standard	value	*USC conversion*
Acoustic improvement Δ_{lij}[3]	ISO 10848	7,8 dB	-
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	14,18 MPa (7,26 MPa)	*2057 psi (1053 psi)*
Dynamic elastic modulus evaluated at 1 Hz E'_{1Hz} - E''_{1Hz}	ISO 4664-1	6,00 - 0,47 MPa	*870 - 68 psi*
Dynamic elastic modulus evaluated at 5 Hz E'_{5Hz} - E''_{5Hz}	ISO 4664-1	6,44 - 0,77 MPa	*934 psi - 112 psi*
Dynamic elastic modulus evaluated at 10 Hz E'_{10Hz} - E''_{10Hz}	ISO 4664-1	6,87 - 1,03 MPa	*996 - 149 psi*
Dynamic elastic modulus evaluated at 50 Hz E'_{50Hz} - E''_{50Hz}	ISO 4664-1	7,87 - 2,22 MPa	*1141 - 322 psi*
Damping factor evaluated at 1 Hz $\tan\delta_{1Hz}$	ISO 4664-1	0,077	-
Damping factor evaluated at 5 Hz $\tan\delta_{5Hz}$	ISO 4664-1	0,118	-
Damping factor evaluated at 10 Hz $\tan\delta_{10Hz}$	ISO 4664-1	0,148	-
Damping factor evaluated at 50 Hz $\tan\delta_{50Hz}$	ISO 4664-1	0,282	-
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	2,9	-
Compression set c.s.	ISO 1856	0,71%	-
Compression at 1 mm deformation σ_{1mm}	ISO 844	2,44 N/mm²	*354 psi*
Compression at 2 mm deformation σ_{2mm}	ISO 844	5,43 N/mm²	*788 psi*
Compression at 3 mm deformation σ_{3mm}	ISO 844	11,10 N/mm²	*1610 psi*
Dynamic stiffness s'[4]	ISO 9052	1822 MN/m³	
Max processing temperature (TGA)	-	200 °C	*392 °F*
Reaction to fire	EN 13501-1	class E	-
Water absorption after 48h	ISO 62	< 1 %	-

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.
(4) ISO standards require for measurement with loads between 0.4 and 4 kPa and not with the product operating load.



PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$(3) : **7,8** dB

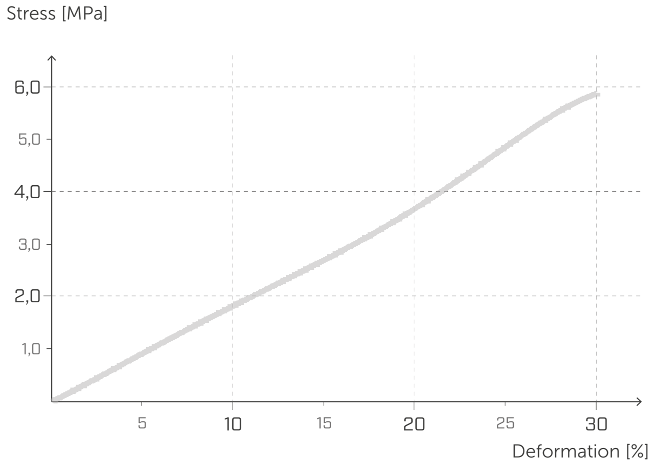
Maximum applied load
(3 mm deformation):

11,1 N/mm²

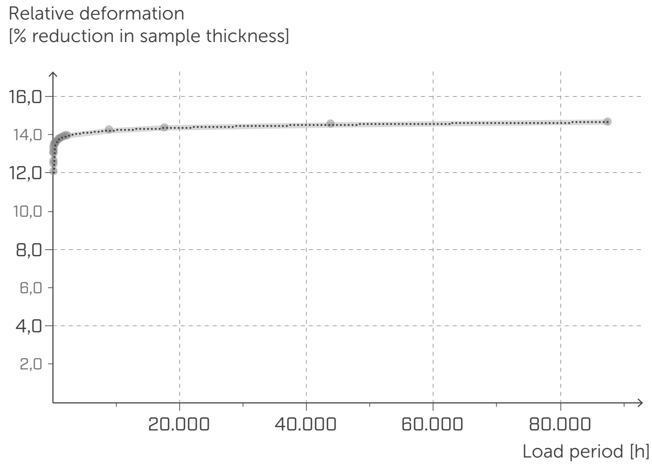
Acoustic service load:

from **0,49** to **1,5** N/mm²

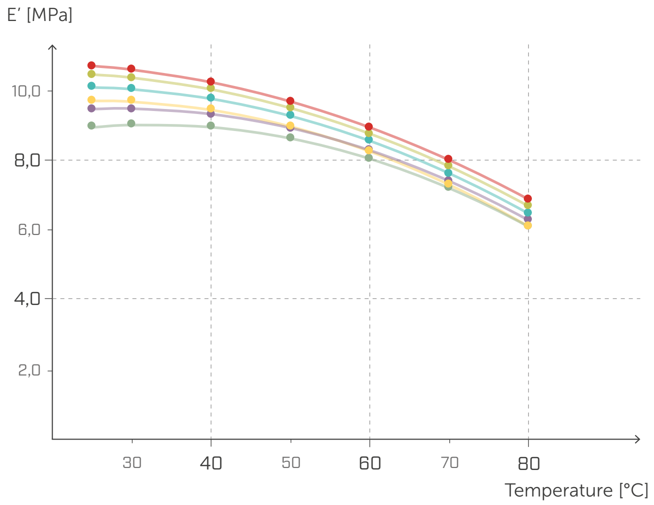
STRESS | DEFORMATION
COMPRESSION



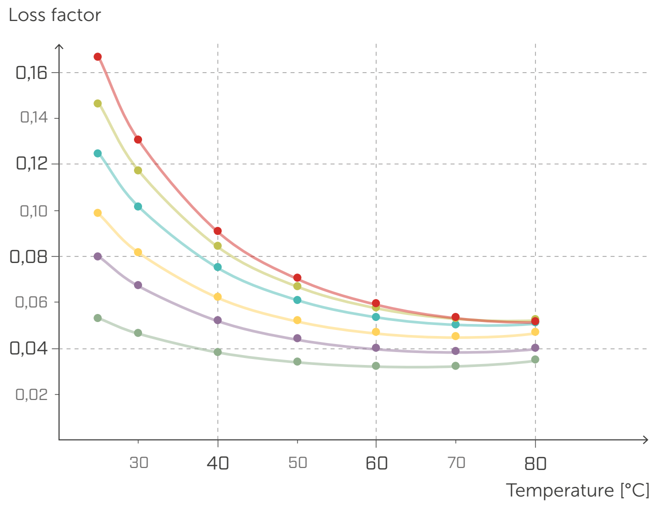
CREEP
COMPRESSION



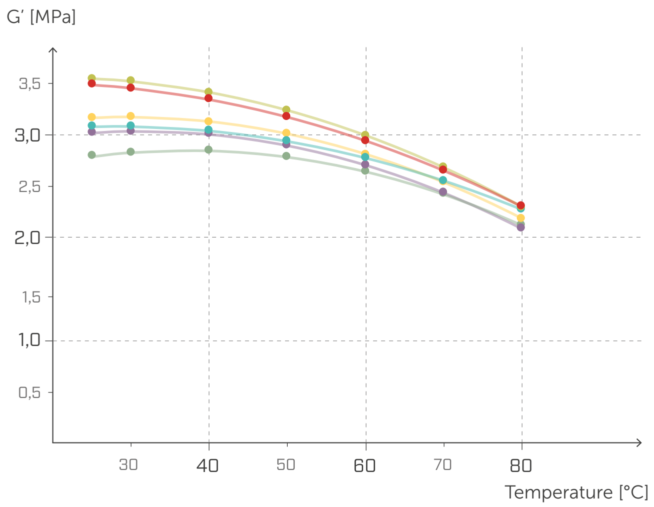
DYNAMIC ELASTIC MODULUS E'
DMTA



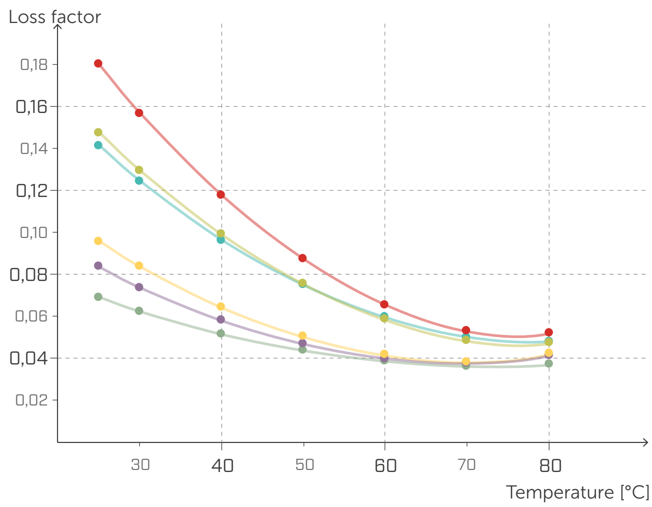
TAN δ UNDER STRESS
DMTA



DYNAMIC ELASTIC MODULUS G'
DMTA



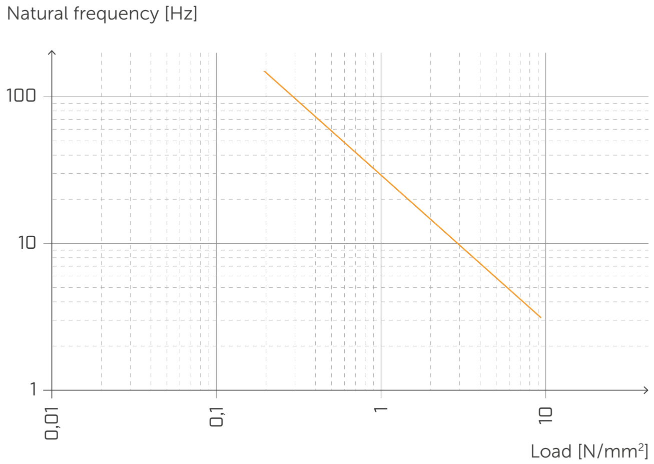
TAN δ SHEAR
DMTA



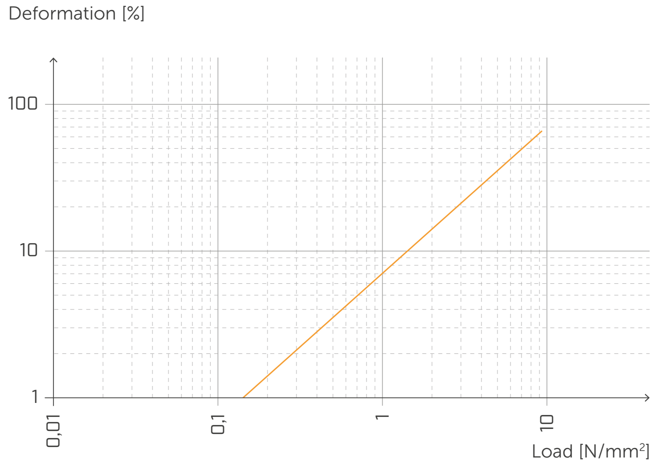
1,0 Hz/MPa 5,0 Hz/MPa 10,0 Hz/MPa 20,0 Hz/MPa 33,3 Hz/MPa 50,0 Hz/MPa

STATIC LOAD
(buildings)

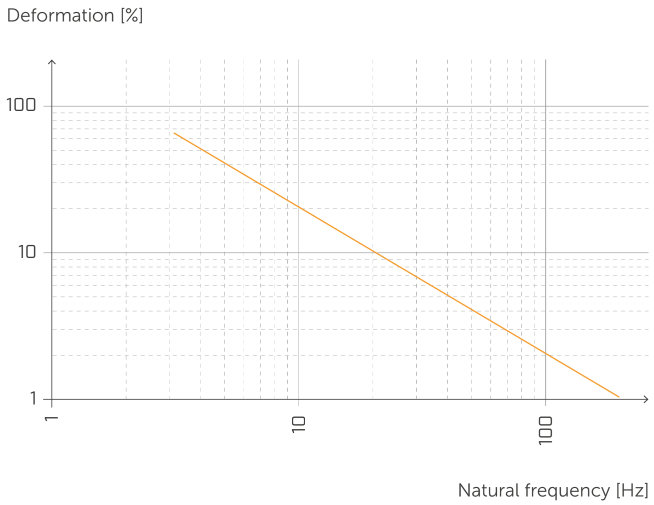
NATURAL FREQUENCY AND LOAD



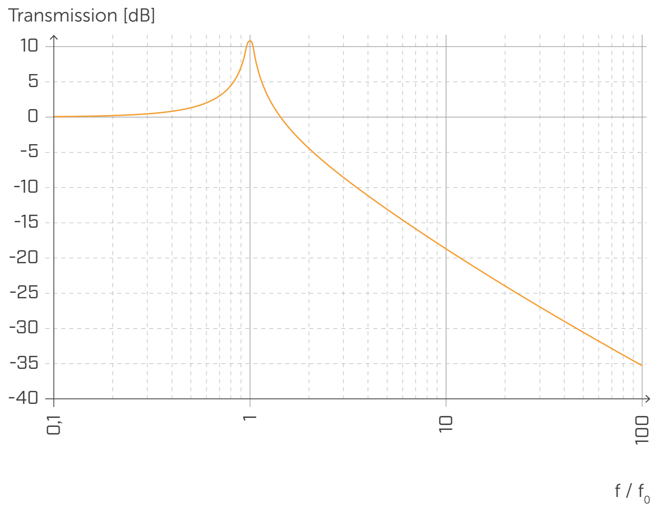
DEFORMATION AND LOAD



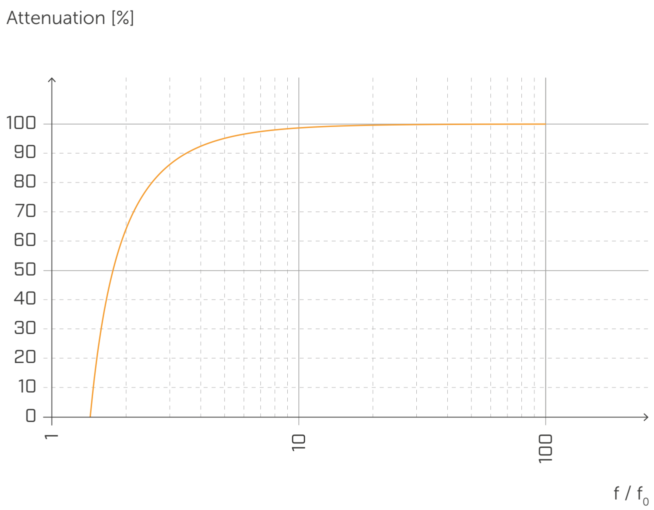
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

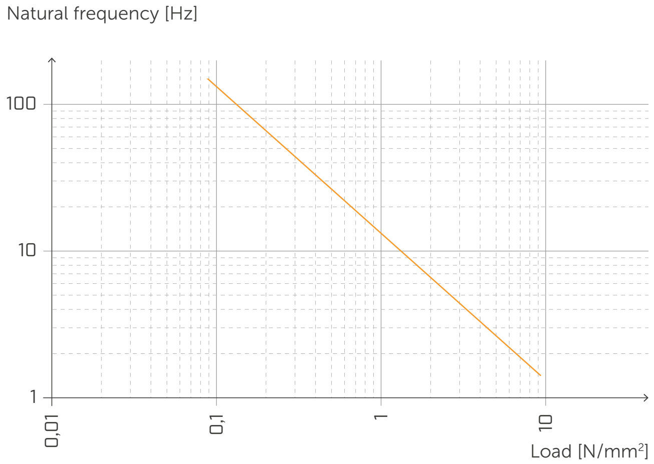


Normalised with respect to the resonance frequency with f = 20 Hz.

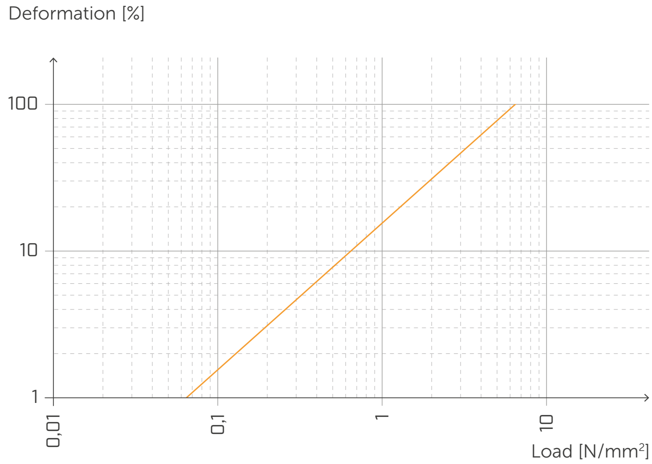
DYNAMIC LOAD
(machines and vibration)

5 Hz

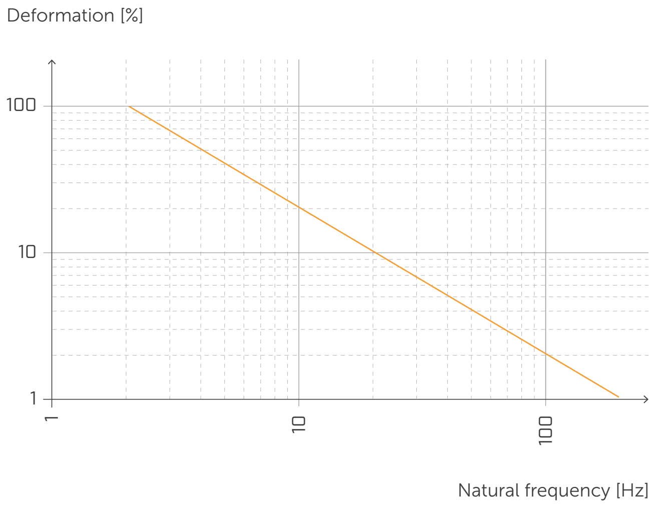
NATURAL FREQUENCY AND LOAD



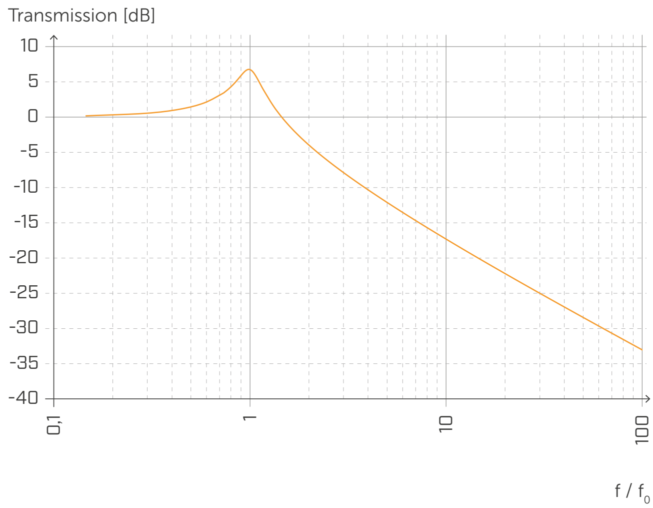
DEFORMATION AND LOAD



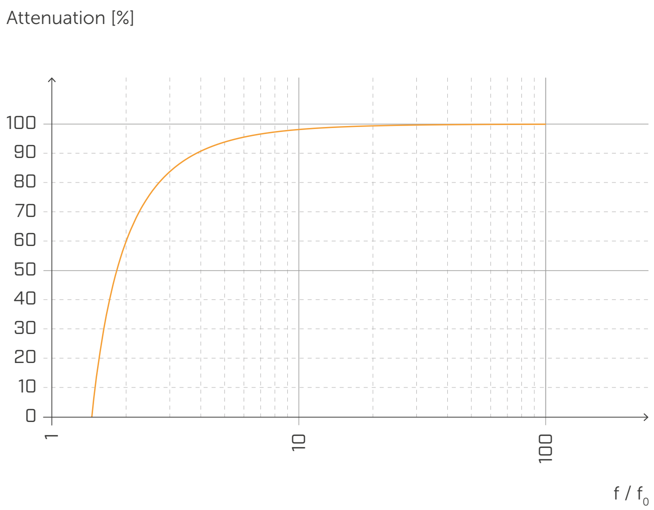
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



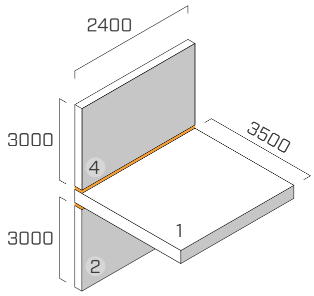
ATTENUATION



Normalised with respect to the resonance frequency with f = 5 Hz.

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

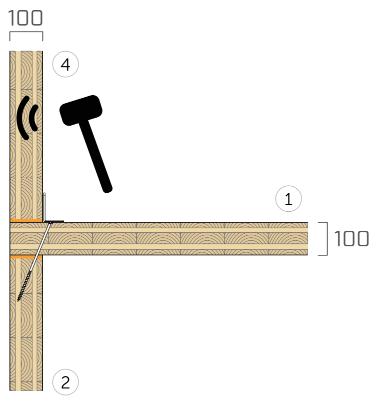
FASTENING SYSTEM

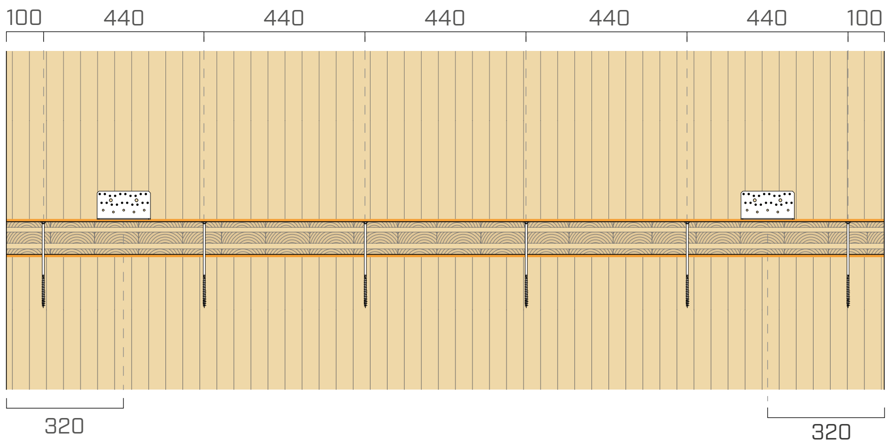
6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm (*17 1/4 in*)
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm (*69 5/16 in*)
fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE

XYLOFON 70 + **XYLOFON PLATE**

position: between the upper wall and the floor + between the floor and the lower wall
dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)
contact area: continuous strip (same width as the wall)
applied load [N/m²]: 625000





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	15,1	21,7	16,7	14,0	18,0	15,9	19,6	15,5	16,8	16,5	14,7	16,8	18,0	15,6	14,4	17,8

$\overline{K_{14}}$ = **16,9 dB** $\overline{K_{14,0}}$ = **13,3 dB** $\Delta_{l,14}$ = **3,6 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	21,1	23,8	15,4	17,4	16,0	18,2	20,6	18,4	20,4	19,8	18,3	17,8	22,8	18,8	18,4	22,3

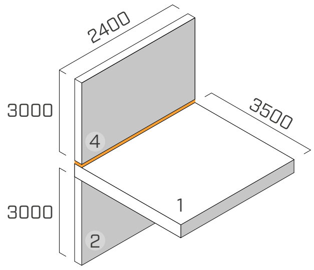
$\overline{K_{12}}$ = **19,0 dB** $\overline{K_{12,0}}$ = **14,5 dB** $\Delta_{l,12}$ = **4,5 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	16,1	28,4	25,6	24,8	23,3	23,9	22,3	22,5	23,1	23,4	25,2	23,7	29,1	31,5	31,2	31,1

$\overline{K_{24}}$ = **25,1 dB** $\overline{K_{24,0}}$ = **17,3 dB** $\Delta_{l,24}$ = **7,8 dB**

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)
floor: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3,5 m - *7.8 ft x 11 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (2,4 m x 3 m - *7.8 ft x 10 ft*)

FASTENING SYSTEM

6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm (*17 1/4 in*)
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm *69 5/16 in*)
fastening pattern on CLT: 31 screws Ø5 x 50 mm

RESILIENT PROFILE

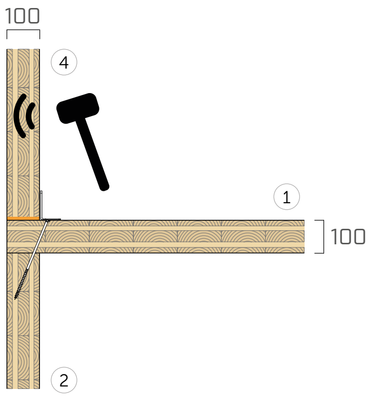
XYLOFON 70 + **XYLOFON PLATE**

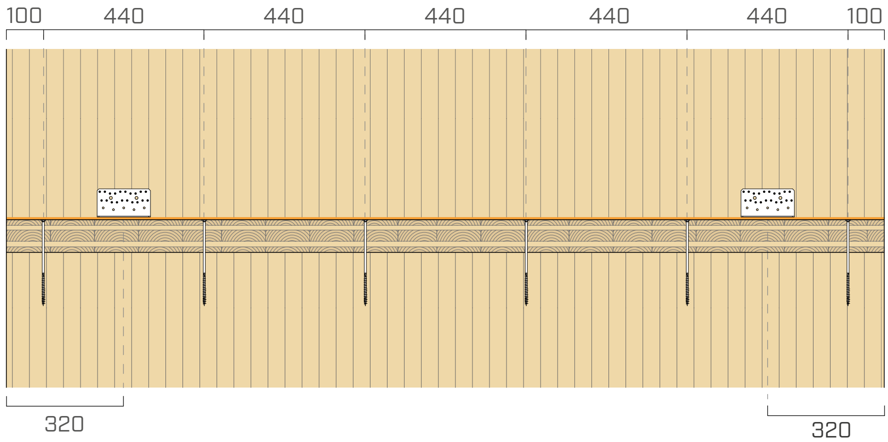
position: between the upper wall and the floor

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 2,40 m (*7.8 ft*)

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

applied load [N/m²]: 625000





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	18,4	16,2	21,3	21,8	18,9	17,4	20,2	16,7	16,7	17,1	14,7	18,3	18,6	16,3	13,8	19,2

$\overline{K_{14}}$ = **18,0 dB** $\overline{K_{14,0}}$ = **13,7 dB** $\Delta_{l,14}$ = **4,7 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	18,9	19,1	15,6	10,6	13,1	12,8	14,6	10,5	13,8	12,0	11,0	11,9	17,2	14,3	16,4	21,3

$\overline{K_{12}}$ = **16,6 dB** $\overline{K_{12,0}}$ = **14,5 dB** $\Delta_{l,12}$ = **-0,9 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	15,0	28,7	25,6	22,0	23,5	23,6	22,5	19,3	18,4	21,2	22,2	22,5	24,8	27,4	29,6	29,9

$\overline{K_{24}}$ = **23,2 dB** $\overline{K_{24,0}}$ = **17,3 dB** $\Delta_{l,24}$ = **5,9 dB**

XYLOFON 80

TABLE OF USE[(1)]

CODE	load for acoustic optimisation[(2)] [kN/m] *[lbf/ft]*				compression for acoustic optimisation[(2)] [N/mm²] *[psi]*		reduction [mm] *[mil]*		*compressive stress at 3 mm (ultimate limit state)* [N/mm²] *[psi]*
	min		max		min	max	min	max	
XYL80080	104	*76706*	192	*141612*	1,3 *189*	2,4 *348*	0,3 *12*	0,57 *22*	***19,51*** *2830*
XYL80090	117	*86295*	216	*159313*					
XYL80100	130	*95883*	240	*177015*					
XYL80120	156	*115060*	288	*212418*					
XYL80140	182	*134236*	336	*247821*					
XYL80160	208	*153413*	384	*283224*					

(1) The load ranges reported here are optimised with respect to the acoustic and static behaviour of the material in compression. However, 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. See the manual for transmissibility and attenuation graphs.

(2) 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% of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0.5\ q_{vk}$).

TECHNICAL DATA

Properties	standard	value	*USC conversion*
Acoustic improvement $\Delta_{l,ij}$[(3)]	ISO 10848	> 7 dB	-
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	25,39 MPa (13,18 MPa)	*3683 psi (1912psi)*
Dynamic elastic modulus evaluated at 1 Hz E'_{1Hz} - E''_{1Hz}	ISO 4664-1	15,44 - 1,52 MPa	*2239 - 220 psi*
Dynamic elastic modulus evaluated at 5 Hz E'_{5Hz} - E''_{5Hz}	ISO 4664-1	16,90 - 2,54 MPa	*2451 psi - 368 psi*
Dynamic elastic modulus evaluated at 10 Hz E'_{10Hz} - E''_{10Hz}	ISO 4664-1	18,02 - 3,34 MPa	*2614 - 484 psi*
Dynamic elastic modulus evaluated at 50 Hz E'_{50Hz} - E''_{50Hz}	ISO 4664-1	21,81 - 6,88 MPa	*3163 - 998 psi*
Damping factor evaluated at 1 Hz $\tan\delta_{1Hz}$	ISO 4664-1	0,099	-
Damping factor evaluated at 5 Hz $\tan\delta_{5Hz}$	ISO 4664-1	0,15	-
Damping factor evaluated at 10 Hz $\tan\delta_{10Hz}$	ISO 4664-1	0,185	-
Damping factor evaluated at 50 Hz $\tan\delta_{50Hz}$	ISO 4664-1	0,315	-
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	10,3	-
Compression set c.s.	ISO 1856	1,31%	-
Compression at 1 mm deformation σ_{1mm}	ISO 844	3,85 N/mm²	*558 psi*
Compression at 2 mm deformation σ_{2mm}	ISO 844	9,52 N/mm²	*1381 psi*
Compression at 3 mm deformation σ_{3mm}	ISO 844	19,51 N/mm²	*2830 psi*
Dynamic stiffness s'[(4)]	ISO 9052	2157 MN/m³	
Max processing temperature (TGA)	-	200 °C	*392 °F*
Reaction to fire	EN 13501-1	class E	-
Water absorption after 48h	ISO 62	< 1 %	-

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

(4) ISO standards require for measurement with loads between 0.4 and 4 kPa and not with the product operating load.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[(3)] : **> 7** dB

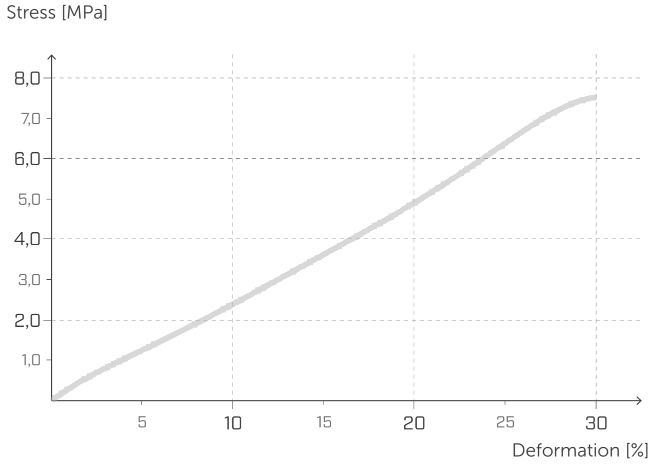
Maximum applicable load (3 mm deformation):

19,51 N/mm²

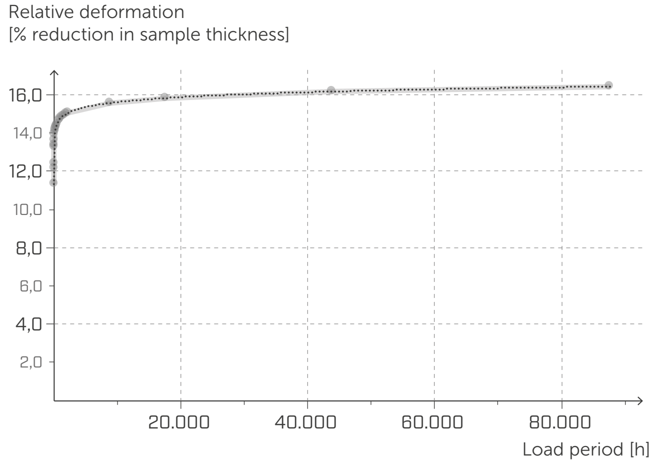
Acoustic service load:

from **1,3** to **2,4** N/mm²

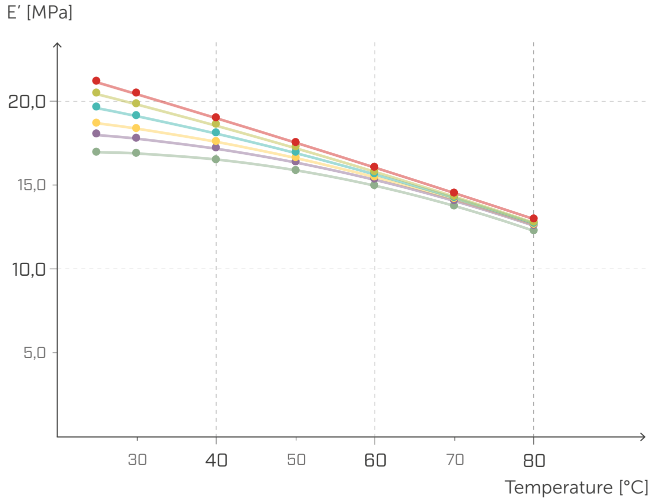
STRESS | DEFORMATION
COMPRESSION



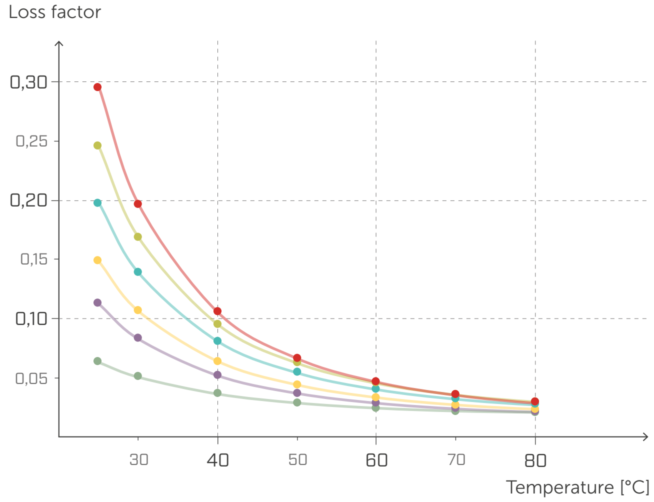
CREEP
COMPRESSION



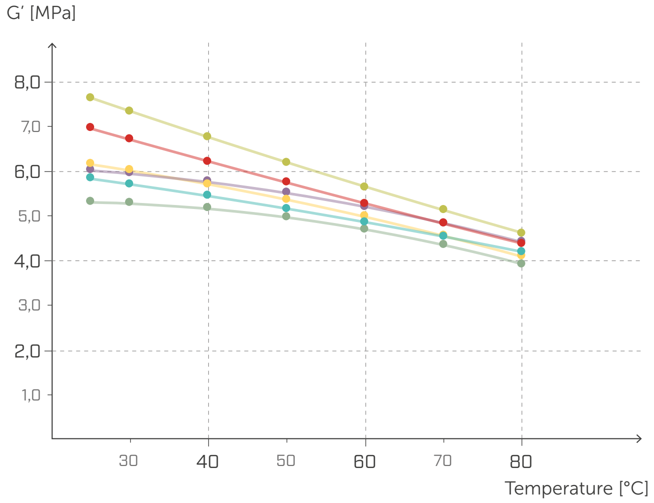
DYNAMIC ELASTIC MODULUS E'
DMTA



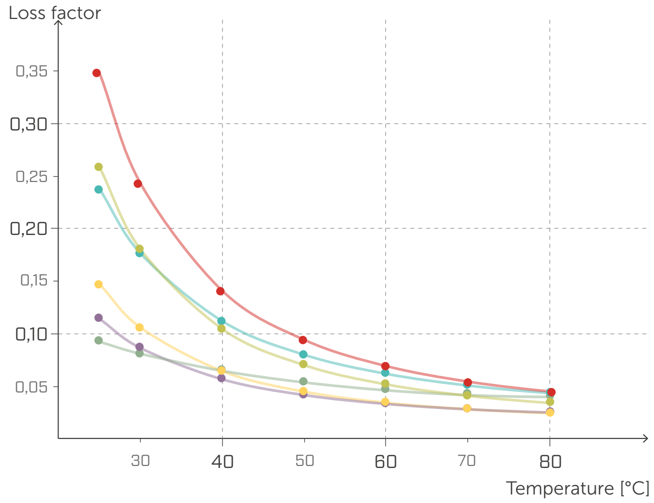
TAN δ UNDER STRESS
DMTA



DYNAMIC ELASTIC MODULUS G'
DMTA



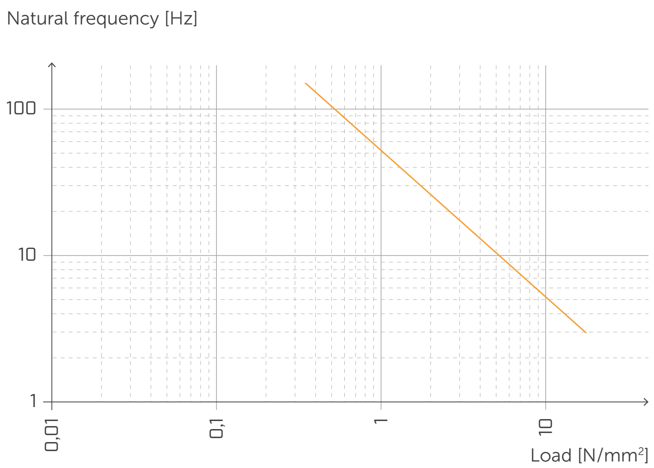
TAN δ SHEAR
DMTA



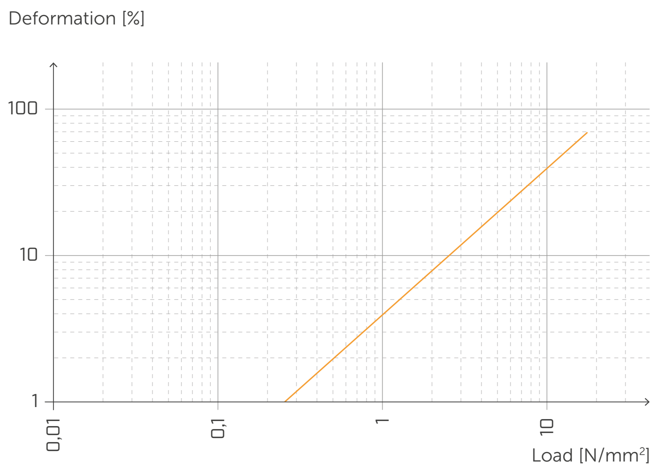
1,0 Hz/MPa | 5,0 Hz/MPa | 10,0 Hz/MPa | 20,0 Hz/MPa | 33,3 Hz/MPa | 50,0 Hz/MPa

STATIC LOAD
(buildings)

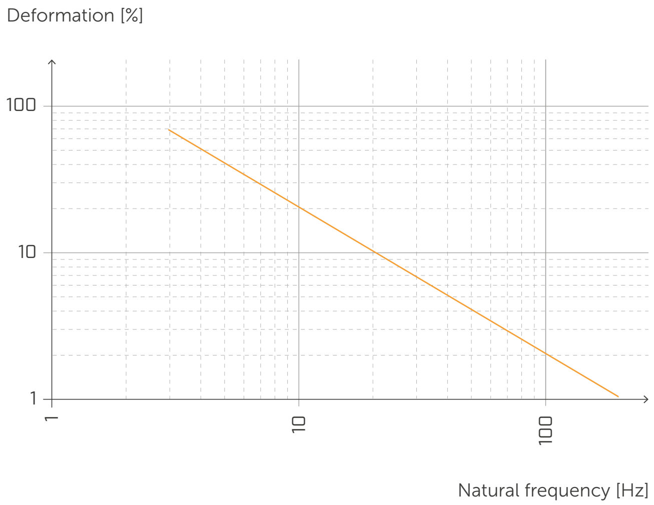
NATURAL FREQUENCY AND LOAD



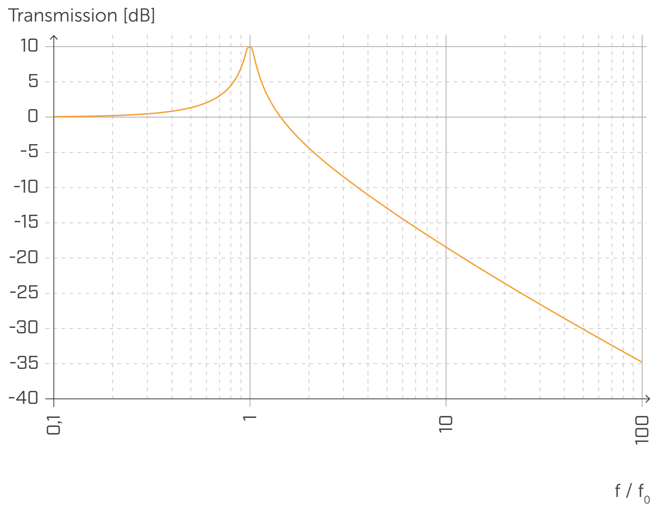
DEFORMATION AND LOAD



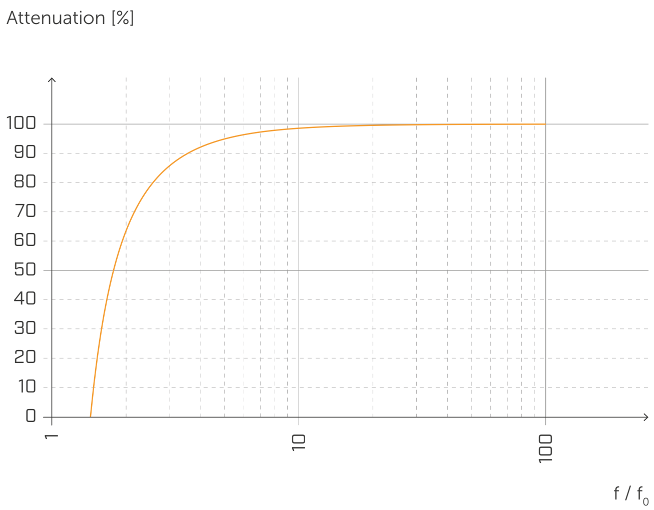
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

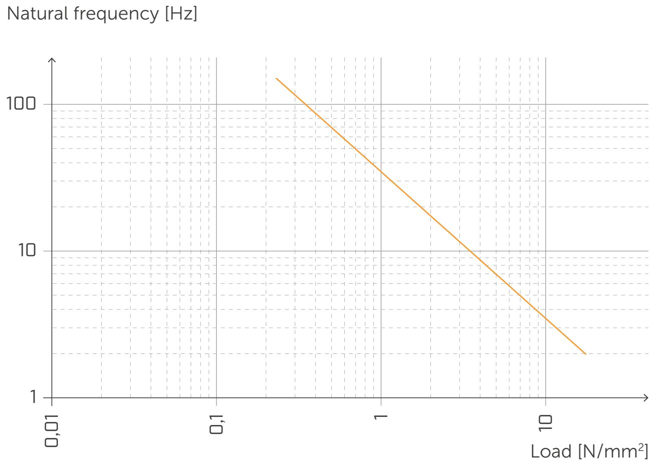


Normalised with respect to the resonance frequency with f = 20 Hz.

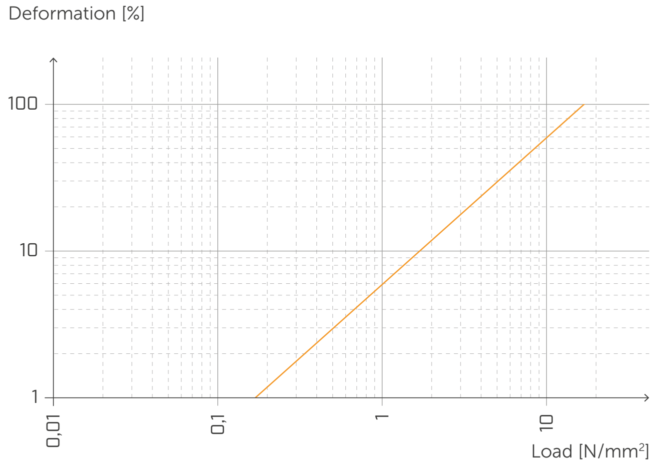
DYNAMIC LOAD
(machines and vibration)

5 Hz

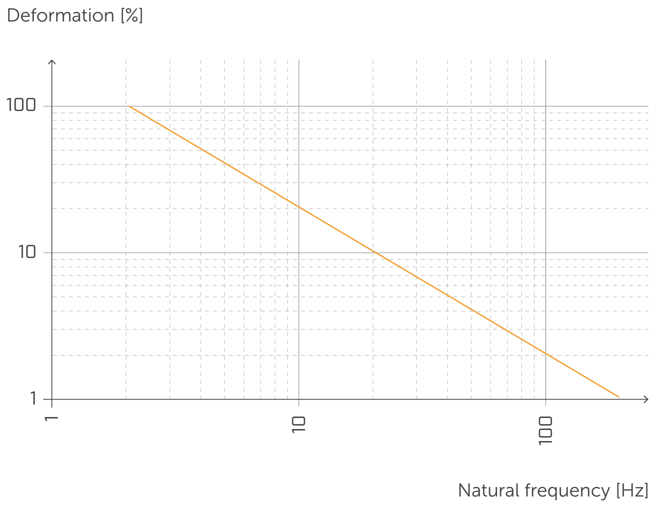
NATURAL FREQUENCY AND LOAD



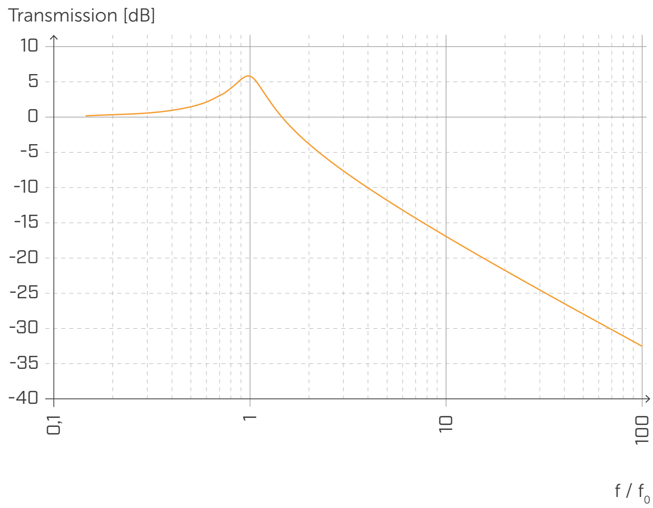
DEFORMATION AND LOAD



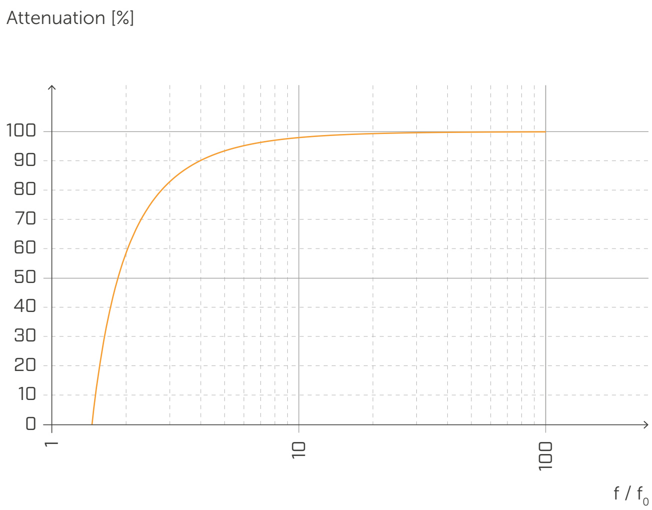
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 5 Hz.

XYLOFON 90

TABLE OF USE[1]

CODE	load for acoustic optimisation[2] [kN/m] *[lbf/ft]*				compression for acoustic optimisation[2] [N/mm²] *[psi]*		reduction [mm] *[mil]*		*compressive stress at 3 mm (ultimate limit state)* [N/mm²] *[psi]*
	min		max		min	max	min	max	
XYL90080	176	*129811*	360	*265522*	2,2 *319*	4,5 *653*	0,3 *12*	0,74 *29*	***28,97*** *4202*
XYL90090	198	*146037*	405	*298713*					
XYL90100	220	*162264*	450	*331903*					
XYL90120	264	*194716*	540	*398283*					
XYL90140	308	*227169*	630	*464664*					
XYL90160	352	*259622*	720	*531045*					

(1) The load ranges reported here are optimised with respect to the acoustic and static behaviour of the material in compression. However, 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. See the manual for transmissibility and attenuation graphs.
(2) 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% of the characteristic value of the incidental load $Q_{linear} = q_{gk} + 0.5\ q_{vk}$).

TECHNICAL DATA

Properties	standard	value	*USC conversion*
Acoustic improvement $\Delta_{l,ij}$[3]	ISO 10848	> 7 dB	-
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	36,56 MPa (21,91 MPa)	*5303 psi (3178psi)*
Dynamic elastic modulus evaluated at 1 Hz E'_{1Hz} - E''_{1Hz}	ISO 4664-1	32,2 - 6,9 MPa	*4670 - 1001 psi*
Dynamic elastic modulus evaluated at 5 Hz E'_{5Hz} - E''_{5Hz}	ISO 4664-1	39,89 - 12,23 MPa	*5786 - 1774 psi*
Dynamic elastic modulus evaluated at 10 Hz E'_{10Hz} - E''_{10Hz}	ISO 4664-1	45,37 - 16,04 MPa	*6580 - 2326 psi*
Dynamic elastic modulus evaluated at 50 Hz E'_{50Hz} - E''_{50Hz}	ISO 4664-1	65,72 - 29,78 MPa	*9532 - 4319 psi*
Damping factor evaluated at 1 Hz $\tan\delta_{1Hz}$	ISO 4664-1	0,214	-
Damping factor evaluated at 5 Hz $\tan\delta_{5Hz}$	ISO 4664-1	0,307	-
Damping factor evaluated at 10 Hz $\tan\delta_{10Hz}$	ISO 4664-1	0,354	-
Damping factor evaluated at 50 Hz $\tan\delta_{50Hz}$	ISO 4664-1	0,453	-
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,28	-
Compression set c.s.	ISO 1856	2,02%	-
Compression at 1 mm deformation σ_{1mm}	ISO 844	5,83 N/mm²	*846 psi*
Compression at 2 mm deformation σ_{2mm}	ISO 844	14,41 N/mm²	*2090 psi*
Compression at 3 mm deformation σ_{3mm}	ISO 844	28,97 N/mm²	*4202 psi*
Dynamic stiffness s'[4]	ISO 9052	> 2200 MN/m³	
Max processing temperature (TGA)	-	200 °C	*392 °F*
Reaction to fire	EN 13501-1	class E	-
Water absorption after 48h	ISO 62	< 1 %	-

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.
(4) ISO standards require for measurement with loads between 0.4 and 4 kPa and not with the product operating load.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[3] : **> 7** dB

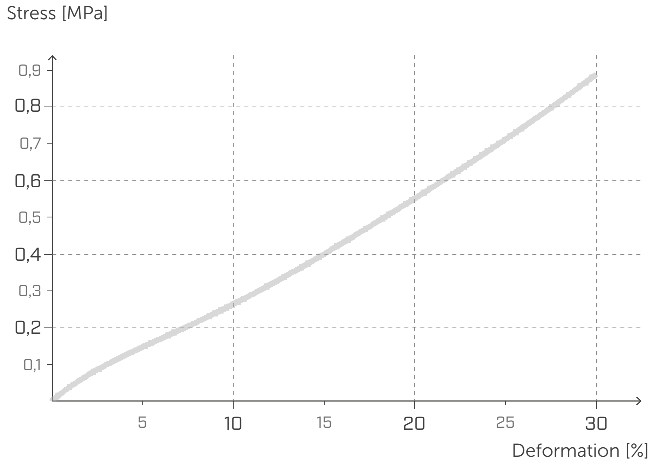
Maximum applied load
(3 mm deformation):

29,87 N/mm²

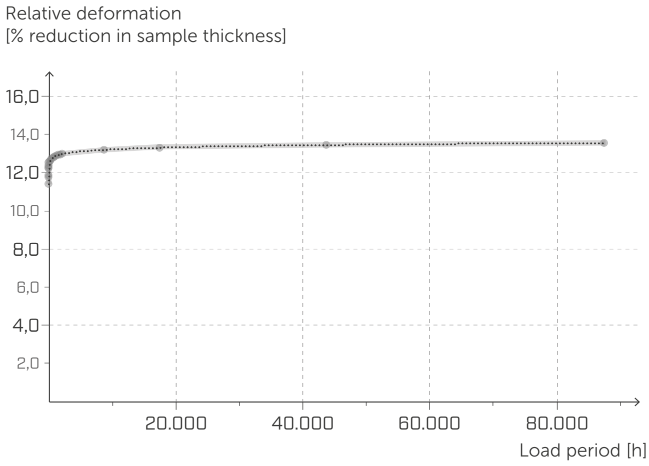
Acoustic service load:

from **2,2** to **4,5** N/mm²

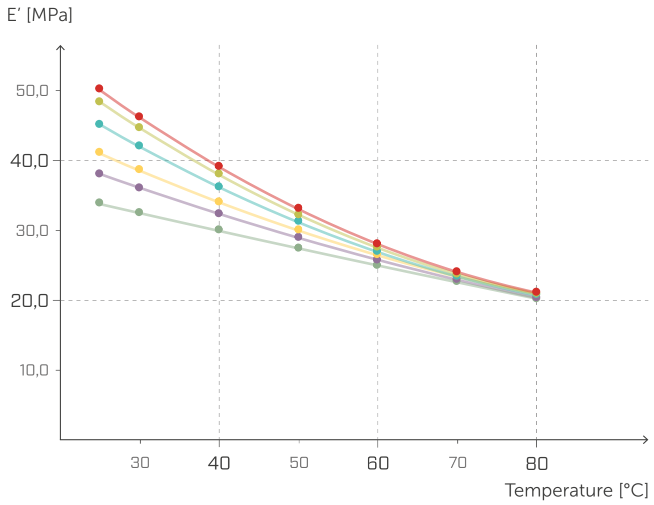
STRESS | DEFORMATION
COMPRESSION



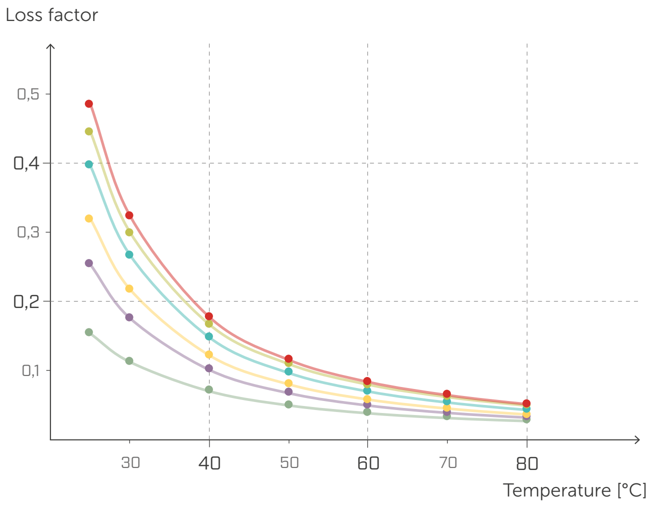
CREEP
COMPRESSION



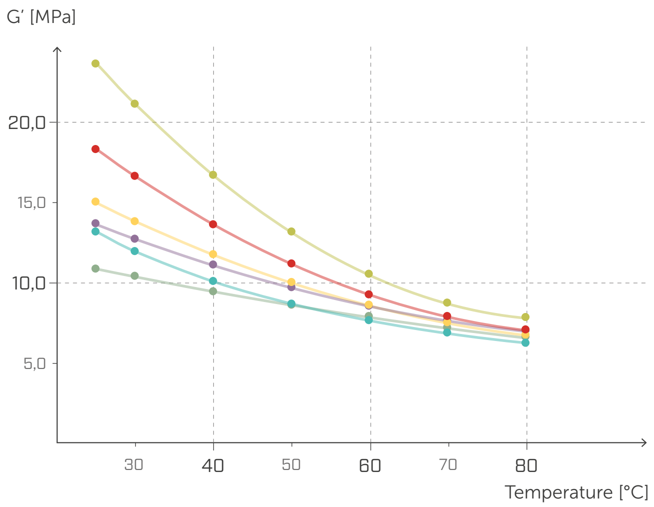
DYNAMIC ELASTIC MODULUS E'
DMTA



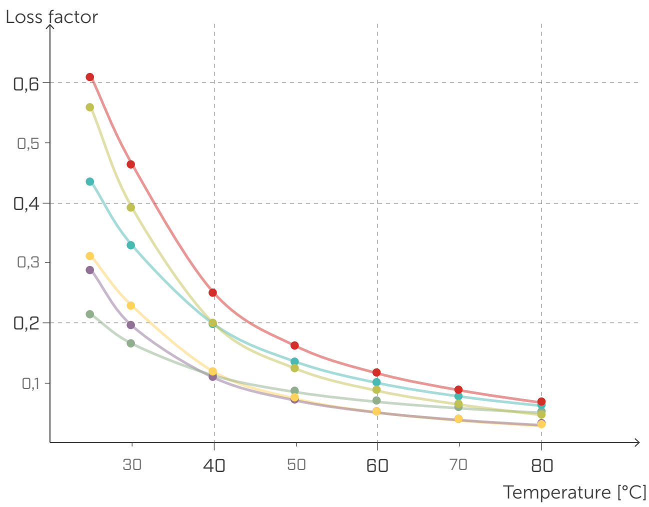
TAN δ UNDER STRESS
DMTA



DYNAMIC ELASTIC MODULUS G'
DMTA



TAN δ SHEAR
DMTA



1,0 Hz/MPa   5,0 Hz/MPa   10,0 Hz/MPa   20,0 Hz/MPa   33,3 Hz/MPa   50,0 Hz/MPa

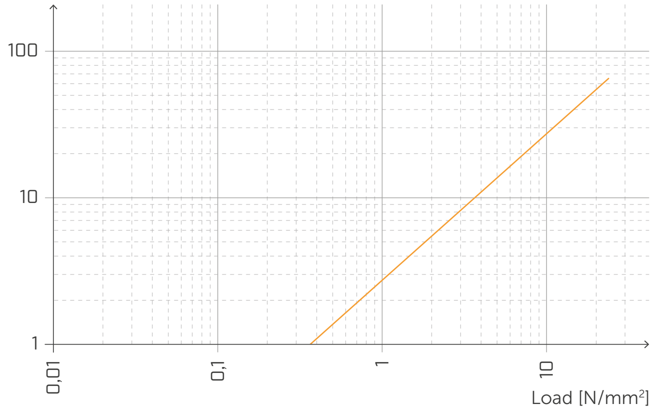
STATIC LOAD
(buildings)

NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]

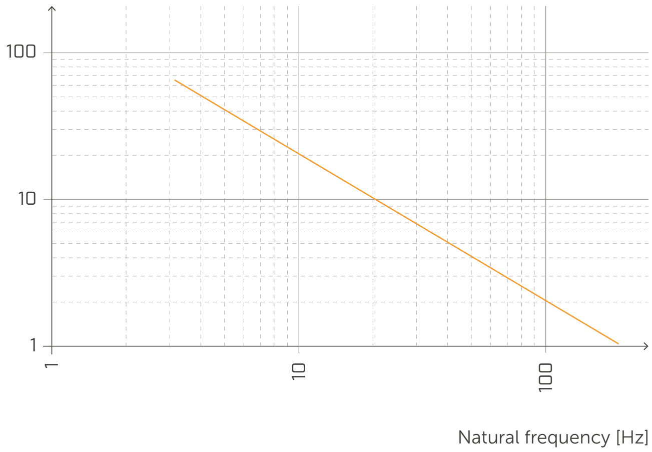
DEFORMATION AND LOAD

Deformation [%]



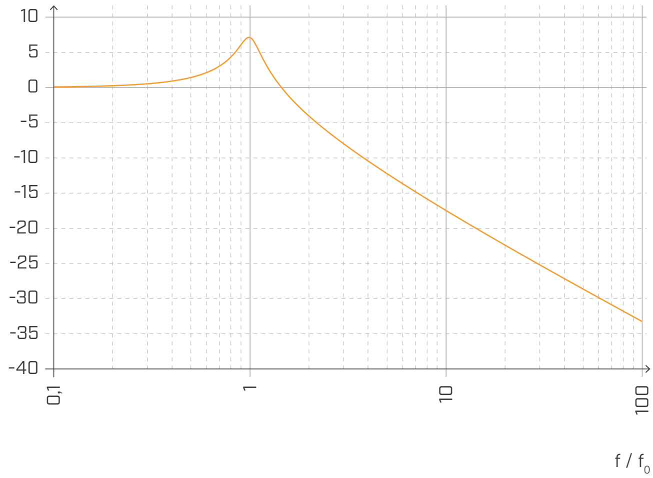
DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



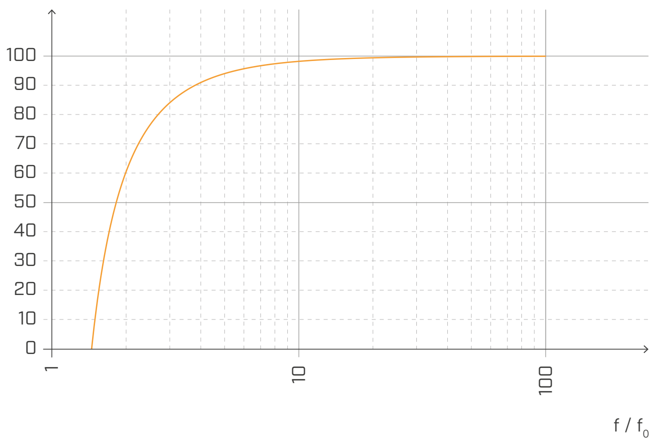
TRANSMISSIBILITY

Transmission [dB]



ATTENUATION

Attenuation [%]



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

DYNAMIC LOAD
(machines and vibration)

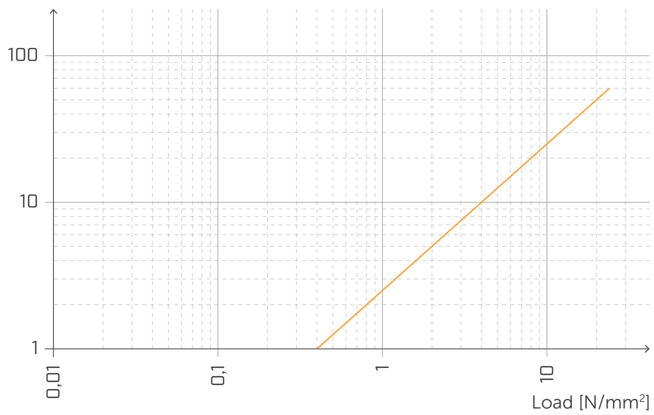
5 Hz

NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]

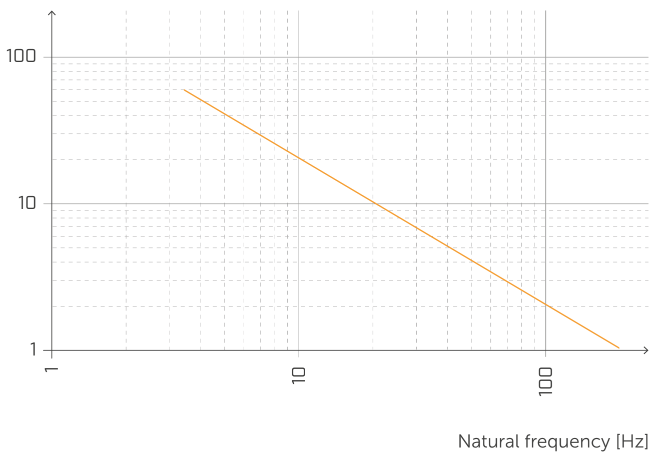
DEFORMATION AND LOAD

Deformation [%]



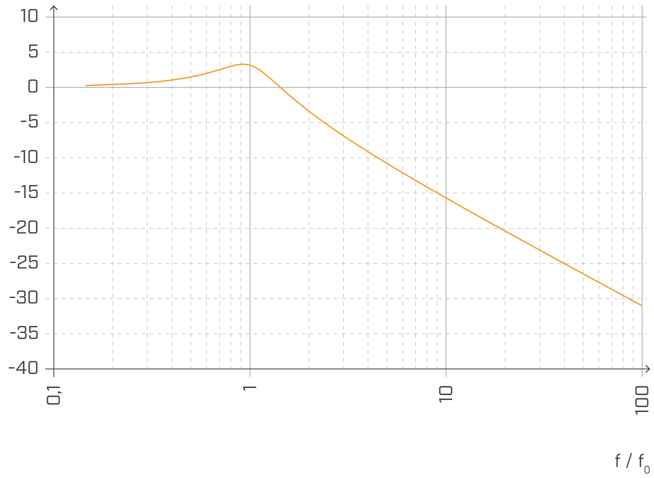
DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



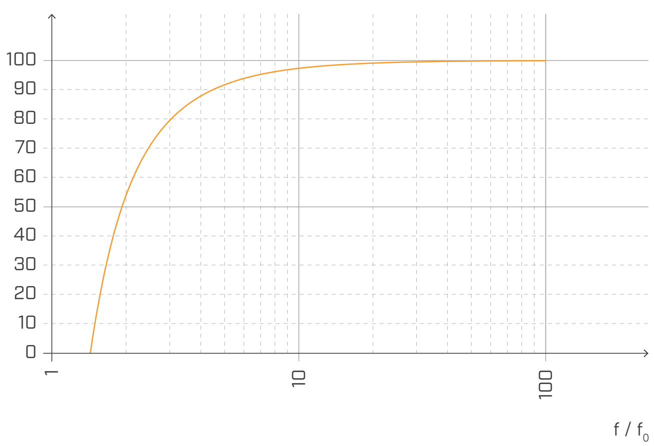
TRANSMISSIBILITY

Transmission [dB]



ATTENUATION

Attenuation [%]



Normalised with respect to the resonance frequency with f = 5 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 Rij,w can be estimated as:

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

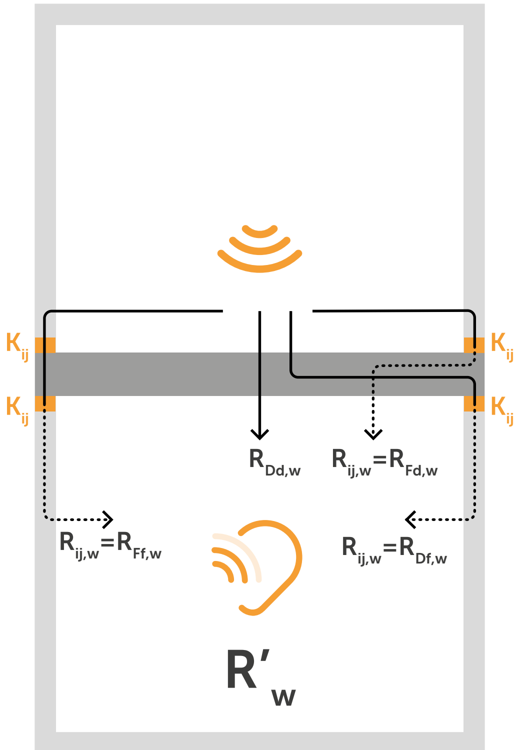
where:

$R_{i,w}$ 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.

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

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

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

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.

Kij 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 ΔLmin = 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

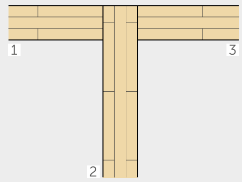
determined by the connecting elements.
In the case of CLT structures weakly bound together, the side transmission contribution can be determined according to the following relations, valid if $0,5 < (m_1/m_2) < 2$.

METHOD 1 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

$K_{13} = 5,7 + 14,1\ M + 5,7\ M^2$ dB

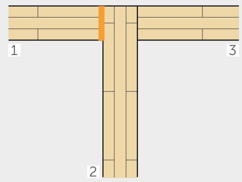
$K_{12} = 5,7 + 5,7\ M^2 = K_{23}$ dB



Solution 2 - T-SHAPED JOINT with resilient layer

$K_{23} = 5,7 + 14,1\ M + 5,7\ M^2$ dB

$K_{12} = 5,7 + 5,7\ M^2 = K_{23}$ dB



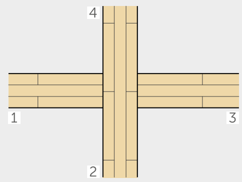
Solution 3 - X-SHAPED JOINT

$K_{13} = 8,7 + 17,1\ M + 5,7\ M^2$ dB

$K_{12} = 8,7 + 5,7\ M^2 = K_{23}$ dB

$K_{24} = 3,7 + 14,1\ M + 5,7\ M^2$ dB

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



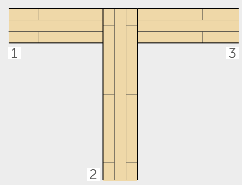
METHOD 2 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

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

f_k=500 Hz

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



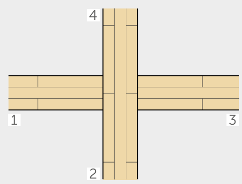
Solution 1 - X-SHAPED JOINT

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

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

f_k=500 Hz

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



THE SIMPLIFIED METHOD

A CALCULATION EXAMPLE USING EN ISO 12354

INPUT DATA

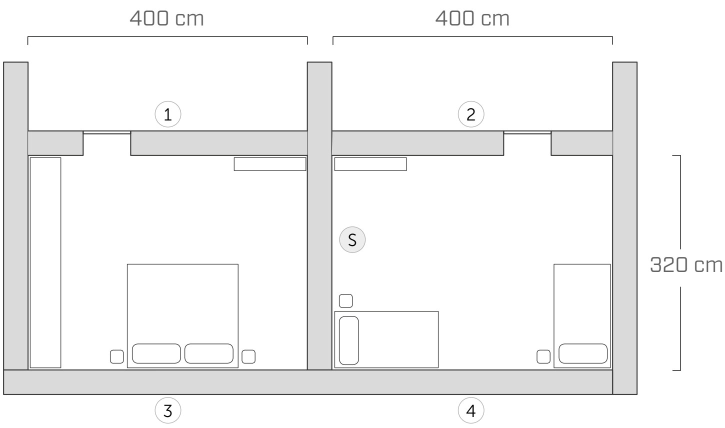
The EN ISO 12354 norms provide two methods to calculate the acoustic performance of a partition: a detailed method and the simplified method.

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.

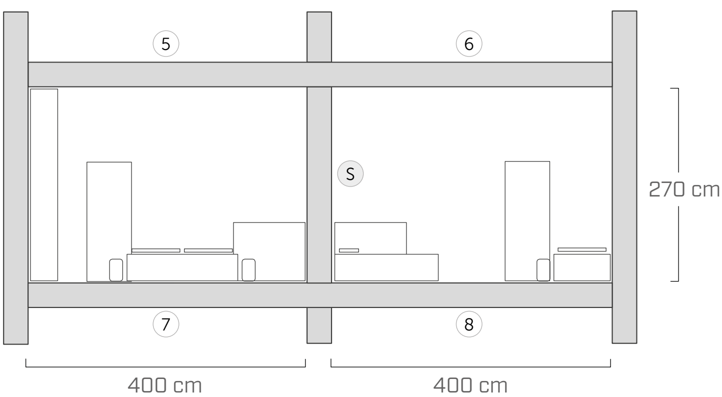
In order to determine the acoustic performance of assembly from the acoustic performance of its components, it is important to determine for every junction element:

- the geometry of the assembly (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 assemblies i-j, for a total of 12 Rij 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

JOINT 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

Download all the documentation about the FLANKSOUND project!
https://www.rothoblaas.com/technical-insights

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

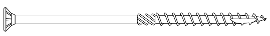



K_{ij} for **15 different** types of joint

- 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

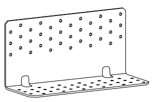
FASTENING

HBS
countersunk screw

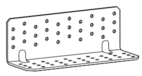


VGZ
fully threaded screw with cylindrical head

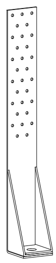
TITAN N
angle bracket for shear loads in solid walls



TITAN F
angle bracket for shear loads on frame walls

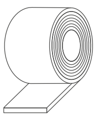


WHT
angle bracket for tensile loads

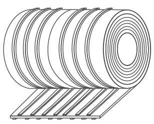


SOUNDPROOFING

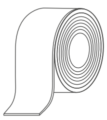
XYLOFON
high performance resilient profile



ALADIN STRIPE
resilient profile

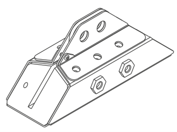


CONSTRUCTION SEALING
airtight profile

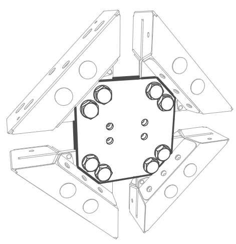


X-RAD

X-ONE
universal connector for CLT panels



X-PLATE
complete range of connection plates



MEASUREMENT CONFIGURATION

MEASUREMENT SETUP: EQUIPMENT AND DATA PROCESSING

The vibration reduction index Kij 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

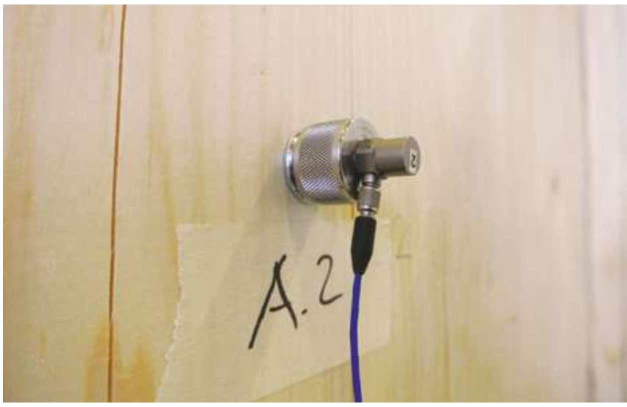
a are the equivalent absorption lengths elements of i and j

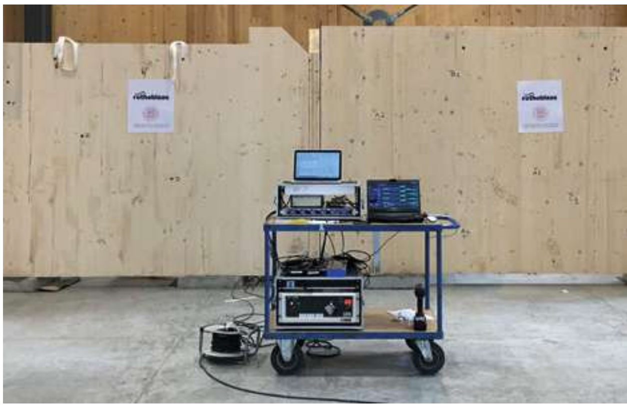
$$a = \frac{2.2\pi^2 S}{c_0 T_s}\sqrt{\frac{f_{ref}}{f}} \; (m)$$

S is the panel surface

f is the frequency

Ts 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.

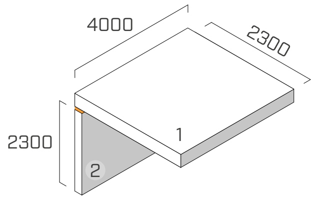
L. Barbaresi, F. Morandi, M. Garai, A. Speranza, "**Experimental analysis of flankng transmission in CLT structures**" of Meetings on Acoustics (POMA), a serial publication of the Acoustical Society of America - POMA-D-17-00015

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- *6 1/4 in*) (2,3 m x 4,0 m - *7.55 ft x 13.12 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (4,0 m x 2,3 m - *13.12 ft x 7.55 ft*)



FASTENING SYSTEM
13 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm (*11 3/4 in*)

RESILIENT PROFILE

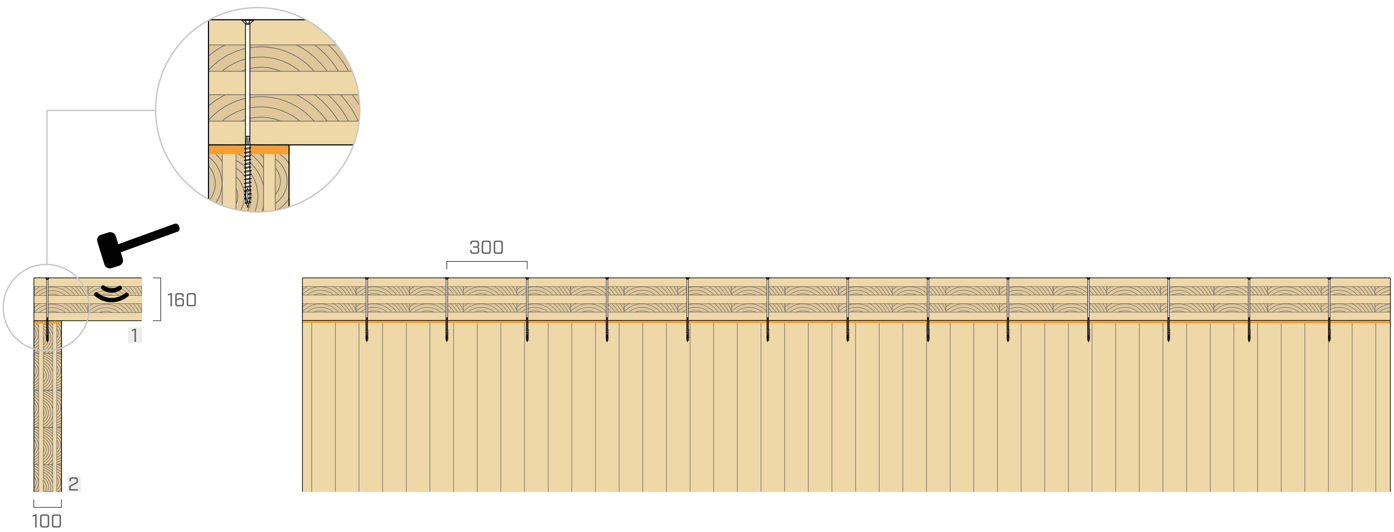
XYLOFON 35

position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [kN]: structure self weight



f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	12,6	10,8	13,6	11,1	9,2	13,3	11,3	16,5	10,2	14,6	14,9	17,4	19,6	25,0	28,5	25,1

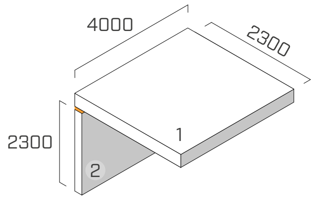
$\overline{K_{12}}$ = **13,2 dB**

L-SHAPED JOINT

EN ISO 10848-1/4

STRUCTURE

floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 4,0 m - *7.55 ft x 13.12 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (4,0 m x 2,3 m - *13.12 ft x 7.55 ft*)



FASTENING SYSTEM

6 **HBS** partially threaded screws Ø9 x 400 mm (HBS8240), spacing 600 mm (*23 5/8 in*)

RESILIENT PROFILE

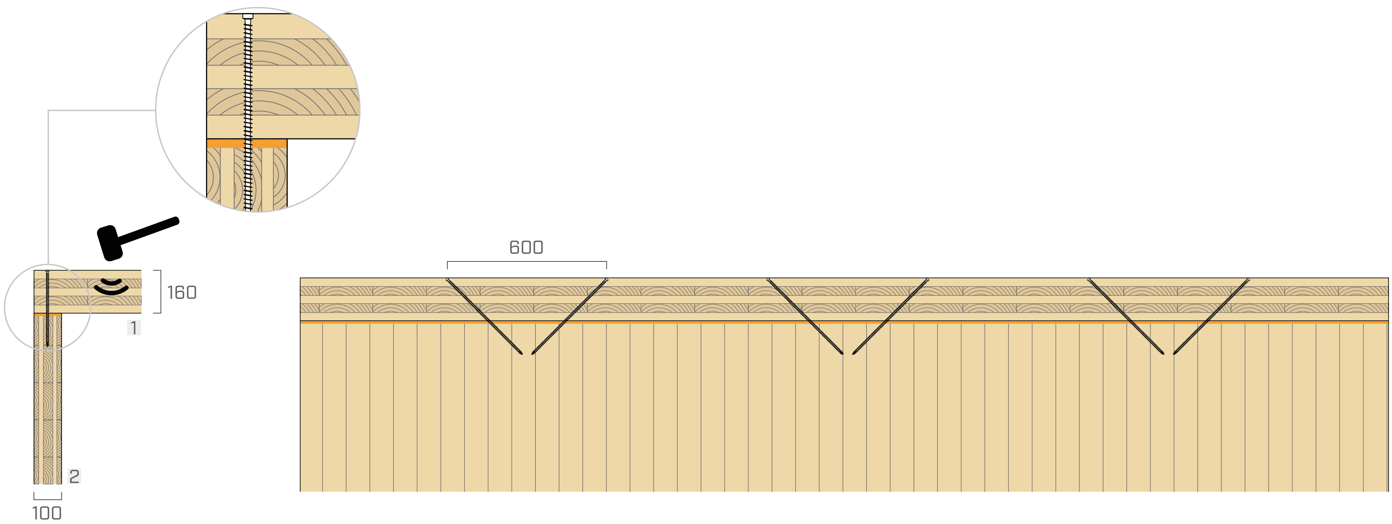
XYLOFON 35

position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [kN]: structure self weight



f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	15,3	11,2	10,6	9,5	11,7	11,5	13,8	15,1	12,0	14,5	13,0	18,6	21,6	22,0	20,8	23,7

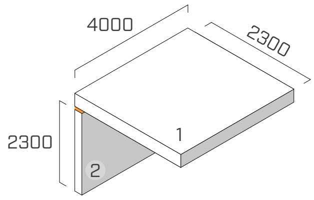
$\overline{K_{12}}$ = **13,3 dB**

L-SHAPED JOINT

EN ISO 10848-1/4

STRUCTURE

floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 4,0 m - *7.55 ft x 13.12 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (4,0 m x 2,3 m - *13.12 ft x 7.55 ft*)



FASTENING SYSTEM

13 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm (*11 3/4 in*)
5 angle brackets **TITAN** (TTN240) spacing 800 mm (*31 1/2 in*)
fastening pattern: total nailing 72 screws Ø5 x 50 mm
2 hold down **WHT** (WHT440)

RESILIENT PROFILE

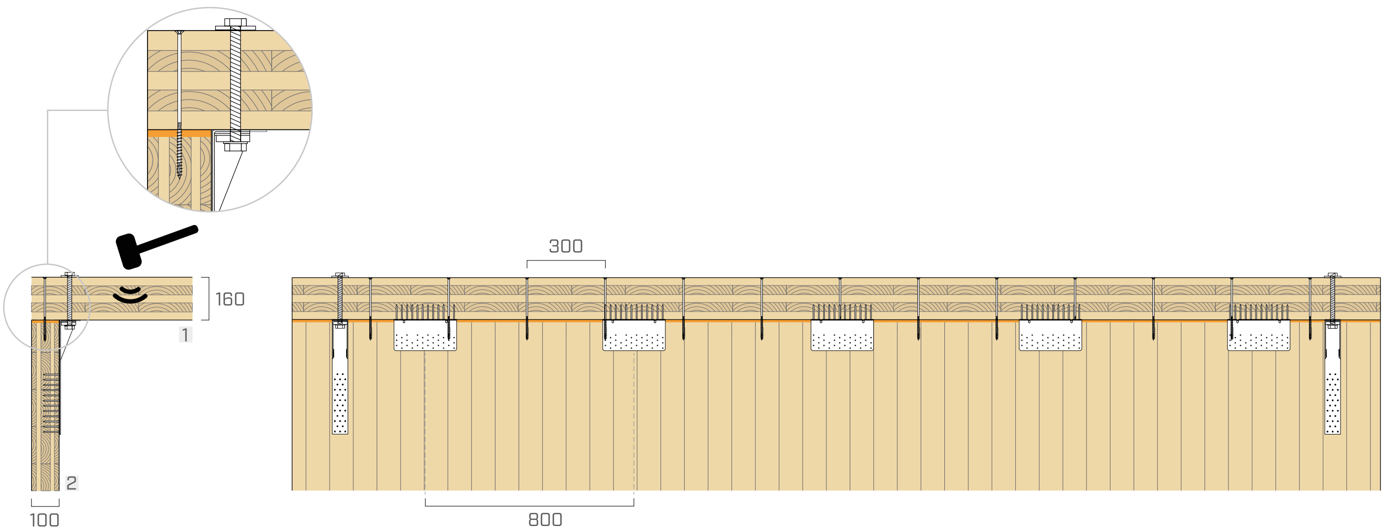
XYLOFON 35

position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [kN]: structure self weight



f [Hz]	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**
K_{12} [dB]	10,9	8,9	7,1	10,6	7,4	9,6	10,2	12,5	11,8	14,1	14,8	15,3	17,1	17,4	21,5	21,2

$\overline{K_{12}}$ = **11,8 dB**

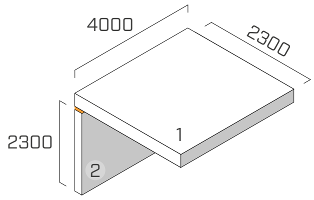
*data estimated based on experimental measurements

L-SHAPED JOINT

EN ISO 10848-1/4

STRUCTURE

floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 4,0 m - *7.55 ft x 13.12 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (4,0 m x 2,3 m - *13.12 ft x 7.55 ft*)



FASTENING SYSTEM

13 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm (*11 3/4 in*)
5 angle brackets **TITAN** (TTN240) with resilient profile **XYLOFON PLATE** (XYL35120240) spacing 800 mm (*31 1/2 in*)
fastening pattern: total nailing 72 screws Ø5 x 50 mm
2 hold down **WHT** (WHT440)

RESILIENT PROFILE

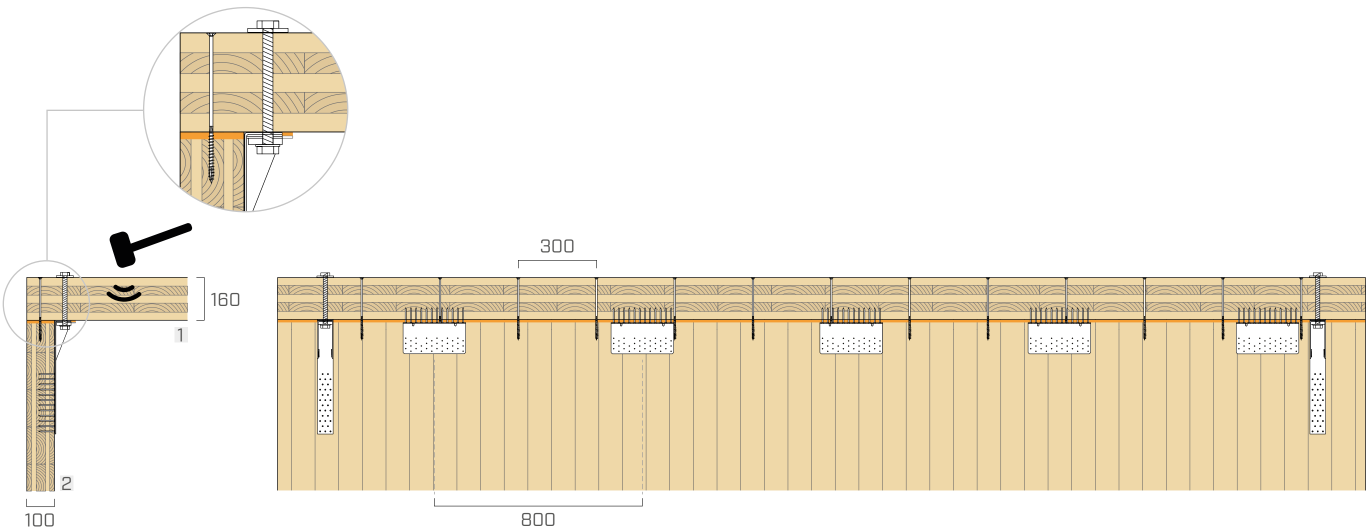
XYLOFON 35 + **XYLOFON PLATE**

position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [kN]: structure self weight



f [Hz]	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**
K_{12} [dB]	11,6	9,4	11,6	12,0	7,2	11,0	10,3	13,7	11,9	15,1	15,6	16,7	17,9	22,2	25,6	22,1

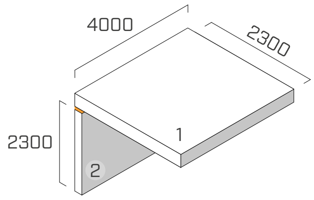
$\overline{K_{12}}$ = **12,6 dB**

*data estimated based on experimental measurements

L-SHAPED JOINT

EN ISO 10848-1/4

STRUCTURE
floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 4,0 m - *7.55 ft x 13.12 ft*)
lower wall: CLT 5 layers (s: 100 mm - *4 in*) (4,0 m x 2,3 m - *13.12 ft x 7.55 ft*)



FASTENING SYSTEM
6 **HBS** partially threaded screws Ø9 x 400 mm (HBS8240), spacing 600 mm (*23 5/8 in*)
5 angle brackets **TITAN** (TTN240) spacing 800 mm (*31 1/2 in*)
fastening pattern: total nailing 72 screws Ø5 x 50 mm
2 hold down **WHT** (WHT440)

RESILIENT PROFILE

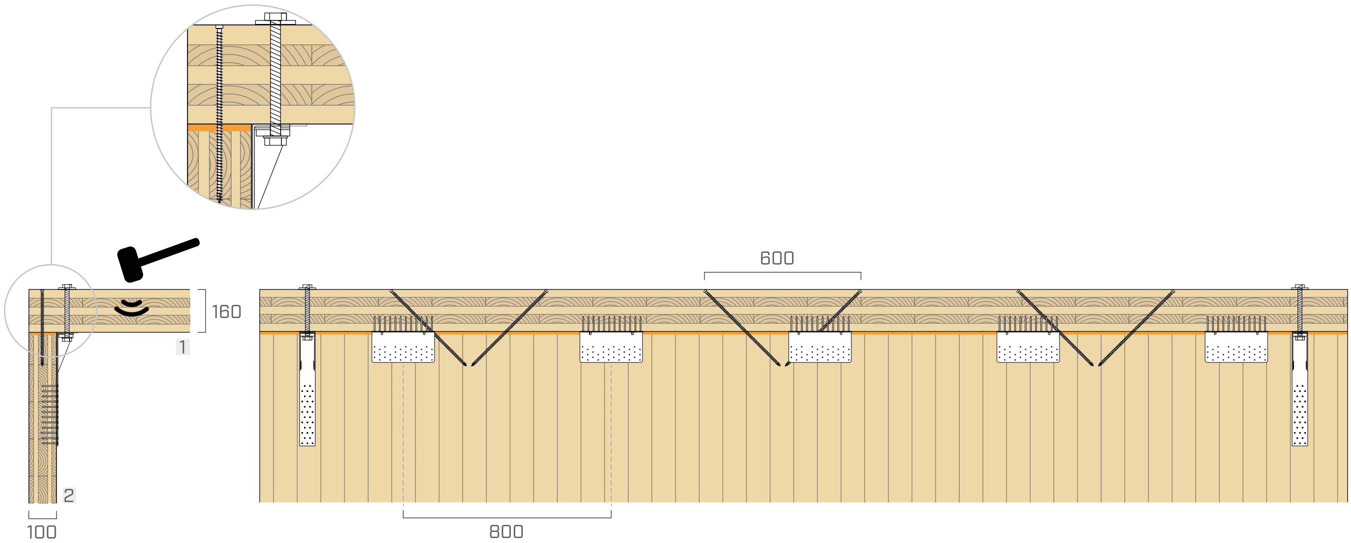
XYLOFON 35

position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [kN]: structure self weight



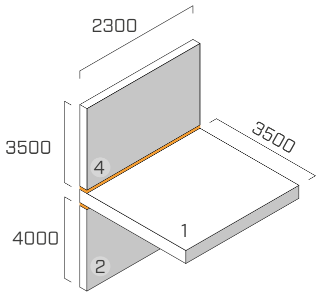
f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	10,6	15,0	8,8	9,6	9,2	8,4	7,7	10,0	11,3	14,3	14,2	16,3	20,0	18,6	20,8	18,7

$\overline{K_{12}}$ = **11,2 dB**

*data estimated based on experimental measurements

T-SHAPED JOINT

EN ISO 10848-1/4



STRUCTURE

STRUCTURE

upper wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*)
floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*),
lower wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 4,0 m- *7.55 ft x 13.12 ft*)

FASTENING SYSTEM

7 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm (*11 3/4 in*)
3 angle brackets **TITAN** (TTN240), spacing 800 mm (*31 1/2 in*)
fastening pattern: total nailing 72 screws Ø5 x 50 mm
4 hold down **WHT** (WHT440)

RESILIENT PROFILE

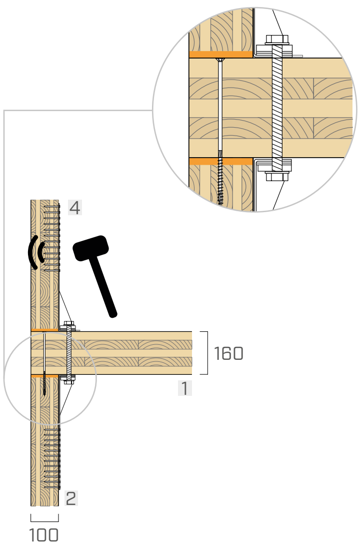
XYLOFON 35

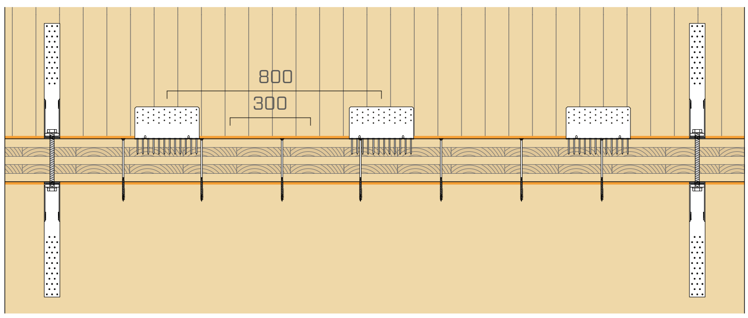
position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	17,4	14,8	9,0	15,5	11,9	13,2	9,9	16,2	20,6	22,5	22,9	21,7	24,9	35,1	37,3	41,2

$$\overline{K_{12}} = 17{,}2\ \text{dB}$$

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	24,4	21,8	16,0	22,5	18,9	20,2	16,9	23,2	27,6	29,5	29,9	28,7	31,9	42,1	44,3	48,2

$$\overline{K_{24}} = 24{,}2\ \text{dB}$$

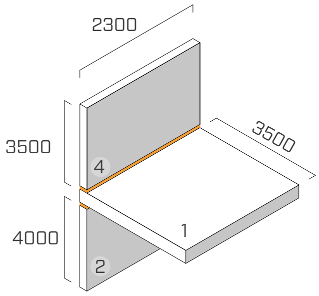
f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	12,5	0,5	0,7	7,2	4,6	7,5	0,7	9,7	9,1	12,3	12,8	18,8	19,5	21,3	25,1	26,3

$$\overline{K_{14}} = 9{,}2\ \text{dB}$$

*data estimated based on experimental measurements

T-SHAPED JOINT

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*)
floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*),
lower wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 4,0 m- *7.55 ft x 13.12 ft*)

FASTENING SYSTEM

7 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm (*11 3/4 in*)
3 angle brackets **TITAN** (TTN240) with resilient profile **XYLOFON PLATE** (XYL35120240) spacing 800 mm (*31 1/2 in*)
fastening pattern: total nailing 72 screws Ø5 x 50 mm
4 hold down **WHT** (WHT440)

RESILIENT PROFILE

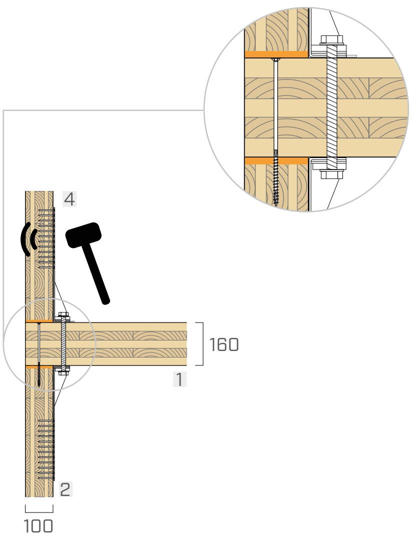
XYLOFON 35 + **XYLOFON PLATE**

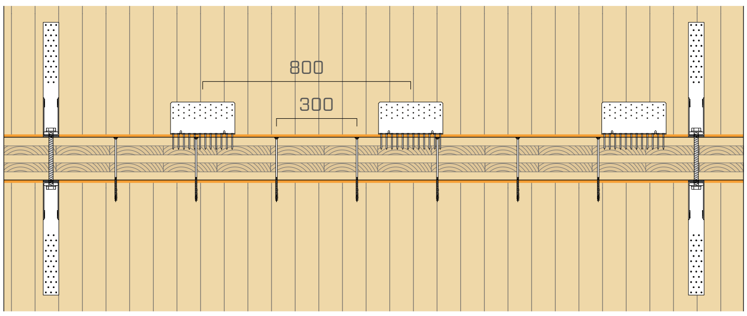
position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	23,6	27,1	16,5	18,7	18,0	14,2	10,6	14,6	16,7	22,0	24,0	26,6	29,4	31,4	34,0	32,5

$\overline{K_{24}}$ = **18,4 dB**

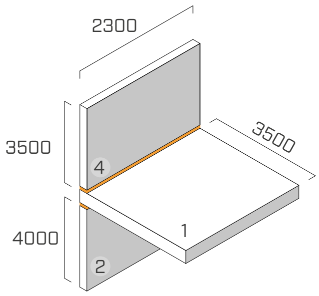
f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	16,6	20,1	9,5	11,7	11,0	7,2	3,6	7,6	9,7	15,0	17,0	19,6	22,4	24,4	27,0	25,5

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

*data estimated based on experimental measurements

T-SHAPED JOINT

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*)
floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*),
lower wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 4,0 m- *7.55 ft x 13.12 ft*)

FASTENING SYSTEM

7 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm (*11 3/4 in*)
3 angle brackets **TITAN** (TTN240) with resilient profile **XYLOFON PLATE** (XYL35120240) spacing 800 mm (*31 1/2 in*)
fastening pattern: total nailing 72 screws Ø5 x 50 mm
2 **LBV** perforated plates (LBV100500)

RESILIENT PROFILE

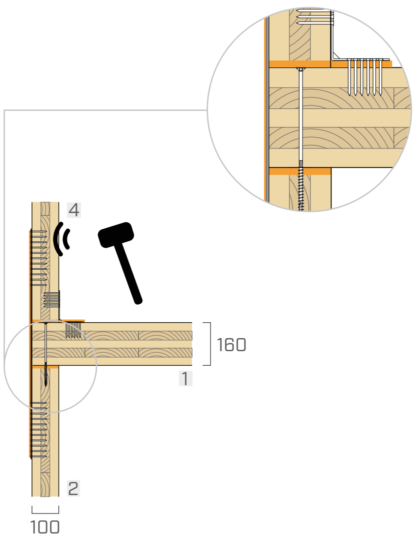
XYLOFON 35 + **XYLOFON PLATE**

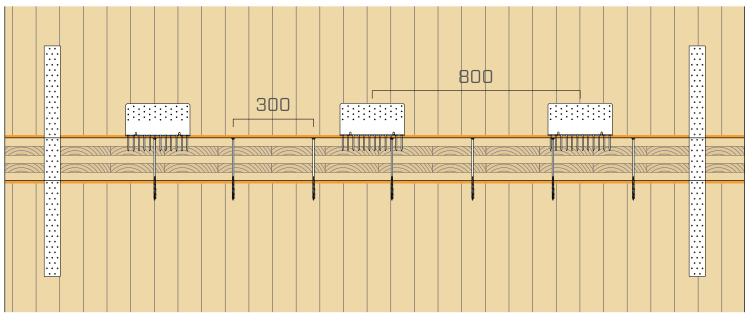
position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	17,4	13,1	7,0	11,1	10,8	11,5	10,5	15,6	20,4	22,4	21,9	24,7	24,5	38,4	38,6	41,0

$$\overline{K_{12}} = \mathbf{16{,}6\ dB}$$

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	23,9	24,5	18,3	20,6	16,3	18,2	19,4	19,6	25,7	27,2	25,6	21,9	24,5	41,7	44,9	49,0

$$\overline{K_{24}} = \mathbf{21{,}6\ dB}$$

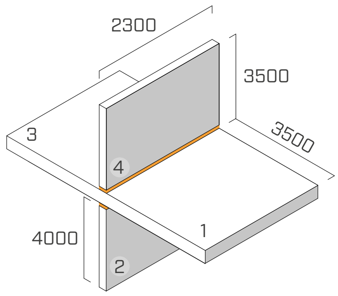
f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	7,1	- 3,1	- 2,5	6,2	6,0	6,4	0,7	9,7	9,5	12,5	12,7	19,3	16,8	21,8	25,2	27,2

$$\overline{K_{14}} = \mathbf{9{,}2\ dB}$$

Data estimated based on experimental measurements.

X-SHAPED JOINT

EN ISO 10848-1/4



STRUCTURE

upper wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*)
floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 7,5 m- *7.55 ft x 25 ft*)
lower wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 4,0 m- *7.55 ft x 13.12 ft*)

FASTENING SYSTEM

7 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 300 mm (*11 3/4 in*)
3 angle brackets **TITAN** (TTN240) with resilient profile **XYLOFON PLATE** (XYL35120240) spacing 800 mm (*31 1/2 in*)
fastening pattern: total nailing 72 screws Ø5 x 50 mm
4 hold down **WHT** (WHT440)

RESILIENT PROFILE

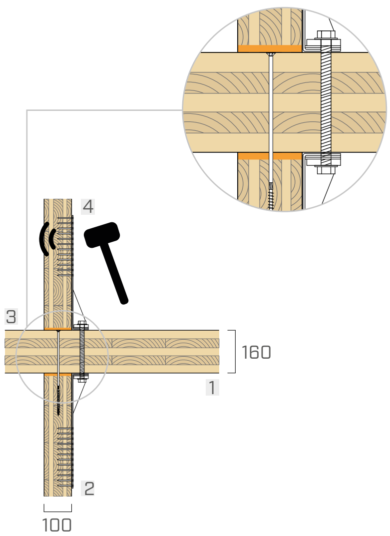
XYLOFON 35 + **XYLOFON PLATE**

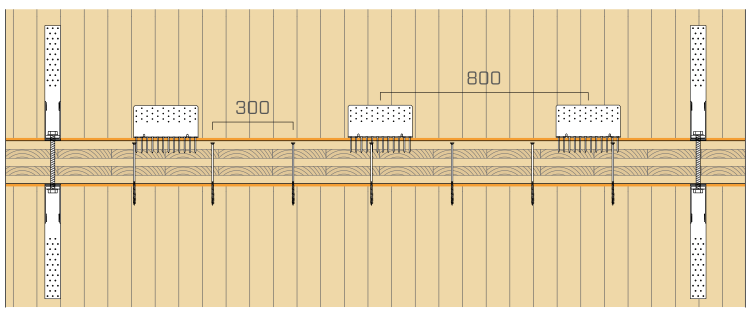
position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	20,4	17,8	12,0	18,5	14,9	16,2	12,9	19,2	23,6	25,5	25,9	24,7	27,9	38,1	40,3	44,2

$\overline{K_{12}}$ = **20,2 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	15,5	3,5	3,7	10,2	7,6	10,5	3,7	12,7	12,1	15,3	15,8	21,8	22,5	24,3	28,1	29,3

$\overline{K_{14}}$ = **12,2 dB**

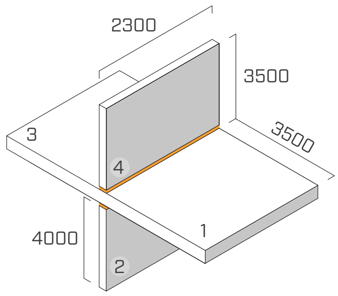
f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	25,4	22,8	17,0	23,5	19,9	21,2	17,9	24,2	28,6	30,5	30,9	29,7	32,9	43,1	45,3	49,2

$\overline{K_{24}}$ = **25,2 dB**

*data estimated based on experimental measurements

X-SHAPED JOINT

EN ISO 10848-1/4



STRUCTURE

uupper wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 3,5 m- *7.55 ft x 11 ft*)
floor: CLT 5 layers (s: 160 mm- *6 1/4 in*) (2,3 m x 7,5 m- *7.55 ft x 25 ft*)
lower wall: CLT 5 layers (s: 100 mm- *4 in*) (2,3 m x 4,0 m- *7.55 ft x 13.12 ft*)

FASTENING SYSTEM

6 angle brackets **TITAN** (TTN240) with resilient profile **XYLOFON PLATE** (XYL35120240) spacing 800 mm (*31 1/2 in*)
fastening pattern: 72 screws Ø5 x 50 mm
4 hold down **WHT** (WHT440)

RESILIENT PROFILE

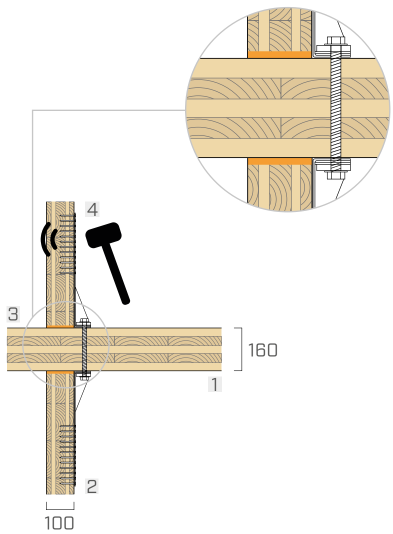
XYLOFON 35 + **XYLOFON PLATE**

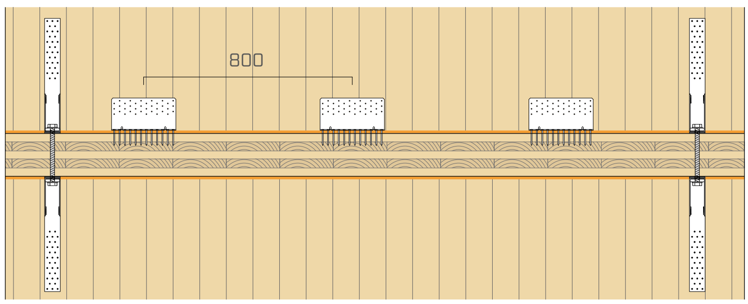
position: between the lower wall and the floor.

dimensions: width = 100 mm (*4 in*) thickness = 6 mm (*1/4 in*) length = 4,0 m (*13.12 ft*)

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

applied load [N/m²]: structure self weight





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	24,6	28,1	17,5	19,7	19,0	15,2	11,6	15,6	17,7	23,0	25,0	27,6	30,4	32,4	35,0	33,5

$$\overline{K_{24}} = \mathbf{19{,}4\ dB}$$

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	19,6	23,1	12,5	14,7	14,0	10,2	6,6	10,6	12,7	18,0	20,0	22,6	25,4	27,4	30,0	28,5

$$\overline{K_{12}} = \mathbf{14{,}4\ dB}$$

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{13} [dB]	10,3	10,0	9,6	9,3	9,0	8,6	8,3	8,0	7,6	7,3	7,0	6,7	6,3	6,0	5,7	5,3

$$\overline{K_{13}} = \mathbf{8{,}0\ dB}$$

*data estimated based on experimental measurements.

SOUND REDUCTION INDEX AND IMPACT SOUND LEVEL

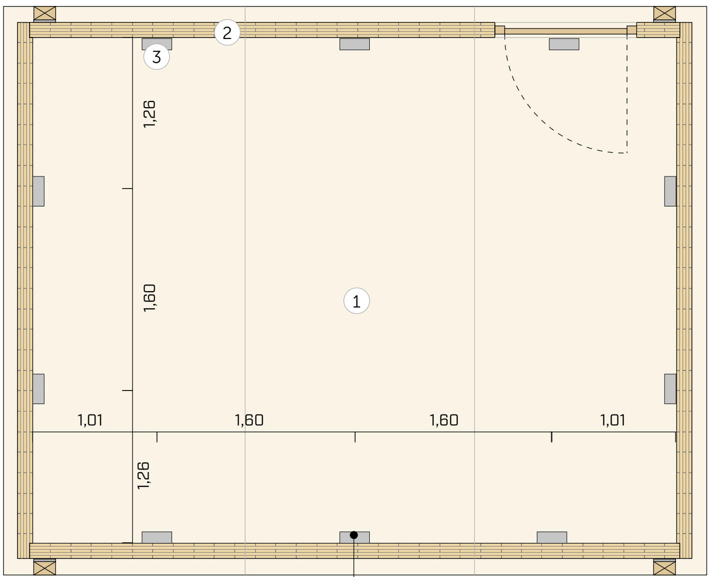
A predictive study of the sound insulation of airborne and impact noise in buildings cannot be determined by calculations alone, but must be supported by experimental data and measurements in the laboratory and on site.

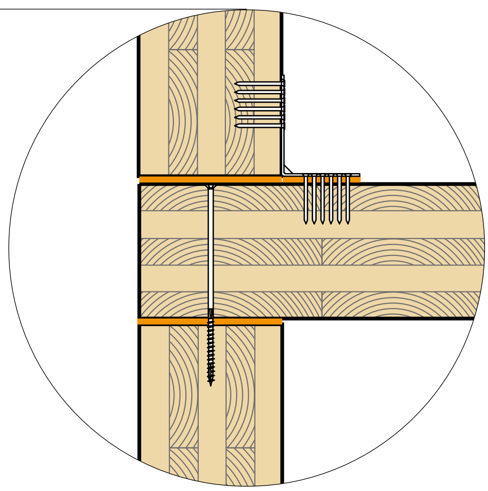
In mass timber construction, as in light-framed construction, the contribution of flanking sound transmission can be significant and it is important to be able to estimate this correctly because regulations require compliance with passive acoustic requirements measured on site.
For this reason, the analysis of the assembly of the separating element cannot be limited, but also the behavior of the resilient profiles must be considered.

In the laboratory in Innsbruck, the upper floor and the ceiling can be raised by up to 30 cm by means of hydraulic jacks, in order to carry out tests, with and without XYLOFON, and thus test its effectiveness.

The laboratory also provides the possibility of loading the structure with threaded tie rods to simulate different loads (e.g. several floors).
For the tests, a load of 17 kN/m (approximately one floor) was applied to the ceiling element and thus also XYLOFON 35

SET UP





The receiving and transmitting rooms have a floor area of 21,5 m^2 (5,24 m lenght; 4,10 m width).
The volume of the transmitting room is 53,0 m^3, and the volume of the receiving room 85,0 m^3.

The floor (1) is made of 160 mm 5-layer CLT, while the walls (2) are made of 100 mm 5-layer CLT panels.
The floor was fixed with **HBS** 6 x 240 mm screws at a distance of 300 mm and 10 **TITAN** (3) TTN240 angle brackets with **LBS** 5 x 70 screws (72 screws each angle bracket).

NOTE: a blower door test was performed prior to measurement to prevent air leaks from affecting the measurement results.

THE RESULTS

For the evaluation of flanking sound transmission, both the dodecahedron and the impact sound machine were used as sources, while accelerometers were applied to the wall in the receiving room.

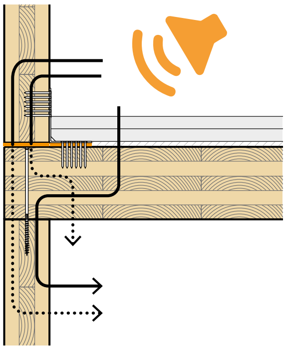
The results obtained were implemented in the formula shown below to determine $R_{ij,situ}$

$$R\ S(0) = R_{ij,situ}$$

$$R\ S(0) = LS\ (f) - Lb\ (f) - K56 + 20\log\ (f \text{ in Hz}) - 10\log\sigma \quad (1)$$

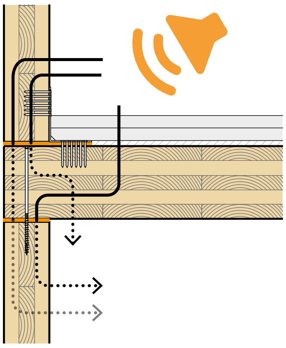
where:

LS (f)	sound pressure level in the transmitting room, function of frequency [dB].
Lb (f)	flanking sound pressure level, function of frequency [dB].
K56	accelerometer calibration coefficient
f	frequency [Hz]
10log σ	radiation coefficient, function of frequency



$\Delta R_{Df+Ff,situ}$ = **5 dB**

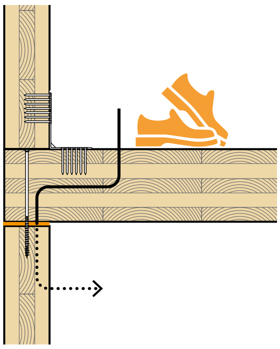
$\Delta STC_{Df+Ff,situ}$ = 4 dB



$\Delta R_{Df+Ff,situ}$ = **10 dB**

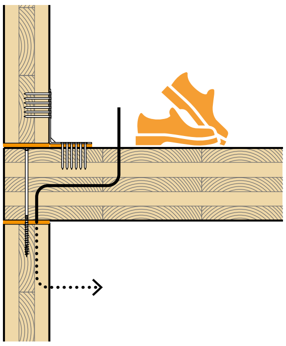
$\Delta STC_{Df+Ff,situ}$ = 10 dB

reduction of flanking airborne sound transmission



$\Delta L_{n,Df+Ff,situ}$ = **7 dB**

$\Delta IIC_{Df+Ff,situ}$ = 7 dB



$\Delta L_{n,Df+Ff,situ}$ = **8 dB**

$\Delta IIC_{Df+Ff,situ}$ = 8 dB

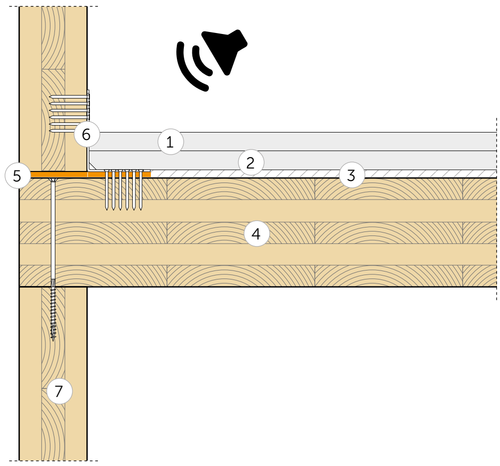
reduction of flanking impact sound transmission

A. Kraler, P. Brugnara, "**Acoustic behaviour of CLT structures: influence of decoupling bearing stripes, floor assembly and connectors under storey-like loads**", Internoise Glasgow 21-24 August 2022

universität innsbruck

ON-SITE MEASUREMENT | CLT FLOOR

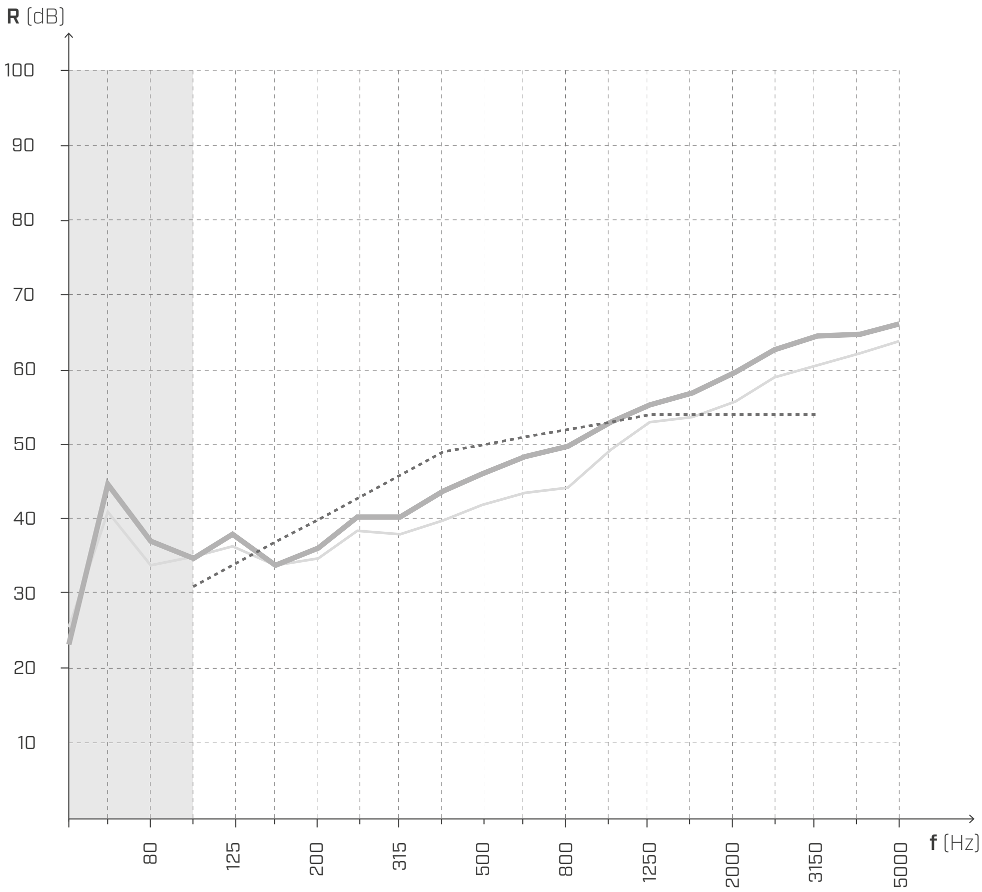
AIRBORNE SOUND INSULATION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 167 kg/ m^2
Receiving room volume = 75,52 m^3

1. reinforced gypsum-fibre board (44 kg/m^2) (s: 32 mm- *1 1/4 in*)
2. high density cardboard and sand panels (34,6 kg/m^2) (s: 30 mm- *1 3/16 in*)
3. SILENT FLOOR PUR (s: 10 mm- *3/8 in*)
4. CLT (s: 160 mm- *6 1/4 in*)
5. XYLOFON
6. TITAN SILENT
7. CLT (s: 160 m- *6 1/4 in*)

AIRBORNE SOUND INSULATION



f [Hz]	R [dB]
50	23,1
63	44,6
80	36,9
100	34,6
125	37,8
160	33,7
200	36,1
250	40,2
315	40,2
400	43,6
500	45,9
630	48,2
800	49,7
1000	52,8
1250	55,1
1600	56,9
2000	59,5
2500	62,5
3150	64,5
4000	64,6
5000	66,1

$R'_w(C;C_{tr})$ = **50 (0;-6) dB**

*$R'_{w,0}(C;C_{tr})$ = **47 (0;-6) dB***

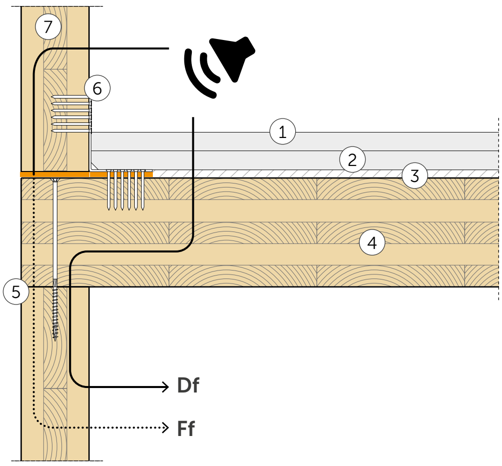
*STC = **50***

*STC_0 = **48***

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 602 Innsbruck.
Test protocol: M03B_L211217_m-Bodenaufbau.

ON-SITE MEASUREMENT | CLT FLOOR

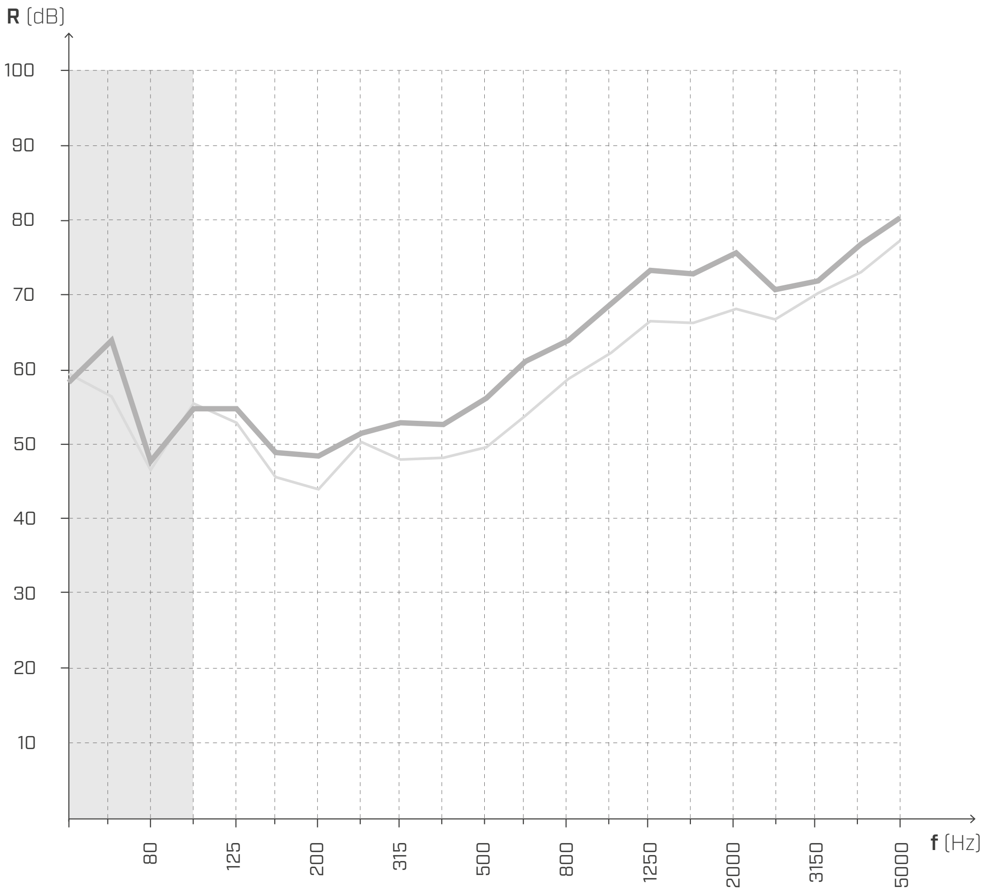
AIRBORNE FLANKING TRANSMISSION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 167 kg/ m^2
Receiving room volume = 75,52 m^3

1. reinforced gypsum-fibre board (44 kg/m^2) (s: 32 mm- *1 1/4 in*)
2. high density cardboard and sand panels (34,6 kg/m^2) (s: 30 mm- *1 3/16 in*)
3. SILENT FLOOR PUR (s: 10 mm- *3/8 in*)
4. CLT (s: 160 mm- *6 1/4 in*)
5. **XYLOFON**
6. TITAN SILENT
7. CLT (s: 160 m- *6 1/4 in*)

AIRBORNE FLANKING TRANSMISSION



f [Hz]	R [dB]
50	58,3
63	63,9
80	47,7
100	54,6
125	54,8
160	48,8
200	48,3
250	51,4
315	52,9
400	52,6
500	56,1
630	61,0
800	63,7
1000	68,8
1250	73,1
1600	72,6
2000	75,6
2500	70,6
3150	71,7
4000	76,6
5000	80,2

$R_{Df+Ff,situ}$ = **62 dB**

$R_{Df+Ff,situ,0}$ = 57 dB

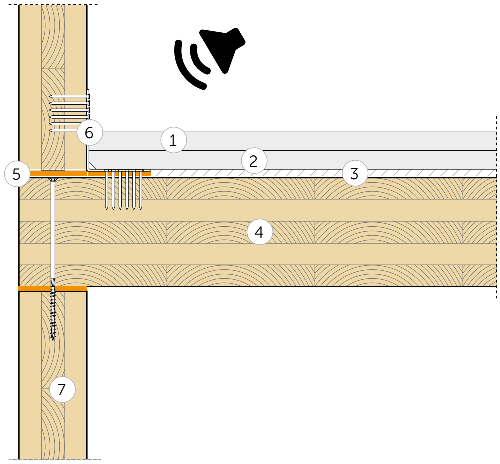
$STC_{Df+Ff, situ}$ = ***61***

$STC_{Df+Ff,situ,0}$ = 57

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 602 Innsbruck.
Test protocol: M03B_L211217_m-Bodenaufbau

ON-SITE MEASUREMENT | CLT FLOOR

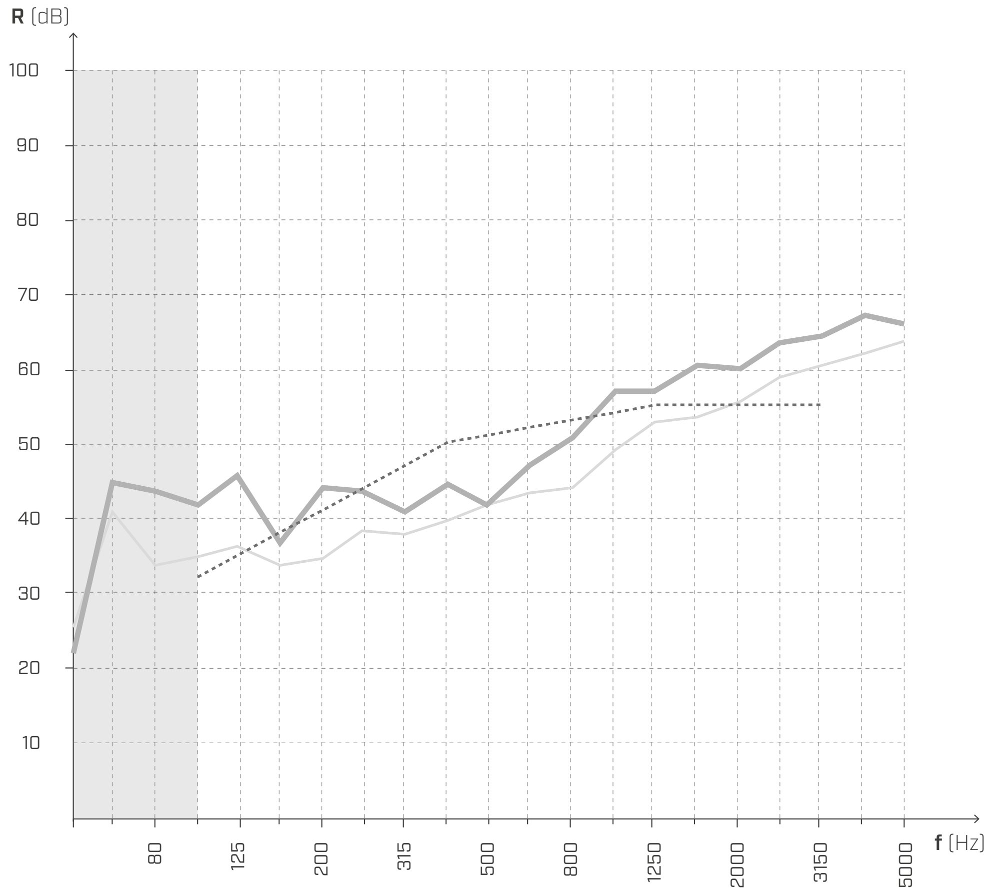
AIRBORNE SOUND INSULATION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 167 kg/ m^2
Receiving room volume = 75,52 m^3

1. reinforced gypsum-fibre board (44 kg/m^2) (s: 32 mm- *1 1/4 in*)
2. high density cardboard and sand panels (34,6 kg/m^2) (s: 30 mm- *1 3/16 in*)
3. SILENT FLOOR PUR (s: 10 mm- *3/8 in*)
4. CLT (s: 160 mm- *6 1/4 in*)
5. **XYLOFON**
6. TITAN SILENT
7. CLT (s: 160 m- *6 1/4 in*)

AIRBORNE SOUND INSULATION



f [Hz]	R [dB]
50	22,0
63	44,8
80	43,6
100	41,8
125	45,7
160	36,8
200	44,2
250	43,6
315	40,9
400	44,5
500	41,8
630	47,1
800	50,8
1000	57,0
1250	57,0
1600	60,6
2000	60,1
2500	63,5
3150	64,5
4000	67,2
5000	66,1

$R'_w(C;C_{tr})$ = **51 (0;-6) dB**

*$R'_{w,0}(C;C_{tr})$ = **47 (0;-6) dB***

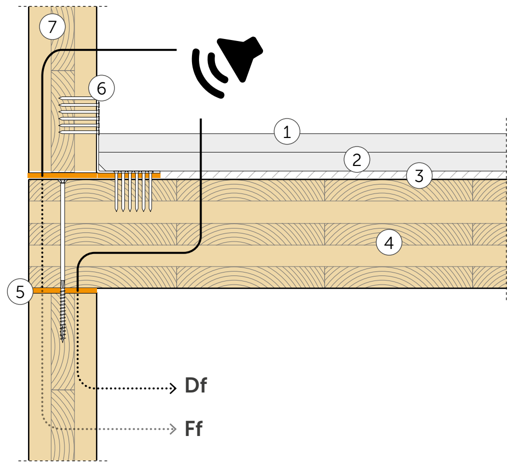
STC = ***51***

*STC_0 = **48***

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 6020 Innsbruck.
Test protocol: M07B_L211217_m-Bodenaufbau

ON-SITE MEASUREMENT | CLT FLOOR

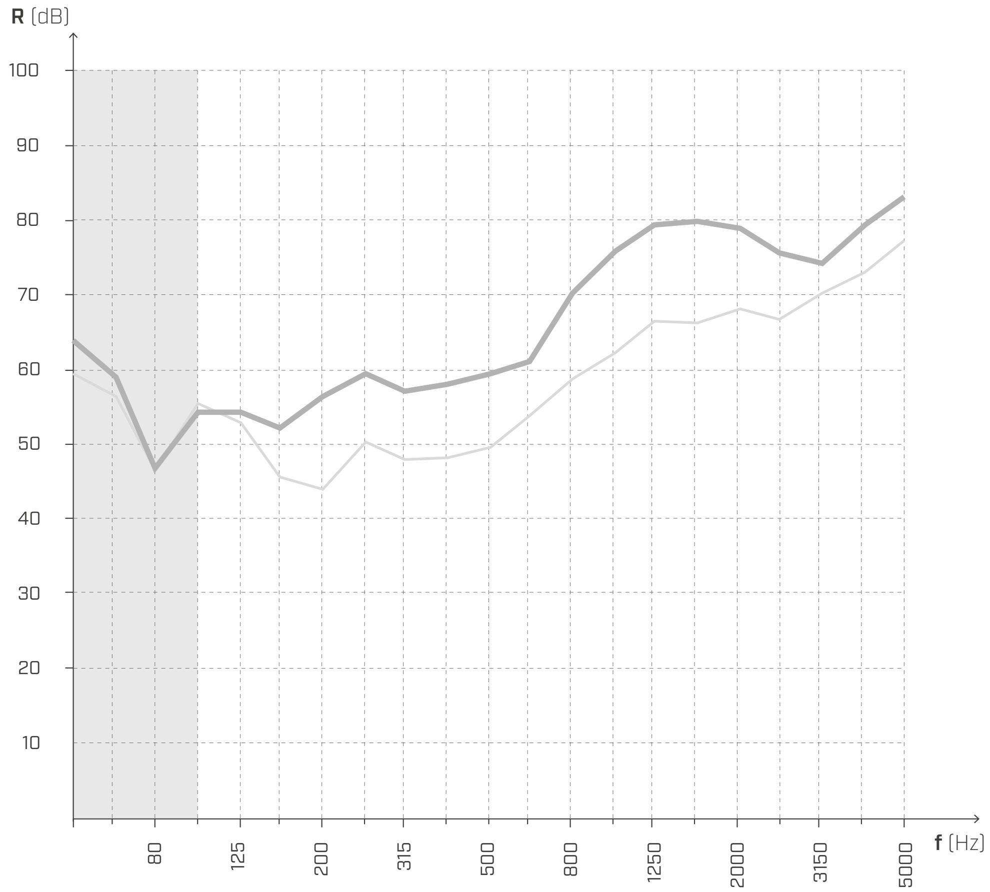
AIRBORNE FLANKING TRANSMISSION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 167 kg/ m^2
Receiving room volume = 75,52 m^3

1. reinforced gypsum-fibre board (44 kg/m^2) (s: 32 mm- *1 1/4 in*)
2. high density cardboard and sand panels (34,6 kg/m^2) (s: 30 mm- *1 3/16 in*)
3. SILENT FLOOR PUR (s: 10 mm- *3/8 in*)
4. CLT (s: 160 mm- *6 1/4 in*)
5. **XYLOFON**
6. TITAN SILENT
7. CLT (s: 160 m- *6 1/4 in*)

AIRBORNE FLANKING TRANSMISSION



f [Hz]	R [dB]
50	63,9
63	59,0
80	46,7
100	54,3
125	54,3
160	52,2
200	56,4
250	59,3
315	57,1
400	58,0
500	59,4
630	60,9
800	70,2
1000	75,8
1250	79,4
1600	79,7
2000	78,8
2500	75,6
3150	74,1
4000	79,2
5000	82,9

with XYLOFON
without XYLOFON

$R_{Df+Ff,situ}$ = **67 dB**

$R_{Df+Ff,situ,0}$ = 57 dB

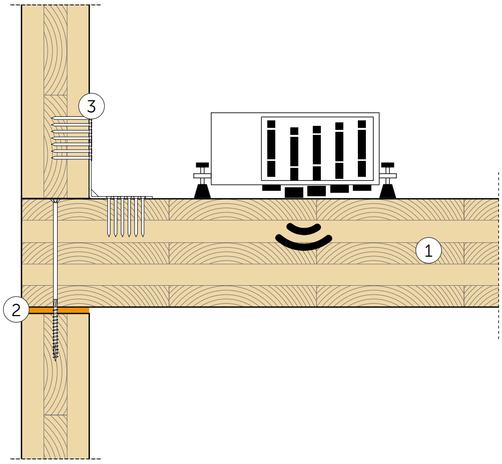
$STC_{Df+Ff,\ situ}$ = ***67***

$STC_{Df+Ff,situ,0}$ = 57

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 602 Innsbruck.
Test protocol: M07B_T210517_o-Bodenaufbau

ON-SITE MEASUREMENT | CLT FLOOR

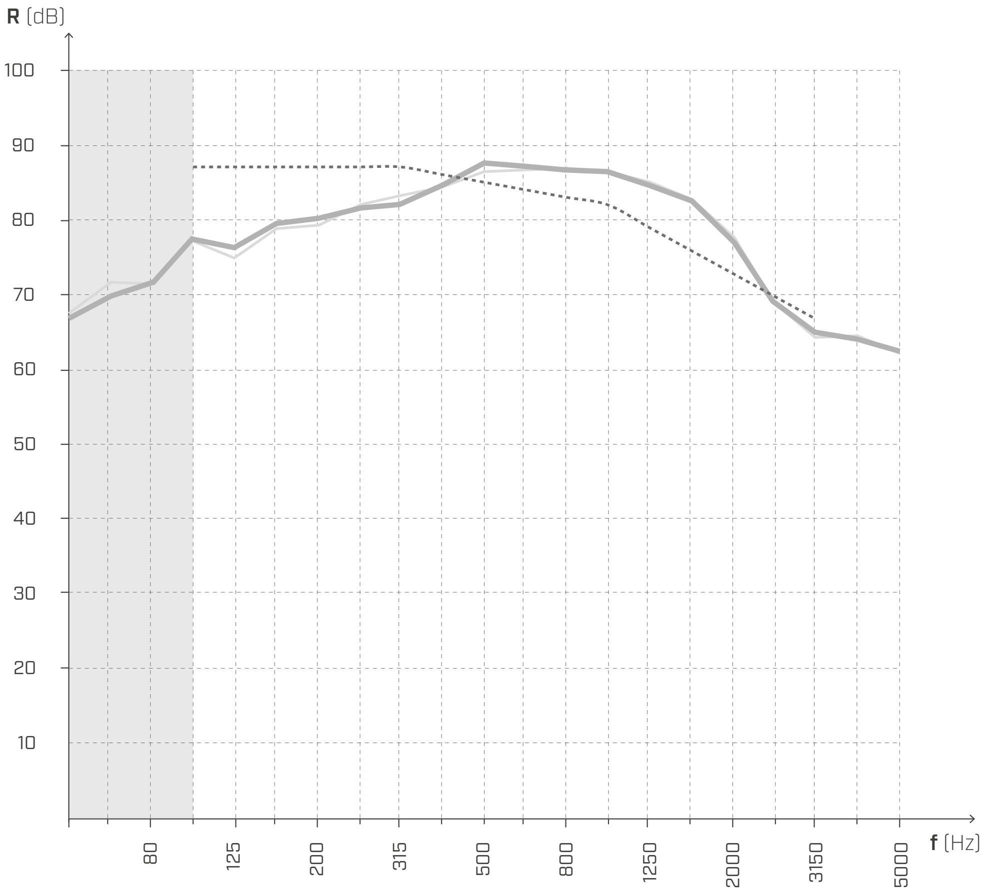
IMPACT SOUND INSULATION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 72 kg/ m^2
Receiving room volume = 75,52 m^3

1. CLT (s: 160 mm- *6 1/4 in*)
2. **XYLOFON**
3. TITAN SILENT

Impact sound NOISE INSULATION



f [Hz]	R [dB]
50	66,7
63	69,7
80	71,6
100	77,6
125	76,2
160	79,5
200	80,2
250	81,7
315	82,3
400	84,8
500	87,7
630	87,2
800	86,9
1000	86,7
1250	84,8
1600	82,7
2000	77,1
2500	69,0
3150	65,0
4000	64,0
5000	62,4

with XYLOFON
without XYLOFON

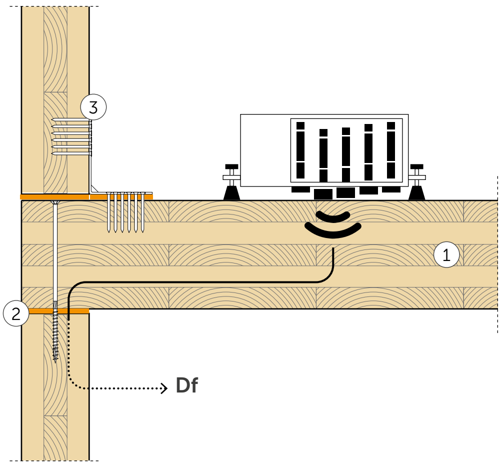
$L'_{n,w}(C_I)$ = **85 (-4) dB**

IIC = ***85***

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 602 Innsbruck.
Test protocol: M06A_T210517_o-Bodenaufbau.

ON-SITE MEASUREMENT | CLT FLOOR

IMPACT FLANKING TRANSMISSION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 167 kg/ m^2
Receiving room volume = 75,52 m^3

1. CLT (s: 160 mm- *6 1/4 in*)
2. XYLOFON
3. TITAN SILENT

IMPACT FLANKING TRANSMISSION

f [Hz]	L_n [dB]
50	55,2
63	54,8
80	56,9
100	58,4
125	52,7
160	52,5
200	55,9
250	60,2
315	56,2
400	54,0
500	61,5
630	60,8
800	63,2
1000	66,0
1250	62,3
1600	59,5
2000	60,6
2500	52,3
3150	50,0
4000	39,5
5000	28,2

$L_{n,Df+Ff,situ}$ = **64 dB**

$L_{n,Df+Ff,situ,0}$ = 71 dB

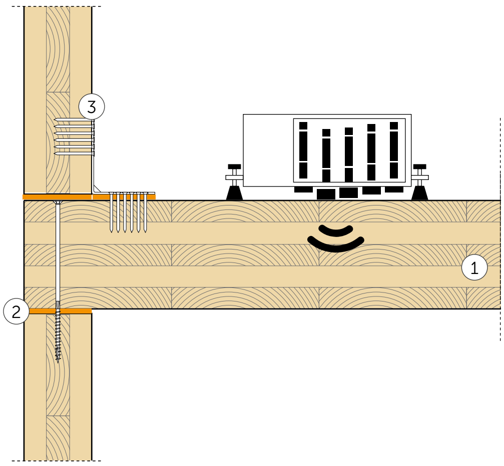
$IIC_{Df+Ff, situ}$ = **64**

$IIC_{Df+Ff,situ,0}$ = 71

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 602 Innsbruck.
Test protocol: M06A_T210517_o-Bodenaufbau

ON-SITE MEASUREMENT | CLT FLOOR

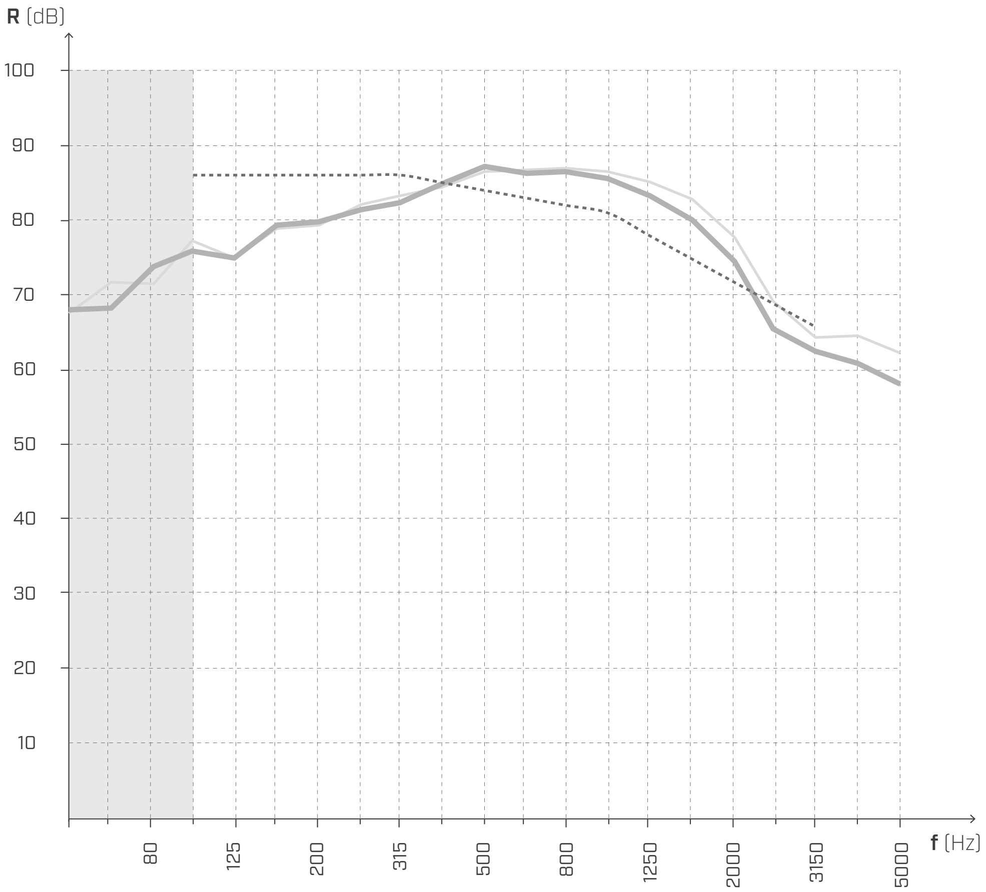
IMPACT SOUND INSULATION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 72 kg/ m^2
Receiving room volume = 75,52 m^3

1. CLT (s: 160 mm- *6 1/4 in*)
2. **XYLOFON**
3. TITAN SILENT

Impact sound NOISE INSULATION



f [Hz]	R [dB]
50	68,0
63	68,2
80	73,7
100	75,8
125	74,9
160	79,3
200	79,8
250	81,5
315	82,3
400	85,1
500	87,4
630	86,4
800	86,7
1000	85,6
1250	83,4
1600	80,2
2000	74,4
2500	65,5
3150	62,3
4000	60,7
5000	57,9

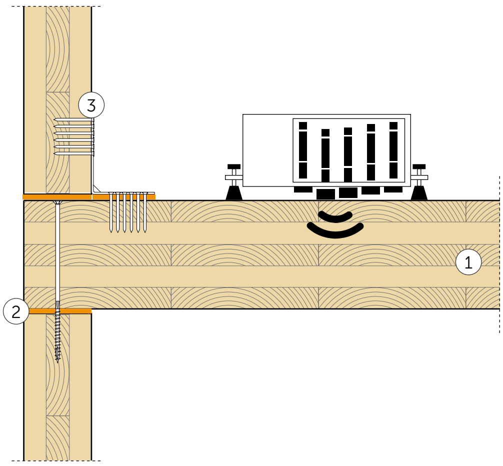
with XYLOFON
without XYLOFON

$L'_{n,w}(C_I)$ = **84 (-4) dB**   *IIC* = ***84***

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 602 Innsbruck.
Test protocol:M07A_T210517_o-Bodenaufbau

ON-SITE MEASUREMENT | CLT FLOOR

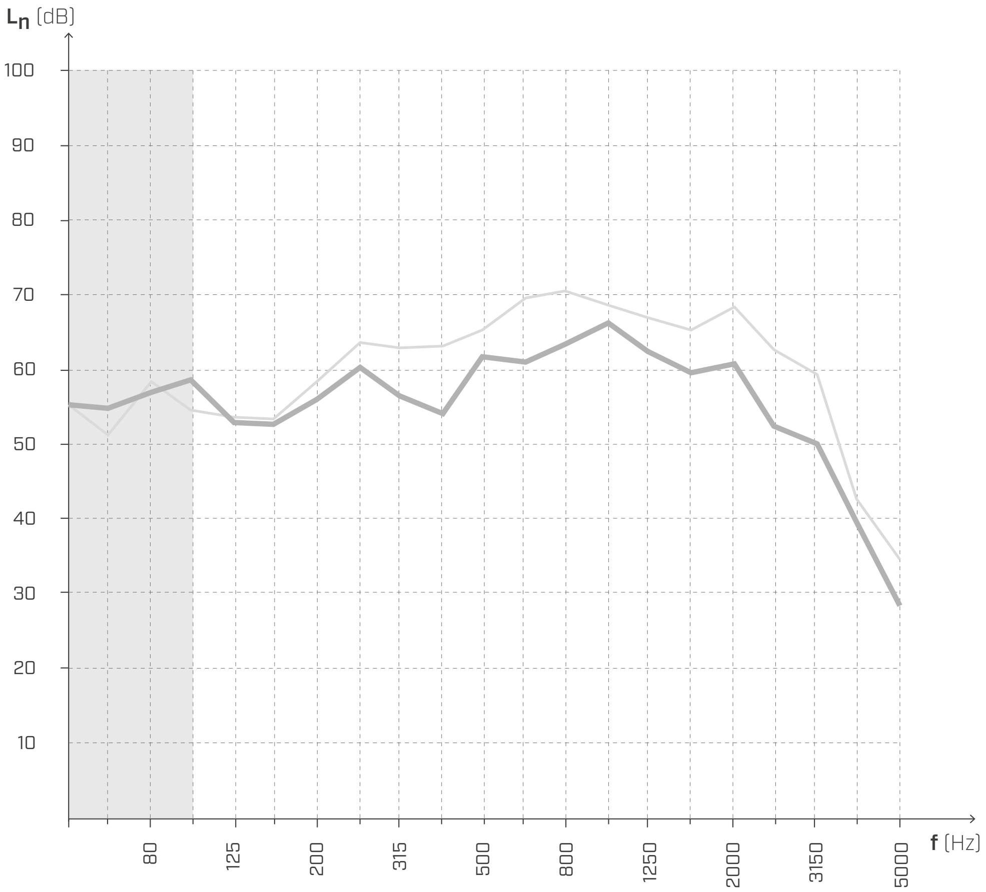
IMPACT FLANKING TRANSMISSION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 167 kg/ m^2
Receiving room volume = 75,52 m^3

1. CLT (s: 160 mm- *6 1/4 in*)
2. XYLOFON
3. TITAN SILENT

IMPACT FLANKING TRANSMISSION



f [Hz]	L_n [dB]
50	56,0
63	53,1
80	60,1
100	58,0
125	51,8
160	53,5
200	57,5
250	58,8
315	55,1
400	54,4
500	60,8
630	61,6
800	62,3
1000	65,7
1250	61,7
1600	59,0
2000	60,3
2500	50,5
3150	43,9
4000	35,2
5000	27,1

with XYLOFON
without XYLOFON

$L_{n,Df+Ff,situ}$ = **63 dB**

$L_{n,Df+Ff,situ,0}$ = *71 dB*

$IIC_{Df+Ff,\ situ}$ = **63**

$IIC_{Df+Ff,situ,0}$ = *71*

Testing laboratory: Universität Innsbruck0Arbeitsbereich für Holzbau0Technikerstraße 13A - 602 Innsbruck.
Test protocol: M07A_T210517_o-Bodenaufbau

ON SITE MEASUREMENTS

The effectiveness of XYLOFON was also verified by measuring passive acoustic requirements in constructed buildings. XYLOFON 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 XYLOFON proved to be an excellent partner for reducing flanking sound transmission.

MARIE CURIE SCHULE

Frankfurt (DE)

description	building for school use
type of structure	CLT panels
location	Frankfurt (Germany)
products	XYLOFON

MULTI-STOREY BUILDING

Toronto (CA)

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

SOLHØY

Østlandet (NO)

description	health centre consisting of 67 health-care flats with attached user services
type of structure	CLT panels
location	Østlandet (Norway)
products	XYLOFON

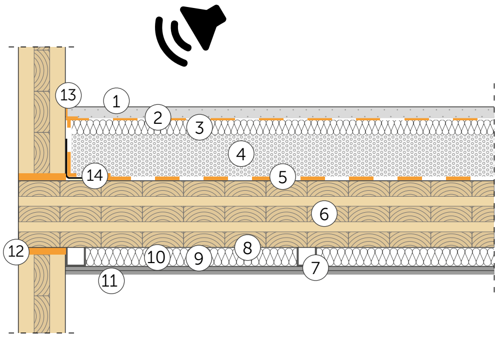
LA BRIOSA HOTEL

Trentino Alto Adige (IT)

description	7-storey building for accommodation use
type of structure	CLT panels
location	Trentino Alto Adige (Italy)
products	XYLOFON, ALADIN, TITAN SILENT

LABORATORY MEASUREMENT | CLT FLOOR 1

AIRBORNE SOUND INSULATION ACCORDING TO ISO 10140-2

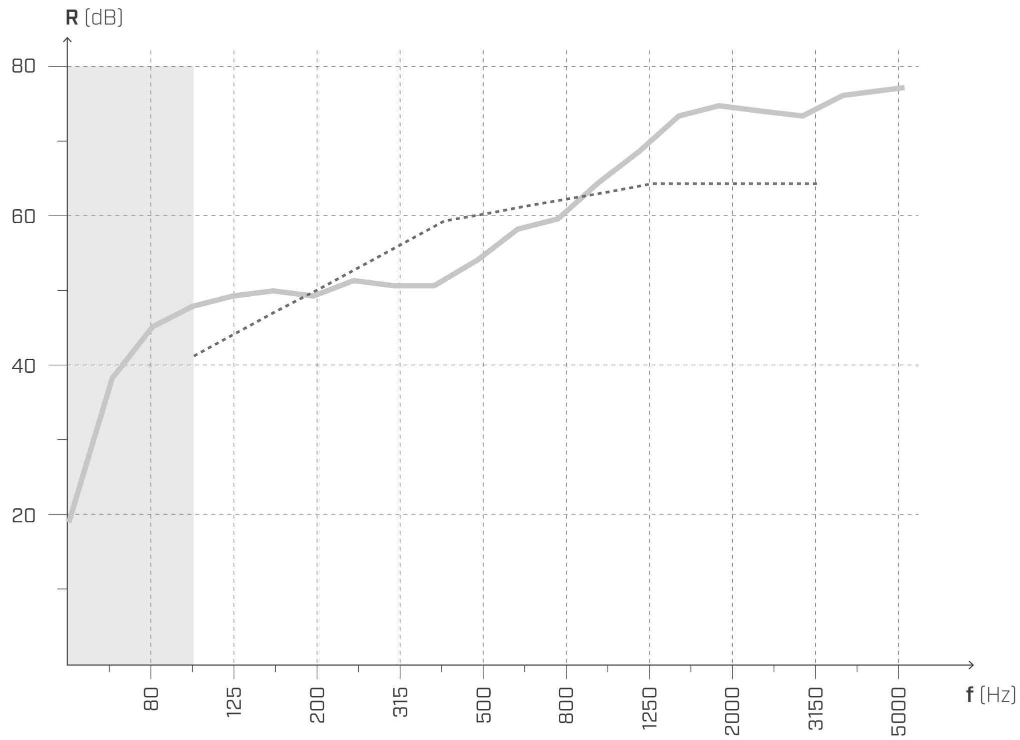


FLOOR SLAB

Surface = 31,17 m^2
Mass = 418,3 kg/m^2
Receiving room volume = 78,4 m^3

1. Concrete screed (2400 $kg/m^{3)}$) (s: 60 mm - *2 3/8 in*)
2. BARRIER 150
3. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
4. Compact gravel fill with cement (1800 kg/m^3) (s: 80 mm - *3 1/8 in*)
5. **SILENT FLOOR BYTUM** (s: 5 mm - *8 mil*)
6. CLT (s: 160 mm - *6 1/4 in*)
7. Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
8. Metal structure for plasterboard
9. Air chamber (s: 10 mm - *3/8 in*)
10. Low density mineral wool insulation (25 kg/m^3) (s: 50 mm - *2 in*)
11. Plasterboard panel x2 (s: 25 mm - *1 in*)
12. **XYLOFON**
13. **SILENT EDGE**
14. Fastening system:
    HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
    TITAN SILENT 800 mm (*31 1/2 in*) spacing

AIRBORNE SOUND INSULATION



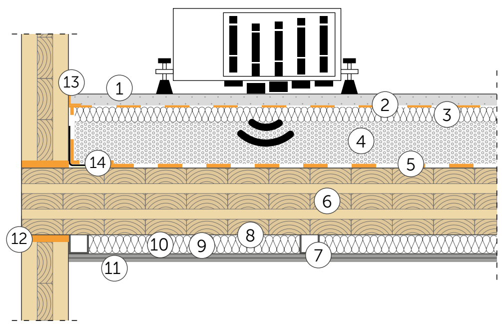
f [Hz]	R [dB]
50	18,6
63	38,2
80	44,8
100	48,0
125	49,5
160	50,1
200	49,0
250	51,6
315	50,6
400	50,7
500	54,2
630	58,4
800	59,9
1000	64,6
1250	68,7
1600	73,6
2000	75,0
2500	74,1
3150	73,8
4000	76,2
5000	76,9
-	**60**

R_w ($C;C_{tr}$) = **60 (-1; -4) dB** STC = **59**

Testing laboratory: Akustik Center Austria, Holzforschung Austria.
Test protocol: 2440_01_2017_M01.

LABORATORY MEASUREMENT | CLT FLOOR 1

IMPACT SOUND INSULATION ACCORDING TO ISO 10140-3

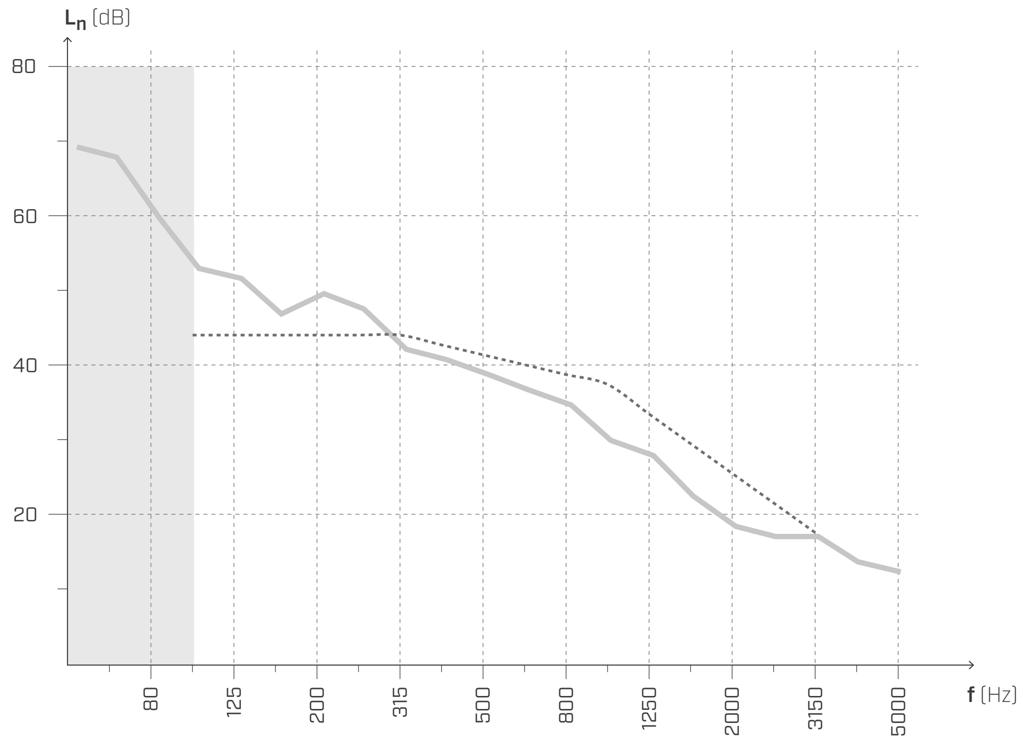


FLOOR SLAB

Surface = 31,17 m^2
Mass = 418,3 kg/m^2
Receiving room volume = 78,4 m^3

(1) Concrete screed (2400 kg/m^3) (s: 60 mm - *2 3/8 in*)
(2) BARRIER 150
(3) Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
(4) Compact gravel fill with cement (1800 kg/m^3) (s: 80 mm - *3.15 i*)
(5) **SILENT FLOOR BYTUM** (s: 5 mm - *8 mil*)
(6) CLT (s: 160 mm - *6 1/4 in*)
(7) Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
(8) Metal structure for plasterboard
(9) Air chamber (s: 10 mm - *3/8 in*)
(10) Low density mineral wool insulation (25 kg/m^3) (s: 50 mm - *2 in*)
(11) Plasterboard panel x2 (s: 25 mm - *1 in*)
(12) **XYLOFON**
(13) **SILENT EDGE**
(14) Fastening system:
HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
TITAN SILENT 800 mm (*31 1/2 in*) spacing

IMPACT SOUND INSULATION



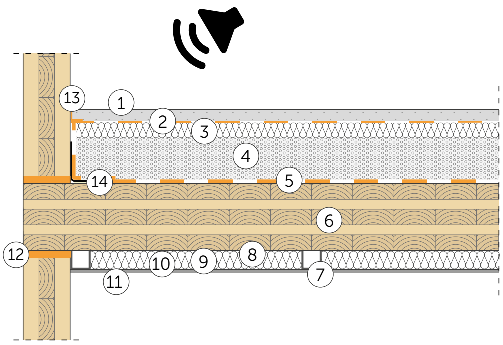
f [Hz]	L_n [dB]
50	69,1
63	67,3
80	59,7
100	52,9
125	51,1
160	46,6
200	49,4
250	47,5
315	41,8
400	40,5
500	38,8
630	36,7
800	34,5
1000	30,1
1250	27,5
1600	22,5
2000	18,2
2500	17,1
3150	17,3
4000	13,8
5000	12,5
-	**42**

$L_{n,w}$ (C_I) = **42 (0) dB** *IIC* = ***67***

Testing laboratory: Akustik Center Austria, Holzforschung Austria.
Test protocol: 2440_01_2017_M01.

LABORATORY MEASUREMENT | CLT FLOOR 2

AIRBORNE SOUND INSULATION ACCORDING TO ISO 10140-2

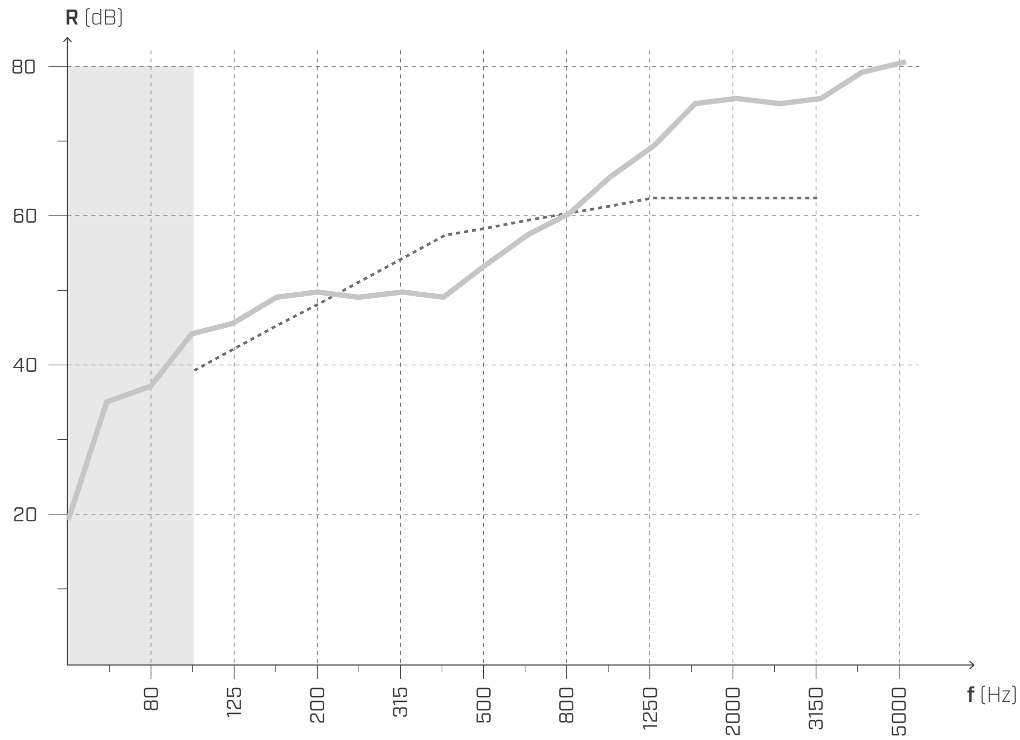


FLOOR SLAB

Surface = 31,17 m^2
Mass = 418,3 kg/m^2
Receiving room volume = 78,4 m^3

1. Concrete screed (2400 kg/m^3) (s: 60 mm - *2 3/8 in*)
2. BARRIER 150
3. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
4. Compact gravel fill with cement (1800 kg/m^3) (s: 80 mm - *3 1/8 in*)
5. **SILENT FLOOR BYTUM** (s: 5 mm - *8 mil*)
6. CLT (s: 160 mm - *6 1/4 in*)
7. Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
8. Metal structure for plasterboard
9. Air chamber (s: 10 mm- *3/8 in*)
10. Low density mineral wool insulation (25 kg/m^3) (s: 50 mm - *2 in*)
11. Plasterboard panel (s: 12,5 mm- *1/2 in*)
12. **XYLOFON**
13. **SILENT EDGE**
14. Fastening system:
    HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
    TITAN SILENT 800 mm (*31 1/2 in*) spacing

AIRBORNE SOUND INSULATION



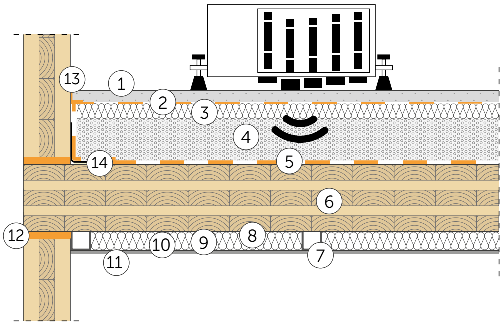
f [Hz]	R [dB]
50	18,7
63	34,9
80	36,9
100	43,8
125	45,6
160	49,1
200	49,9
250	49,1
315	49,4
400	48,7
500	53,0
630	57,4
800	59,9
1000	64,6
1250	68,9
1600	74,2
2000	74,9
2500	74,6
3150	75,1
4000	78,4
5000	79,9
-	**59**

R_w ($C;C_{tr}$) = **59 (-1; -4) dB** STC = **57**

Testing laboratory: Akustik Center Austria, Holzforschung Austria.
Test protocol: 2440_03_2017_M02.

LABORATORY MEASUREMENT | CLT FLOOR 2

IMPACT SOUND INSULATION ACCORDING TO ISO 10140-3

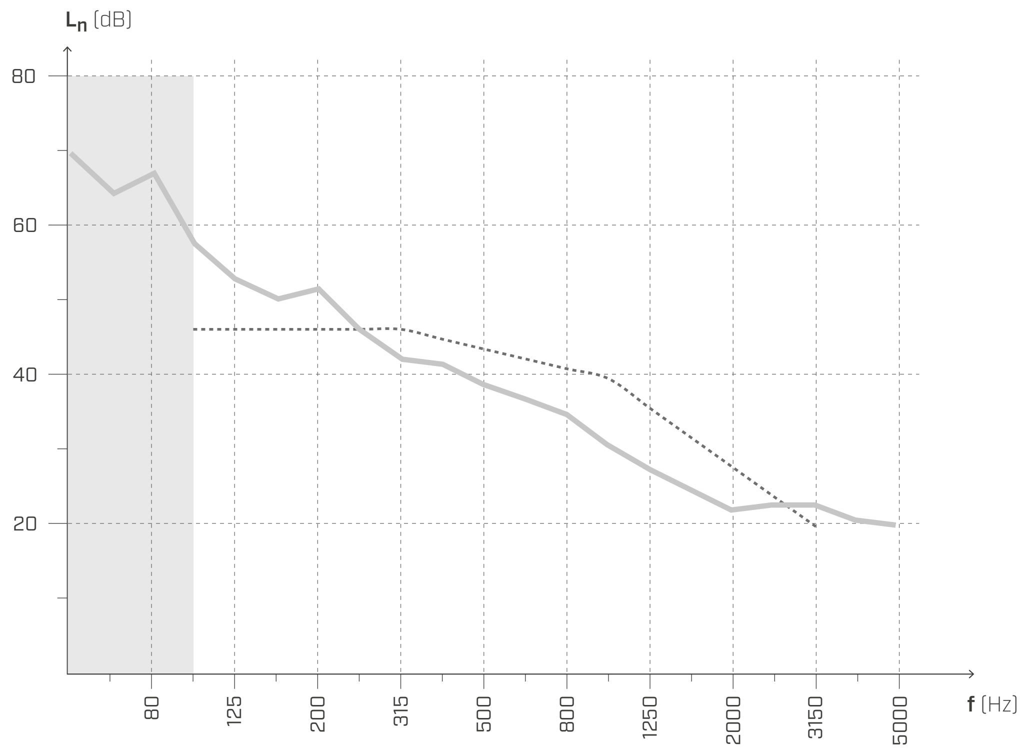


FLOOR SLAB

Surface = 31,17 m^2
Mass = 418,3 kg/m^2
Receiving room volume = 78,4 m^3

1. Concrete screed (2400 kg/m^3) (s: 60 mm - *2.36 i*)
2. BARRIER 150
3. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
4. Compact gravel fill with cement (1800 kg/m^3) (s: 80 mm - *3 1/8 in*)
5. **SILENT FLOOR BYTUM** (s: 5 mm - *8 mil*)
6. CLT (s: 160 mm - *6 1/4 in*)
7. Resilient plasterboard connectors (s: 60 mm- *2.36 i*)
8. Metal structure for plasterboard
9. Air chamber (s: 10 mm- *3/8 in*)
10. Low density mineral wool insulation (25 kg/m^3) (s: 50 mm - *2 in*)
11. Plasterboard panel x2 (s: 25 mm- *1 in*)
12. **XYLOFON**
13. **SILENT EDGE**
14. Fastening system:
    HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
    TITAN SILENT 800 mm (*31 1/2 in*) spacing

IMPACT SOUND INSULATION



f [Hz]	L_n [dB]
50	69,6
63	64,5
80	66,9
100	57,4
125	52,7
160	50,1
200	51,5
250	46,2
315	42,0
400	41,0
500	38,9
630	36,8
800	34,7
1000	30,4
1250	27,4
1600	24,2
2000	21,9
2500	22,7
3150	22,1
4000	20,6
5000	19,4
-	**44**

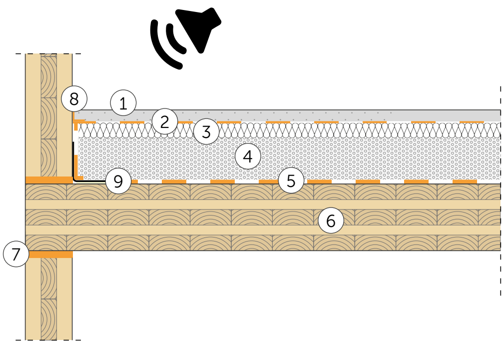
$L_{n,w}$ (C_I) = **44 (1) dB**

IIC = **62**

Testing laboratory: Akustik Center Austria, Holzforschung Austria.
Test protocol: 2440_03_2017_M02.

LABORATORY MEASUREMENT | CLT FLOOR 3

AIRBORNE SOUND INSULATION ACCORDING TO ISO 10140-2

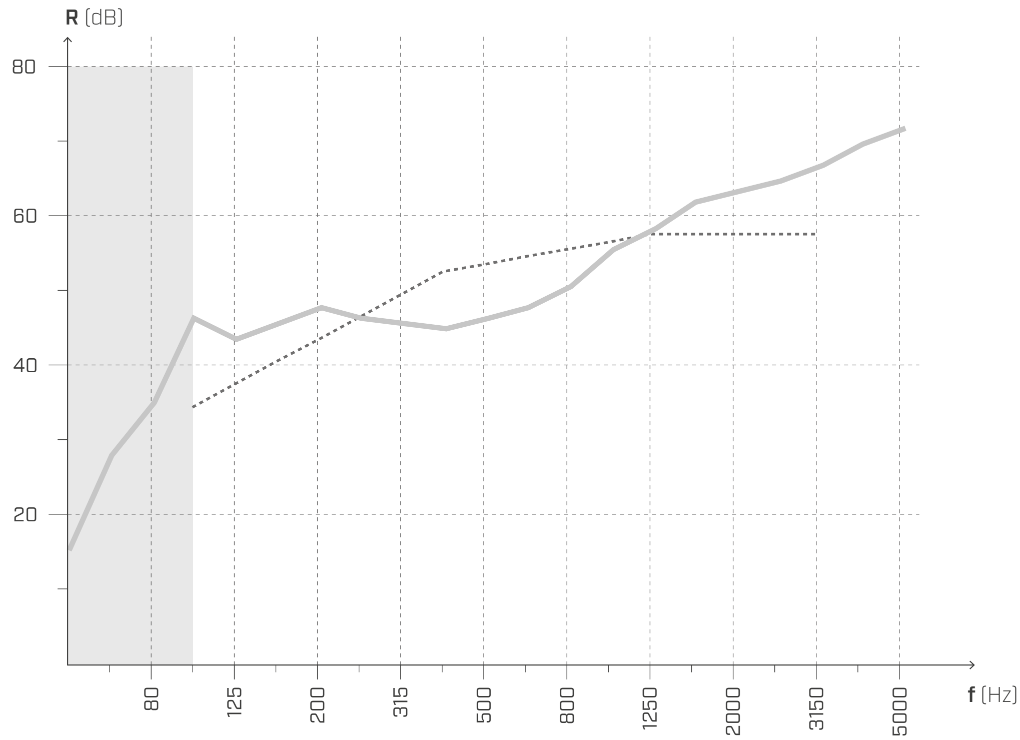


FLOOR SLAB

Surface = 31,17 m^2
Mass = 418,3 kg/m^2
Receiving room volume = 78,4 m^3

1. Concrete screed (2400 kg/m^3) (s: 60 mm - *2 3/8 in*)
2. BARRIER 150
3. Mineral wool insulation s' $\leq$ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
4. Compact gravel fill with cement (1800 kg/m^3) (s: 80 mm - *3 1/8 in*)
5. **SILENT FLOOR BYTUM** (s: 5 mm - *8 mil*)
6. CLT (s: 160 mm - *6 1/4 in*)
7. **XYLOFON**
8. **SILENT EDGE**
9. Fastening system:
   HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
   TITAN SILENT 800 mm (*31 1/2 in*) spacing

AIRBORNE SOUND INSULATION



f [Hz]	R [dB]
50	15,5
63	27,8
80	35,3
100	46,1
125	43,8
160	45,7
200	47,6
250	46,4
315	45,8
400	44,9
500	46,6
630	47,4
800	50,3
1000	55,7
1250	58,2
1600	61,6
2000	62,8
2500	64,8
3150	66,6
4000	69,6
5000	71,6
-	**53**

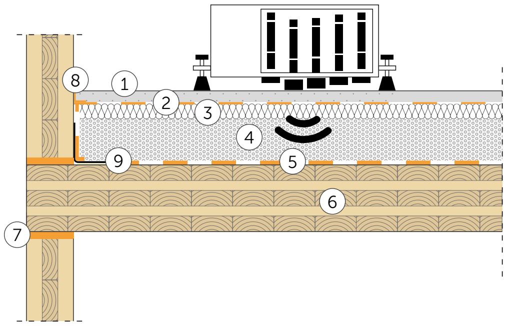
R_w ($C;C_{tr}$) = **53 (-1; -3) dB**

STC = **53**

Testing laboratory: Akustik Center Austria, Holzforschung Austria.
Test protocol: 2440_05_2017_M03.

LABORATORY MEASUREMENT | CLT FLOOR 3

IMPACT SOUND INSULATION ACCORDING TO ISO 10140-3

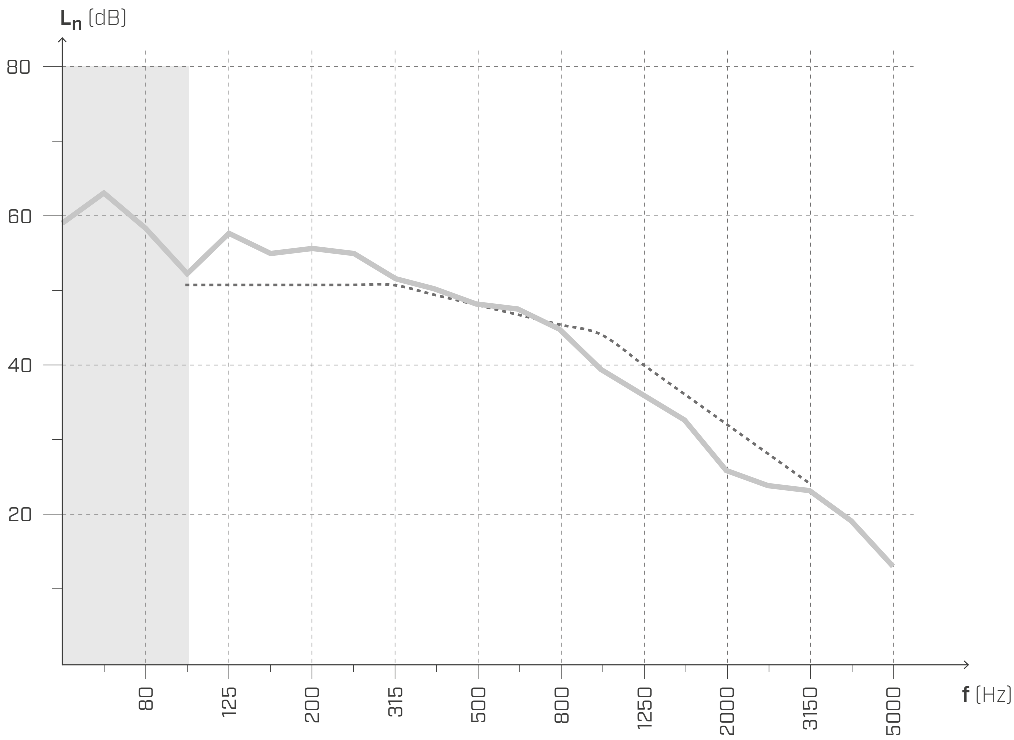


FLOOR SLAB

Surface = 31,17 m^2
Mass = 418,3 kg/m^2
Receiving room volume = 78,4 m^3

1. Concrete screed (2400 kg/m^3) (s: 60 mm - *2 3/8 in*)
2. BARRIER 150
3. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
4. Compact gravel fill with cement (1800 kg/m^3) (s: 80 mm - *3 1/8 in*)
5. **SILENT FLOOR BYTUM** (s: 5 mm - *8 mil*)
6. CLT (s: 160 mm- *6 1/4 in*)
7. **XYLOFON**
8. **SILENT EDGE**
9. Fastening system:
   HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
   TITAN SILENT 800 mm (*31 1/2 in*) spacing

IMPACT SOUND INSULATION



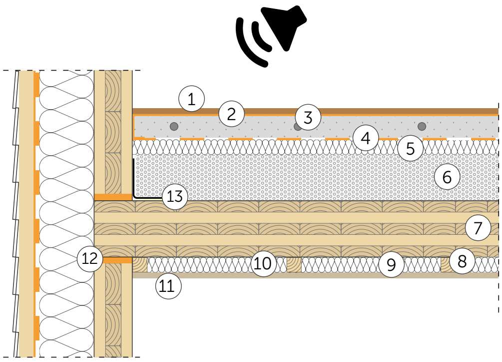
f [Hz]	L_n [dB]
50	59,3
63	63,1
80	58,4
100	51,9
125	57,5
160	55,1
200	55,4
250	55,0
315	51,4
400	50,0
500	47,9
630	47,3
800	44,9
1000	39,3
1250	36,0
1600	32,6
2000	26,0
2500	24,2
3150	23,1
4000	19,1
5000	13,3
-	**48**

$L_{n,w}$ (C_I) = **48 (0) dB**   *IIC* = **62**

Testing laboratory: Akustik Center Austria, Holzforschung Austria.
Test protocol: 2440_06_2017_M03.

ON-SITE MEASUREMENT | CLT FLOOR 5

AIRBORNE SOUND INSULATION ACCORDING TO ISO 140-4

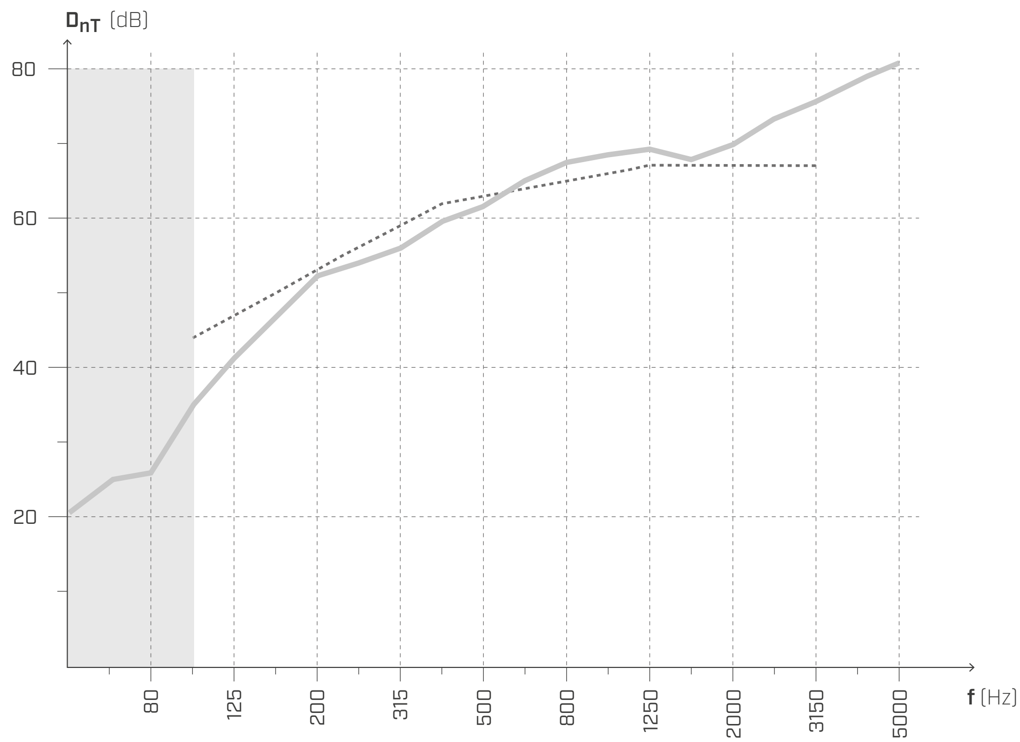


FLOOR SLAB

Surface = 35,14 m^2
Mass = 384 kg/m^2
Receiving room volume = 88 m^3

1. Timber floor (s: 15 mm - *9/16 in*)
2. **SILENT STEP** (s: 2 mm - *8 mil*)
3. In-floor heating system (s: 70 mm - *2 3/4 in*)
4. **BARRIER 150**
5. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
6. Compact gravel fill (s: 85 mm - *3 3/8 in*)
7. CLT (s: 150 mm - *6 in*)
8. Solid wood batten with resilient connectors
9. Air chamber (s: 6 mm - *1/4 in*)
10. Low density mineral wool insulation (25 kg/m^3) (s: 40 mm - *1 9/16 in*)
11. Fir covering (s: 19 mm - *3/4 in*)
12. **XYLOFON**
13. Fastening system:
    HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
    TITAN SILENT 1000 mm (*40 in*) spacing

AIRBORNE SOUND INSULATION



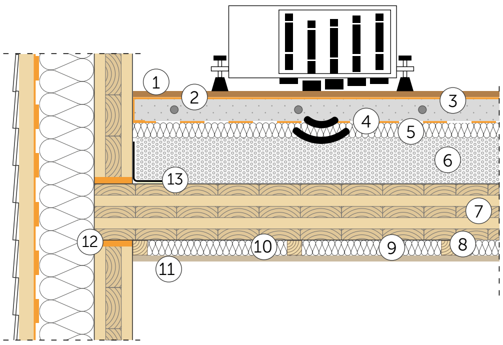
f [Hz]	D_{nT} [dB]
50	20,5
63	24,6
80	25,5
100	34,8
125	41,2
160	46,6
200	52,2
250	53,9
315	56
400	59,5
500	61,5
630	64,9
800	67,4
1000	68,4
1250	69,2
1600	67,8
2000	69,9
2500	73,3
3150	75,6
4000	79,6
5000	80,3
-	**63**

$D_{nT,w}$ $(C;C_{tr})$ = **63 (-3; -10) dB**   NNIC = ***64***

Testing laboratory: INGENIEURBÜRO ROTHBACHER GmbH.
Test protocol: 17-466.

ON-SITE MEASUREMENT | CLT FLOOR 5

IMPACT SOUND INSULATION ACCORDING TO ISO 10140-3

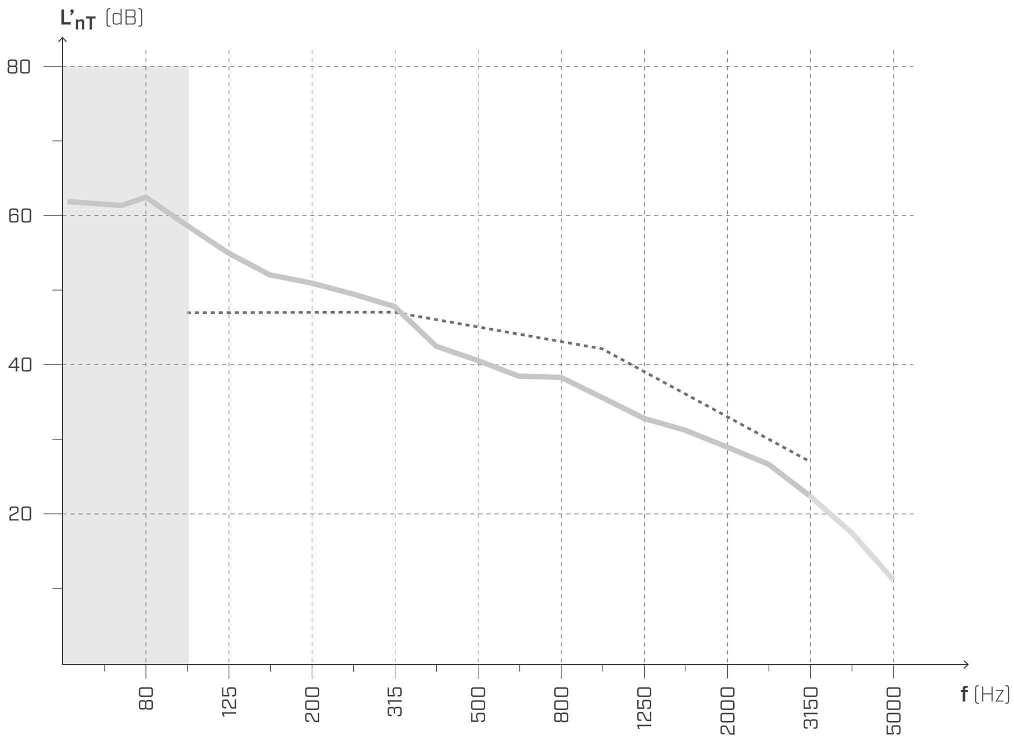


FLOOR SLAB

Surface = 35,14 m^2
Mass = 384 kg/m^2
Receiving room volume = 88 m^3

1. Timber floor (s: 15 mm - *9/16 in*)
2. **SILENT STEP** (s: 2 mm - *8 mil*)
3. In-floor heating system (s: 70 mm - *2 3/4 in*)
4. **BARRIER 100**
5. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
6. Compact gravel fill (s: 85 mm - *3 3/8 in*)
7. CLT (s: 150 mm - *6 in*)
8. Solid wood batten with resilient connectors
9. Air chamber (s: 6 mm - *1/4 in*)
10. Low density mineral wool insulation (25 kg/m^3) (s: 40 mm - *1 9/16 in*)
11. Fir covering (s: 19 mm - *3/4 in*)
12. **XYLOFON**
13. Fastening system:
    HBS 8 x 240 mm, 300 mm (*11 3/4 in*) spacing
    TITAN SILENT 1000 mm (*40 in*) spacing

IMPACT SOUND INSULATION



f [Hz]	L'_{nT} [dB]
50	61,8
63	61,3
80	63
100	58,7
125	55
160	52
200	50,9
250	49,5
315	47,7
400	42,4
500	40,5
630	38,5
800	38,3
1000	35,5
1250	32,7
1600	31,1
2000	28,9
2500	26,6
3150	22,4
4000	17,6
5000	11,4
-	**45**

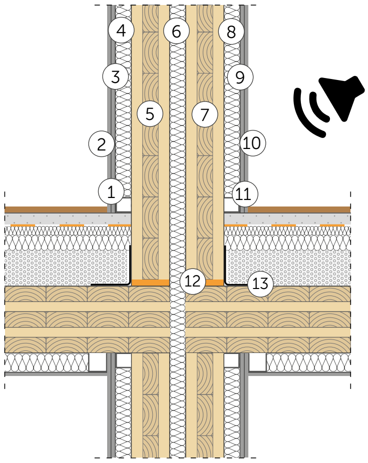
$L'_{nT,w}$ (C_I) = **45 (2) dB**

NIRS = **61**

Testing laboratory: INGENIEURBÜRO ROTHBACHER GmbH.
Test protocol: 17-466.

ON-SITE MEASUREMENT | CLT WALL 8

AIRBORNE SOUND INSULATION ACCORDING TO ISO 16283-1

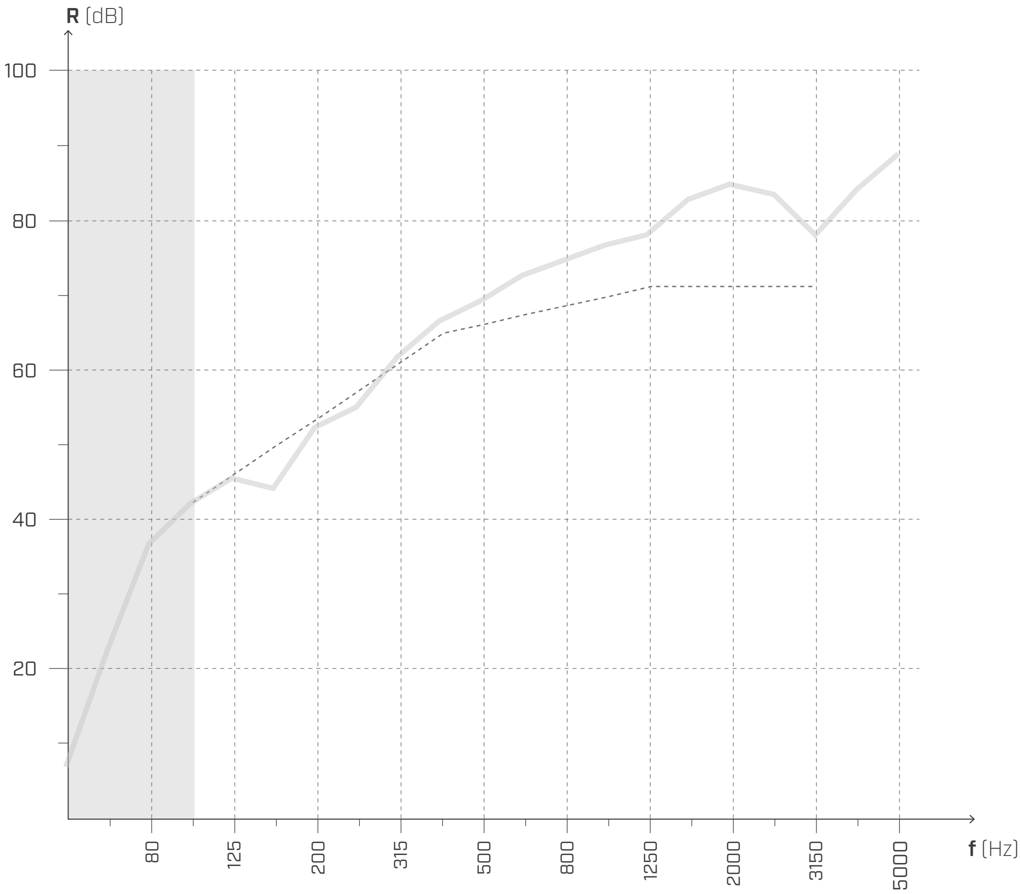


WALL

Surface = 9,6 m^2
Receiving room volume = 67 m^3

1. Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
2. Plasterboard panel x2 (s: 25 mm - *1 in*)
3. Metal structure with plasterboard (s: 50 mm - *2 in*)
4. Low density mineral wool insulation (s: 50 mm - *2 in*)
5. CLT (s: 100 mm - *4 in*)
6. High density mineral wool insulation (s: 30 mm - *1 3/16 in*)
7. CLT (s: 100 mm - *4 in*)
8. Low density mineral wool insulation (s: 50 mm - *2 in*)
9. Metal structure with plasterboard (s: 50 mm - *2 in*)
10. Plasterboard panel x2 (s: 25 mm - *1 in*)
11. Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
12. XYLOFON
13. Fastening system:
    HBS 8 x 240 mm, 500 (*20 in*) mm spacing
    WBR 100, 1000 (*40 in*) mm spacing

AIRBORNE SOUND INSULATION



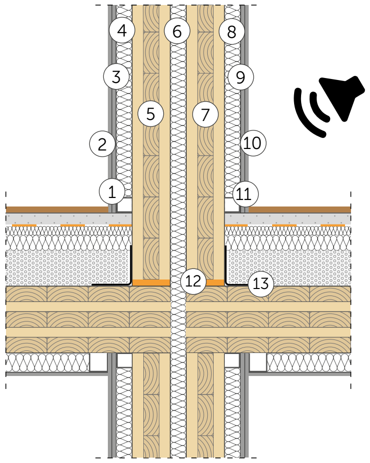
f [Hz]	R [dB]
50	6,9
63	22,7
80	36,6
100	41,9
125	45,2
160	44,0
200	52,1
250	55,0
315	61,5
400	66,3
500	69,3
630	72,5
800	74,4
1000	76,4
1250	78,1
1600	≥ 82,6
2000	≥ 84,9
2500	≥ 83,0
3150	≥ 77,6
4000	≥ 83,6
5000	≥ 88,7

$R'_w (C;C_{tr})$ = **66 (-3; -9) dB**   FSTC = **67**

Responsible for measurements: University of Bologna.
Test protocol: test 26/09/2017.

ON-SITE MEASUREMENT | CLT WALL 8

AIRBORNE SOUND INSULATION ACCORDING TO ISO 16283-1

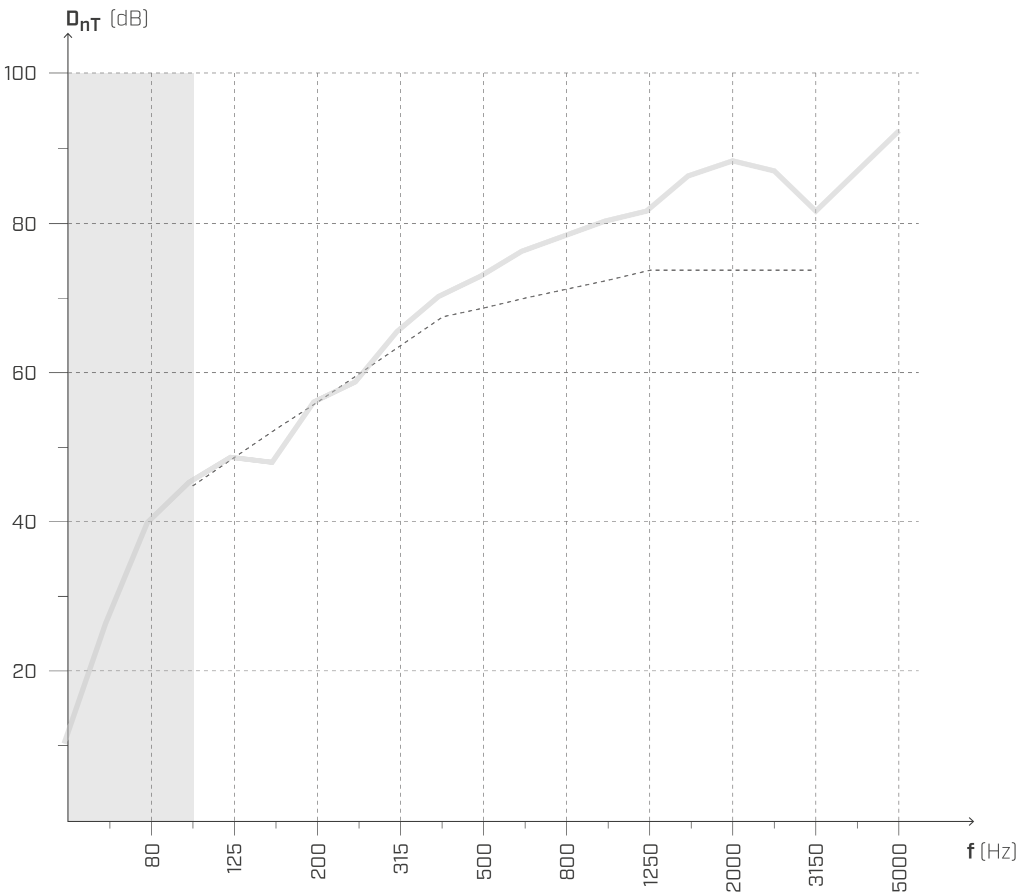


FLOOR SLAB

Surface = 9,6 m^2
Receiving room volume = 67 m^3

(1) Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
(2) Plasterboard panel x2 (s: 25 mm - *1 in*)
(3) Metal structure with plasterboard (s: 50 mm - *2 in*)
(4) Low density mineral wool insulation (s: 50 mm - *2 in*)
(5) CLT (s: 100 mm - *4 in*)
(6) High density mineral wool insulation (s: 30 mm - *1 3/16 in*)
(7) CLT (s: 100 mm - *4 in*)
(8) Low density mineral wool insulation (s: 50 mm - *2 in*)
(9) Metal structure with plasterboard (s: 50 mm - *2 in*)
(10) Plasterboard panel x2 (s: 25 mm - *1 in*)
(11) Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
(12) **XYLOFON**
(13) Fastening system:
HBS 8 x 240 mm, 500 (*20 in*) mm spacing
WBR 100, 1000 (*40 in*) mm spacing

AIRBORNE SOUND INSULATION



f [Hz]	D_{nT} [dB]
50	10,4
63	26,2
80	40,1
100	45,4
125	48,7
160	47,5
200	55,6
250	58,5
315	65,0
400	69,8
500	72,8
630	76,0
800	77,9
1000	79,9
1250	81,6
1600	≥ 86,1
2000	≥ 88,4
2500	≥ 86,5
3150	≥ 81,1
4000	≥ 87,1
5000	≥ 92,2

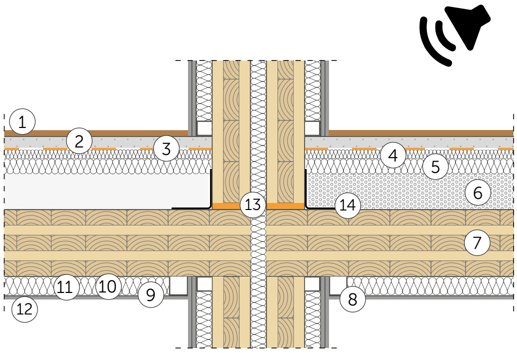
$D_{nT,w}$ $(C;C_{tr})$ = **70 (-3;-9) dB**

FSTC = ***67***

Responsible for measurements: University of Bologna.
Test protocol: test 26/09/2017.

ON-SITE MEASUREMENT | CLT FLOOR 8

AIRBORNE SOUND INSULATION ACCORDING TO ISO 16283-1

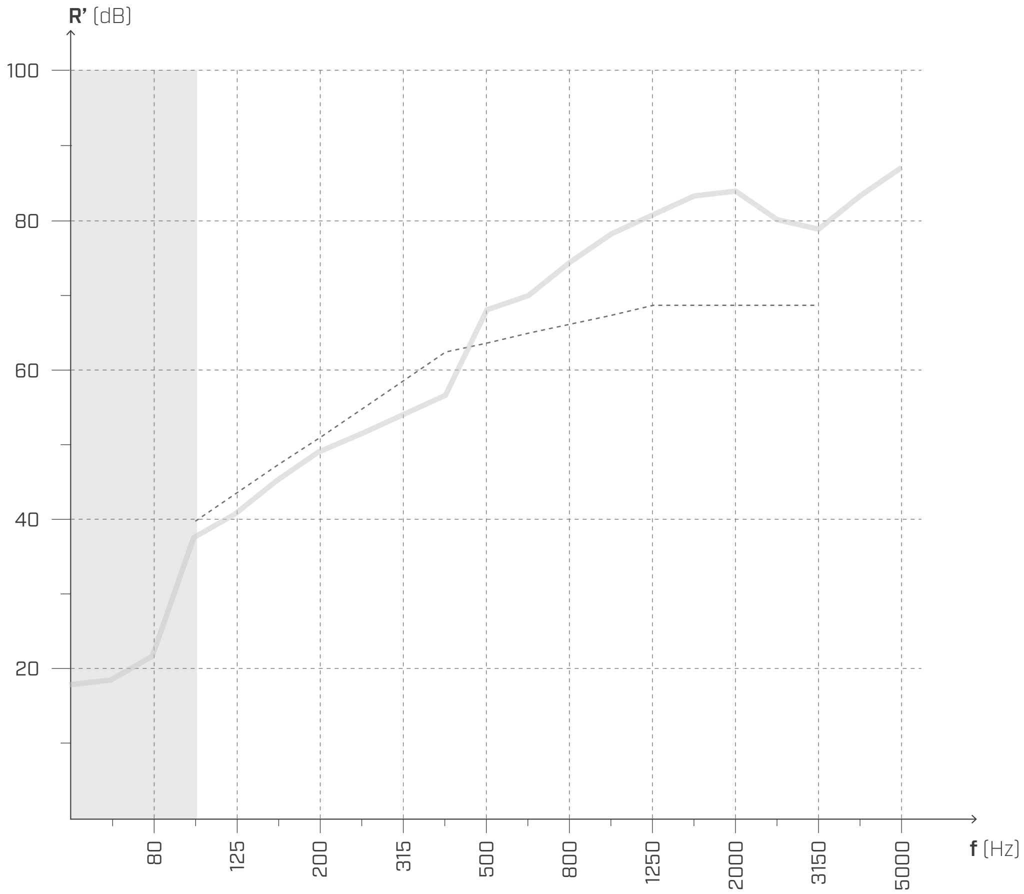


FLOOR SLAB

Surface = 26 m^2
Receiving room volume = 67 m^3

1. Floor (s: 15 mm - *9/16 in*)
2. Concrete screed (2400 kg/m^3) (s: 65 mm - *2 9/16 in*)
3. **BARRIER SD150**
4. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
5. EPS insulation (s: 50 mm - *2 in*)
6. Gravel fill (s: 45 mm - *1 3/4 in*)
7. CLT (s: 160 mm - *6 1/4 in*)
8. Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
9. Metal structure with plasterboard (s: 50 mm - *2 in*)
10. Air chamber (s: 10 mm - *3/8 in*)
11. Low density mineral wool insulation (s: 50 mm - *2 in*)
12. Plasterboard panel (s: 12,5 mm - *1/2 in*)
13. **XYLOFON**
14. Fastening system:
    HBS 8 x 240 mm, 500 mm (*20 in*) spacing
    WBR 100, 1000 (*40 in*) mm spacing

AIRBORNE SOUND INSULATION



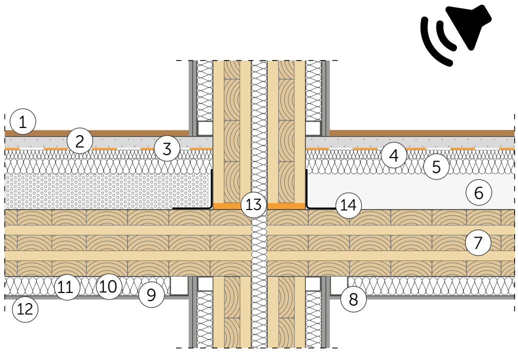
f [Hz]	R' [dB]
50	18,0
63	18,9
80	21,9
100	37,9
125	41,2
160	45,5
200	49,4
250	51,5
315	53,9
400	56,7
500	68,2
630	69,8
800	74,1
1000	78,0
1250	80,7
1600	83,0
2000	84,0
2500	79,9
3150	78,9
4000	83,0
5000	≥ 87,2

$R'_w (C;C_{tr})$ = **62 (-1; -8) dB**   FSTC = **63**

Responsible for measurements: University of Bologna.
Test protocol: test 26/09/2017.

ON-SITE MEASUREMENT | CLT FLOOR 8

AIRBORNE SOUND INSULATION ACCORDING TO ISO 16283-1

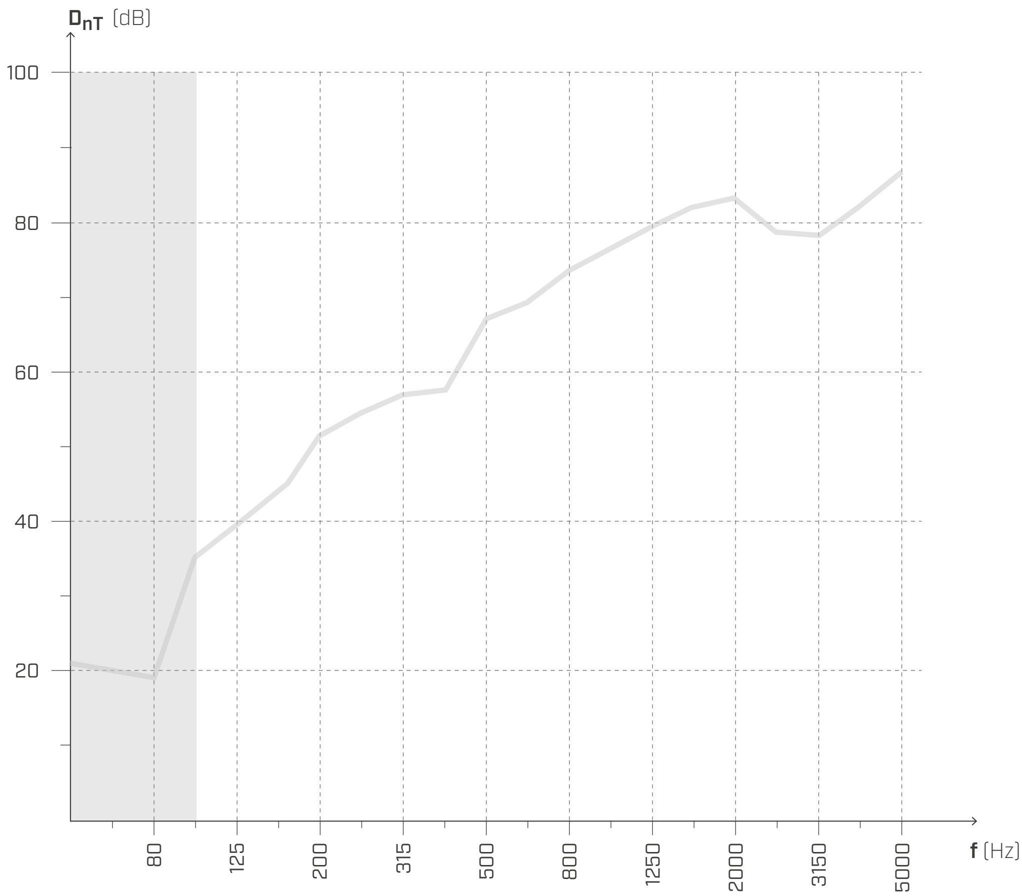


FLOOR SLAB

Surface = 26 m^2
Receiving room volume = 67 m^3

(1) Floor (s: 15 mm - *9/16 in*)
(2) Concrete screed (2400 kg/m^3) (s: 65 mm - *2 9/16 in*)
(3) **BARRIER 100**
(4) Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
(5) EPS insulation (s: 50 mm - *2 in*)
(6) Gravel fill (s: 45 mm - *1 3/4 in*)
(7) CLT (s: 160 mm - *6 1/4 in*)
(8) Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
(9) Metal structure with plasterboard (s: 50 mm - *2 in*)
(10) Air chamber (s: 10 mm - *3/8 in*)
(11) Low density mineral wool insulation (s: 50 mm - *2 in*)
(12) Plasterboard panel (s: 12,5 mm - *1/2 in*)
(13) **XYLOFON**
(14) Fastening system:
HBS 8 x 240 mm, 500 mm (*20 in*) spacing
WBR 100, 1000 (*40 in*) mm spacing

AIRBORNE SOUND INSULATION



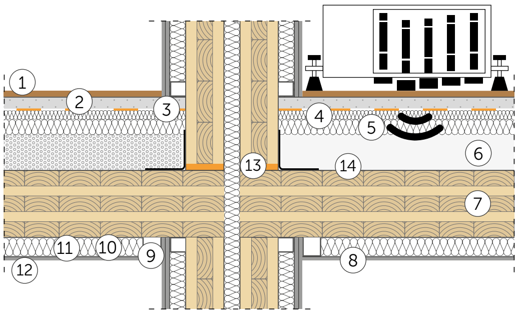
f [Hz]	D_{nT} [dB]
50	20,9
63	20,4
80	18,8
100	35,0
125	39,8
160	43,5
200	51,6
250	54,4
315	56,7
400	57,4
500	67,1
630	69,2
800	73,6
1000	76,4
1250	79,6
1600	82,4
2000	83,4
2500	78,8
3150	78,3
4000	82,5
5000	≥ 86,9

$D_{nT,w}$ $(C;C_{tr})$ = **62 (-2;-9) dB** FSTC = **63**

Responsible for measurements: University of Bologna.
Test protocol: test 26/09/2017.

ON-SITE MEASUREMENT | CLT FLOOR 8

IMPACT SOUND INSULATION ACCORDING TO ISO 16283-2

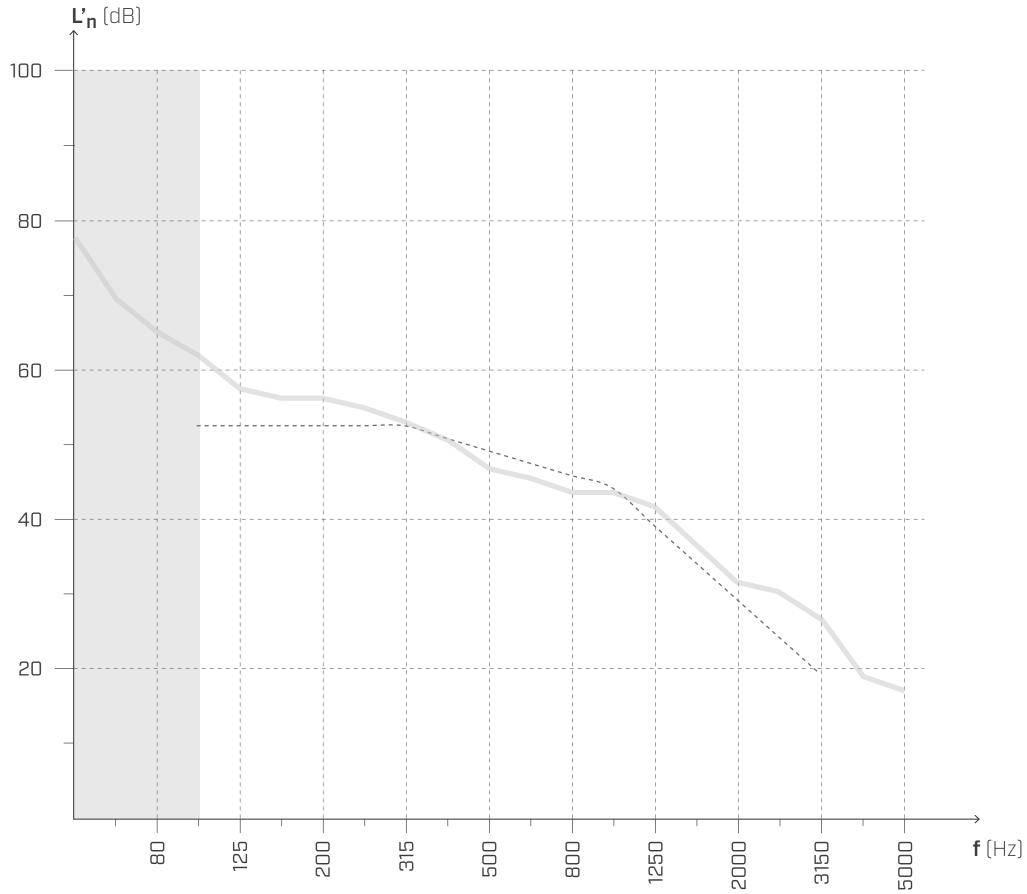


FLOOR SLAB

Surface = 26 m^2
Receiving room volume = 67 m^3

1. Floor (s: 15 mm - *9/16 in*)
2. Concrete screed (2400 kg/m^3) (s: 65 mm - *2 9/16 in*)
3. **BARRIER 100**
4. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
5. EPS insulation (s: 50 mm - *2 in*)
6. Gravel fill (s: 45 mm - *1 3/4 in*)
7. CLT (s: 160 mm - *6 1/4 in*)
8. Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
9. Metal structure with plasterboard (s: 50 mm - *2 in*)
10. Air chamber (s: 10 mm - *3/8 in*)
11. Low density mineral wool insulation (s: 50 mm - *2 in*)
12. Plasterboard panel (s: 12,5 mm - *1/2 in*)
13. **XYLOFON**
14. Fastening system:
    HBS 8 x 240 mm, 500 mm (*20 in*) spacing
    WBR 100, 1000 (*40 in*) mm spacing

IMPACT SOUND INSULATION



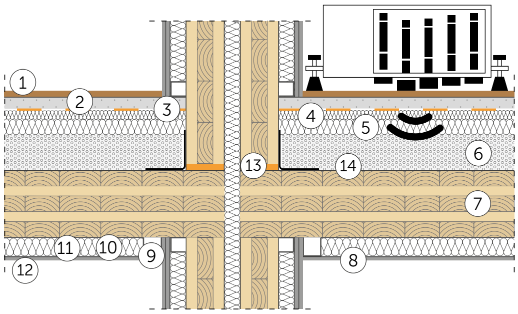
f [Hz]	L'n [dB]
50	77,7
63	69,8
80	65,2
100	62,0
125	57,6
160	56,4
200	56,7
250	54,9
315	53,1
400	50,9
500	47,0
630	45,4
800	44,1
1000	43,7
1250	42,2
1600	36,7
2000	32,0
2500	30,8
3150	26,8
4000	19,5
5000	17,1

$L'_{n,w}$ (C_I) = **50 (1;) dB**   *IIC* = ***58***

Responsible for measurements: University of Bologna.
Test protocol: test 26/09/2017.

ON-SITE MEASUREMENT | CLT FLOOR 8

IMPACT SOUND INSULATION ACCORDING TO ISO 16283-2

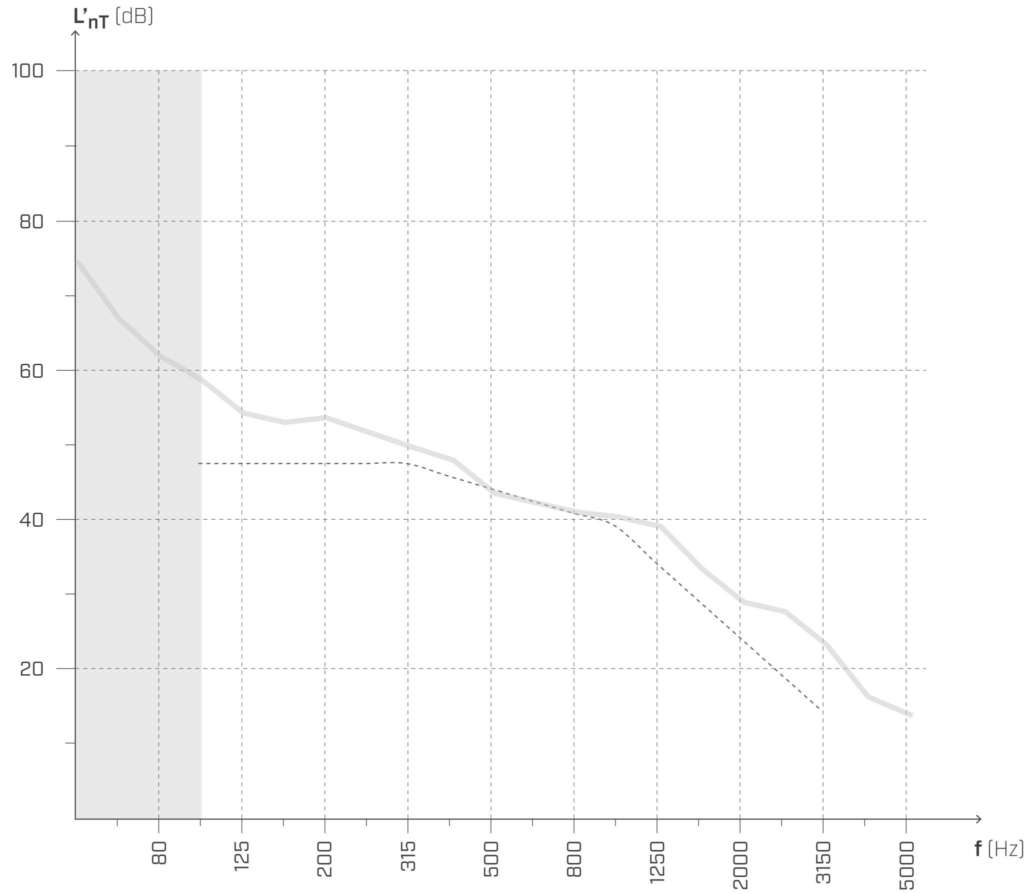


FLOOR SLAB

Surface = 26 m^2
Receiving room volume = 67 m^3

1. Floor (s: 15 mm - *9/16 in*)
2. Concrete screed (2400 kg/m^3) (s: 65 mm - *2 9/16 in*)
3. **BARRIER 100**
4. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (s: 30 mm - *1 3/16 in*)
5. EPS insulation (s: 50 mm - *2 in*)
6. Gravel fill (s: 45 mm - *1 3/4 in*)
7. CLT (s: 160 mm - *6 1/4 in*)
8. Resilient plasterboard connectors (s: 60 mm - *2 3/8 in*)
9. Metal structure with plasterboard (s: 50 mm - *2 in*)
10. Air chamber (s: 10 mm - *3/8 in*)
11. Low density mineral wool insulation (s: 50 mm - *2 in*)
12. Plasterboard panel (s: 12,5 mm - *1/2 in*)
13. **XYLOFON**
14. Fastening system:
    HBS 8 x 240 mm, 500 mm (*20 in*) spacing
    WBR 100, 1000 (*40 in*) mm spacing

IMPACT SOUND INSULATION



f [Hz]	L'nT [dB]
50	74,3
63	66,5
80	61,9
100	58,7
125	54,3
160	53,1
200	53,4
250	51,6
315	49,8
400	47,6
500	43,7
630	42,1
800	40,8
1000	40,3
1250	38,9
1600	33,4
2000	28,7
2500	27,5
3150	23,5
4000	16,1
5000	13,8

$L'_{nT,w}$ (C_I) = **47 (1) dB**

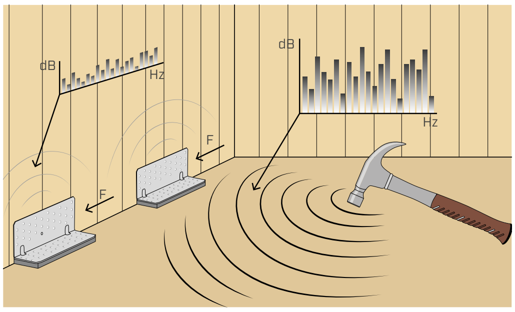
AIIC = **58**

Responsible for measurements: University of Bologna.
Test protocol: test 26/09/2017.

ACOUSTIC AND MECHANICAL INTERACTION

ACOUSTIC - MECHANICAL BEHAVIOR OF TITAN SILENT

The TITAN SILENT 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.



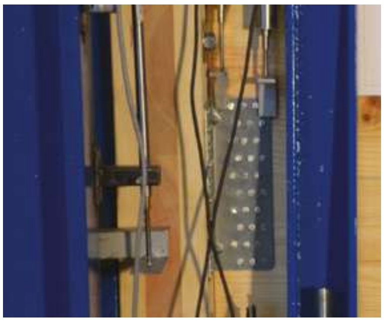
EXPERIMENTAL INVESTIGATION: MECHANICAL BEHAVIOUR

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

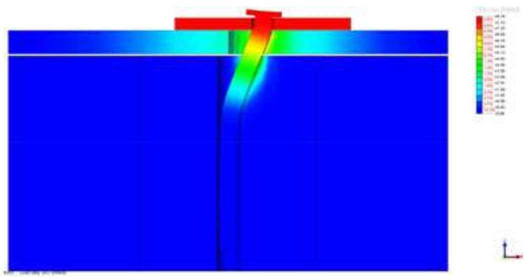
Monotonic shear tests were carried out, in the first experimental phase, using linear loading procedures in displacement control, aimed at evaluating the variation in ultimate strength and stiffness offered by the TTF200 connection with LBA Ø4 x 60 mm nails.

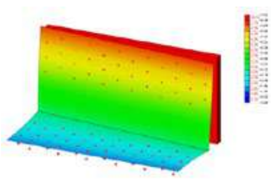
Test samples:
CLT panels
TITAN TTF200 angle bracket



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 analyzed: XYLOFON 35 (6 mm), ALADIN STRIPE SOFT (5 mm) and ALADIN STRIPE EXTRA SOFT (7 mm).



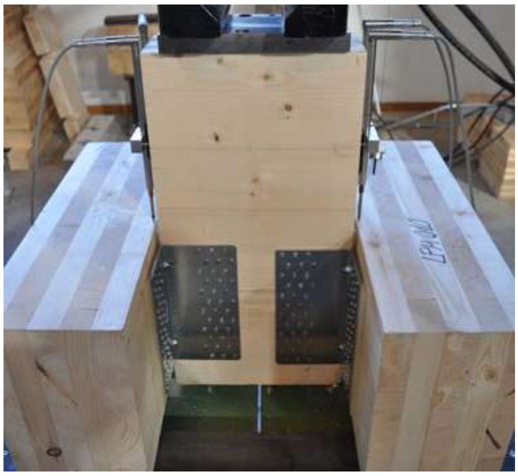


Tx deformation [mm]
for induced displacement 8 mm

SECOND LABORATORY PHASE

Laboratory tests were carried out at this phase in accordance with requirements of EN 26891. The TITAN SILENT mock-up, assembled with different TITAN angle brackets in combination with the resilient profile XYLOFON 35 (6 mm), have been brought to failure to investigate the maximum load, the load at 15 mm and the relative displacements, without load influence and therefore crushing effects on the acoustic profile (maximum gap between the plate and the timber panel).

Test samples:
5-layer CLT panels
TITAN angle brackets with full fastening
TTF200 - TTN240 - TTS240 - TTV240
XYLOFON 35 resilient profile



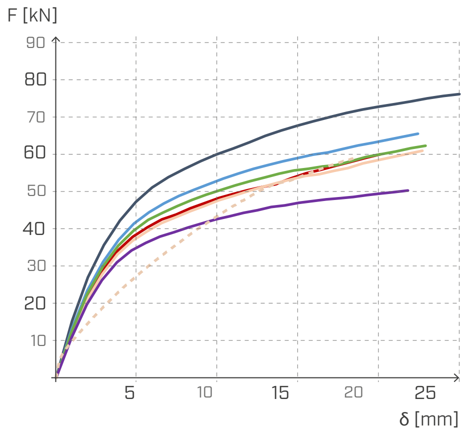
VARIATION OF MECHANICAL SHEAR STRENGTH AS A FUNCTION OF SOUNDPROOFING PROFILE

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 STRIPE SOFT red.*	3	59,0	-14 %	8.58	-10 %
TTF200 + ALADIN STRIPE EXTRA SOFT red.*	4	56,4	-18 %	8.25	-14 %
TTF200 + ALADIN STRIPE SOFT	5	55,0	-20 %	7.98	-16 %
TTF200 + XYLOFON PLATE	6	54,3	-21 %	7,79	-18 %
TTF200 + ALADIN STRIPE EXTRA SOFT	7	47,0	-31 %	7,30	-24 %
TTF200 + XYLOFON PLATE - test 003	6	54,2	-21 %	5,49	-43 %

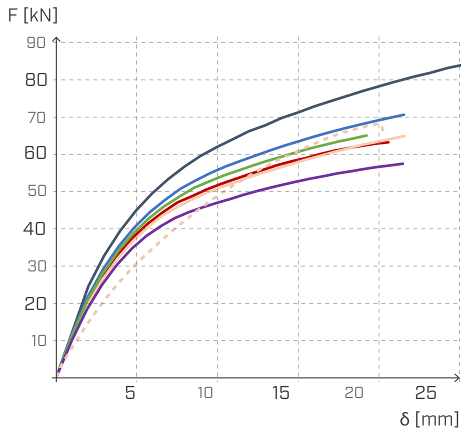
* Reduced thickness: reduced profile height due to the trapezoidal section and consequent crushing induced by the head of the nail during operation.



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 STRIPE SOFT red.*	3	64,0	-11 %	8,40	-8 %
TTN240 + ALADIN STRIPE EXTRA SOFT red.*	4	61,0	-15 %	8.17	-11 %
TTN240 + ALADIN STRIPE SOFT	5	59,0	-18 %	8,00	-13 %
TTN240 + XYLOFON PLATE	6	58,0	-19 %	7,81	-15 %
TTN240 + ALADIN STRIPE EXTRA SOFT	7	53,5	-26 %	7.47	-18 %
TTN240 + XYLOFON PLATE - test 001	6	61,5	-15%	6,19	-32%

* 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 OF NINO AND TITAN SILENT 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.

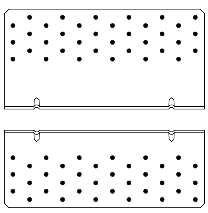
TITAN

The strength of TITAN coupled with XYLOFON PLATE 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 XYLOFON 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 + XYLOFON PLATE	LBA nails	4 x 60	36	36	24,8
	LBS screws	5 x 50	36	36	22,8
TTS240 + XYLOFON PLATE	HBS PLATE screws	8 x 80	14	14	12,5
TTF200 + XYLOFON PLATE	LBA nails	4 x 60	30	30	17,2
	LBS screws	5 x 50	30	30	15,8

TIMBER-TO-TIMBER FASTENING PATTERN

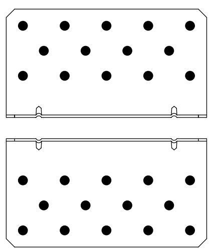
TTN240



36 LBA nails/LBS screws

36 LBA nails/LBS screws

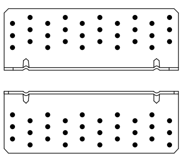
TTS240



14 LBA nails/LBS screws

14 LBA nails/LBS screws

TTF200



30 LBA nails/LBS screws

30 LBA nails/LBS screws

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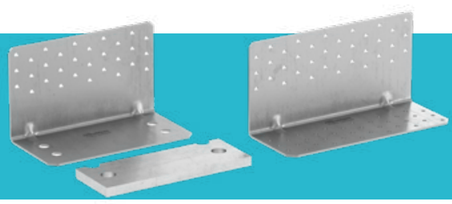


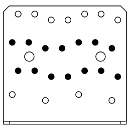
NINO

The strength of NINO coupled with XYLOFON PLATE was defined through a series of experimental tests carried out in collaboration with the Institute for BioEconomy (CNR-IBE in San Michele all'Adige). This made it possible to increase the technical know-how and refine the assessment method, thus obtaining resistances that take into account the real behaviour of the angle bracket.

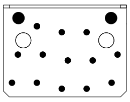
ANGLE BRACKET	fastening						
	type	Ø x L [mm]	n_V [pcs]	n_H [pcs]	n VGS Ø9	$F_{1,Rk}$ [kN]	$F_{2/3,Rk}$ [kN]
NINO100100 + XYLOFON PLATE	LBA nails	4 x 60	14	13	2	20	34,6
	LBS screws	5 x 50	14	13	2	20	16,9
NINO15080 + XYLOFON PLATE	LBA nails	4 x 60	20	11	3	37,2	34,6
	LBS screws	5 x 50	20	11	3	37,2	25,5
NINO100200 + XYLOFON PLATE	LBA nails	4 x 60	21	13	3	41,2	18,7
	LBS screws	5 x 50	21	13	3	41,2	17,2

TIMBER-TO-TIMBER FASTENING PATTERN

NINO100100



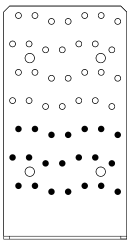
14 LBA nails/LBS screws



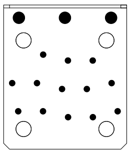
2 VGS screws Ø9

13 LBA nails/LBS screws

NINO15080



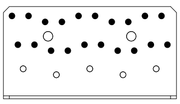
21 LBA nails/LBS screws



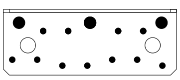
3 VGS screws Ø9

13 LBA nails/LBS screws

NINO100200

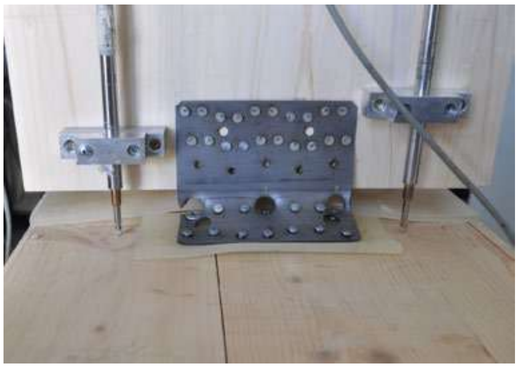


20 LBA nails/LBS screws



3 VGS screws Ø9

11 LBA nails/LBS screws



Monotonic tensile test (F_1) on NINO15080 in timber-to-timber configuration.

Monotonic shear test ($F_{2/3}$) on NINO15080 in timber-to-timber configuration.

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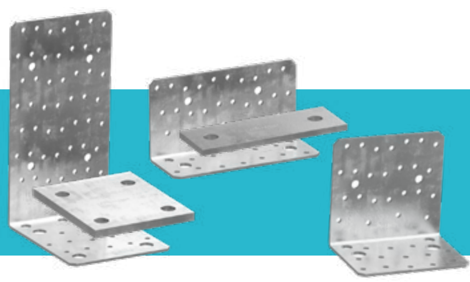


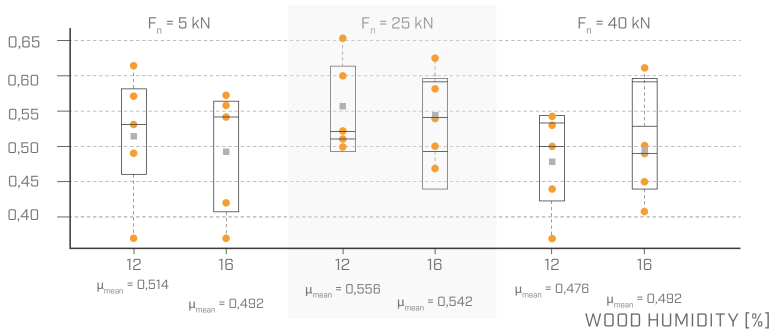
MECHANICAL INTERACTION AND FRICTION

For Rothoblaas, identifying the mechanical behaviour of solutions used in wood structures is a subject that doesn't allow for compromise. In this view, two research projects were developed in cooperation with two Austrian universities: Technische Universität Graz in Graz and Fakultät für Technische Wissenschaften in Innsbruck.

XYLOFON WOOD FRICTION

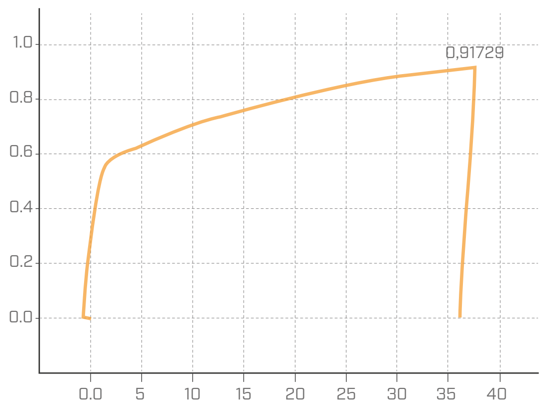
With the University of Graz, the goal was to characterise the static friction coefficient between wood and XYLOFON. In particular, XYLOFON profiles of various shores, combining different timber species. CLT elements (5 layers with 20 mm thick planks) made of spruce, classified as a soft wood, and of birch, from the semi-hardwood family, were used for the test setups. In addition to investigating the various wood types, an attempt was also made to understand how wood humidity influences the friction coefficient.
Below are some example values obtained from the tests performed on XYLOFON 70. An additional variable was then considered, representing the vertical load acting upon the acoustic profiles, reproduced in the test through a pre-load induced on the CLT panel system being evaluated.

FRICTION COEFFICIENT



For each configuration, graphs demonstrating the movement/friction coefficient μ were plotted, to understand to what degree it is useful to consider the contribution of friction for static purposes.

FRICTION COEFFICIENT

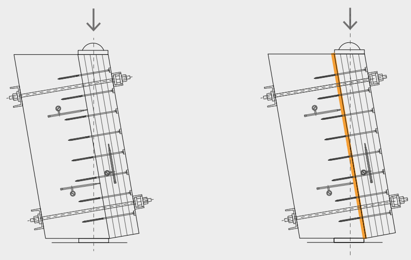


MECHANICAL INTERACTION XYLOFON AND HBS PARTIAL THREAD SCREWS

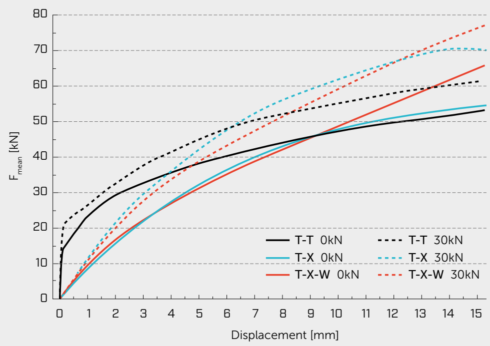
Having investigated the influence of the resilient profile on the mechanical strengths of the shear angle brackets (TITAN), the behaviour of partially threaded screws was investigated in the same context.

The test completes the investigation into the characterisation of acoustic behaviour under static and/or mechanical stress.

The image below shows the test set-up used for the research. It was decided to investigate various XYLOFON shores, also in order to understand how much the hardness of the material affects the variation in the resistance and stiffness to shearing of the connection with partial thread screws.



Through experimental testing and analytical approaches, the mechanical and deformation performance of connections between CLT panels — made with 8x280 HBS screws installed with/without XYLOFON WASHER separating washers — was analysed with and without the use of resilient, intermediate XYLOFON35 decoupling profiles.



- The full scientific report on the experimental testing is available at Rothoblaas.
- Experimental testing conducted in collaboration with Technische Versuchs und Forschungsanstalt (TVFA), Innsbruck.

INFLUENCE OF MECHANICAL FASTENING USING STAPLES

This test had the aim of determining the influence of the staples used to fasten the XYLOFON product onto CLT panels during construction.
Tests were carried out by the University of Bologna - Industrial Engineering Department, completing the tests begun during the first edition of the Flanksound Project.

TEST SETUP

The measurement system consisted of a horizontal CLT panel to which two vertical panels were applied, as in the diagram (figure 1). Each panel was connected with 6 vertical HBS 8 x 240 screws and 2 TITAN SILENT TTF220 angle brackets with LBS 5 x 50 screws per side (figure 2).
A strip of XYLOFON 35 resilient material was applied on the contact surface of both panels.
On the left panel, the XYLOFON was fastened with staples applied in pairs stepped 20 cm, while they were not used on the panel on the right.

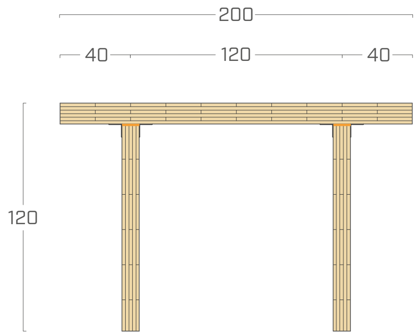


fig. 1

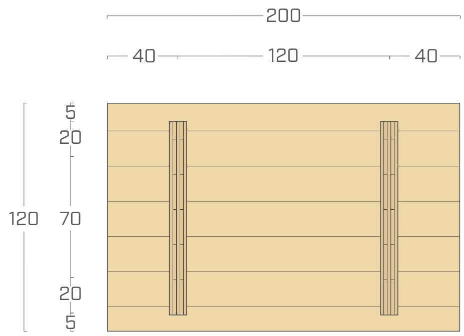
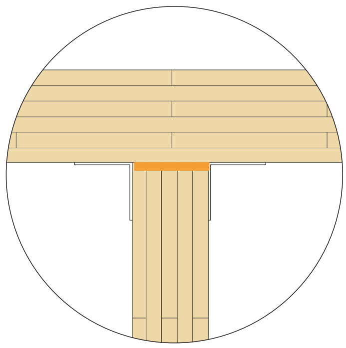
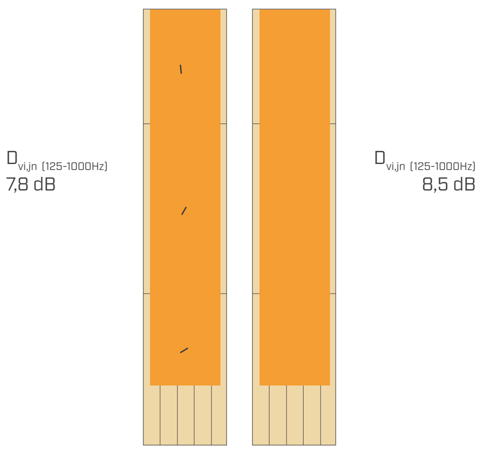


fig. 2



CONSIDERATIONS

Given the smaller size of the panels, it was decided to use Dv,ij,n as the index, given that only geometric dimensions are used to average out the difference in vibration speed levels.
Precisely due to the small size, use of K_{ij} as the comparison parameter is not recommended, given the effect of internal resonance between the panels.
The values were averaged between 125 and 1000 Hz.
It is also worth remembering that the uncertainty associated with the testing method used is ±2 dB, as indicated in ISO/FDIS 12354-1:2017.



The results show that the use of staples for prefixing the resilient strip **does not result in a substantial difference** between the **$D_{v,ij,n}$** values for the same panel fixing systems.

$D_{v,ij,n\ (125\text{-}1000Hz)}$ = **7,8 dB**

panel **with staples**

$D_{v,ij,n\ (125\text{-}1000Hz)}$ = **8,5 dB**

panel **without staples**

FIRE SAFETY IN MULTI-STOREY BUILDINGS

Rothoblaas participated in the research project "**Fire Safe implementation of visible mass timber in tall buildings - compartment fire testing**" coordinated by Research Institutes of Sweden (RISE).

The project aims to perform a series of tests on CLT compartments in order to define the fire performance of timber structures and, if necessary, identify additional measures to ensure fire safety.
The objectives also included the definition of protection criteria for multi-storey buildings and the verification of timber joints directly exposed to fire.

TEST SETUP

For this study, five tests were performed on compartments with internal dimensions 23.0 x 22.5 x 9.0 ft (7,0 x 6,85 x 2,73 m).

Four of these compartments (test ①, ②, ③ and ⑤) had two ventilation openings of 7.4 x 5.8 ft (2,25 x 1,78 m) resulting in an opening factor of 0.112 $ft^{1/2}$ (0,062 $m^{1/2}$).

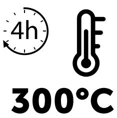
The remaining test (④ test) had six larger openings, resulting in an opening factor of 0.453 $ft^{1/2}$ (0.25 $m^{1/2}$), which is approximately the average of office compartment opening factors.
The matrix of the tests performed is shown on the following page.

Photo of the compartment at the end of assembly, before starting the test

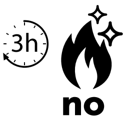
Photo of the compartment after switching on

Photo of the compartment during the test

The tests were stopped after 4 hours and the test is considered passed if the following requirements are fulfilled:



after 4 hours temperatures are below 300°C



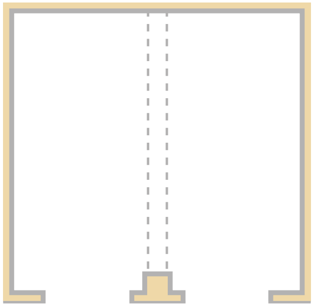
no secondary flashover after 3 hours

D. Brandon, J. Sjöström, A. Temple, E. Hallberg, F. Kahl, "**Fire Safe implementation of visible mass timber in tall buildings – compartment fire testing**", RISE Report 2021:40

MATRIX OF THE TESTS PERFORMED

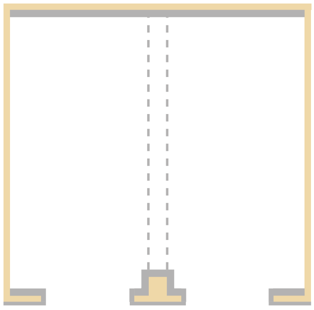
TEST 1 - configuration

Exposed surface	
ceiling	100%
beam	100%
left wall	0%
right wall	0%
front wall	0%
column	0%



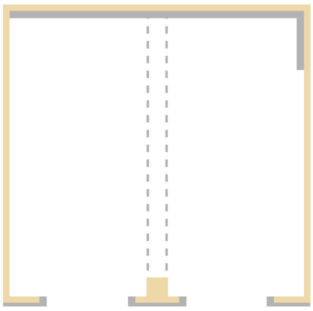
TEST 2 - configuration

Exposed surface	
ceiling	100%
beam	100%
left wall	100%
right wall	100%
front wall	0%
column	0%



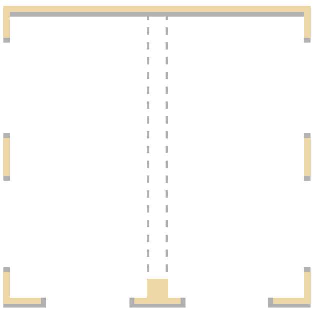
TEST 3 - configuration

Exposed surface	
ceiling	100%
beam	100%
left wall	100%
right wall	78%
front wall	100%
column	100%



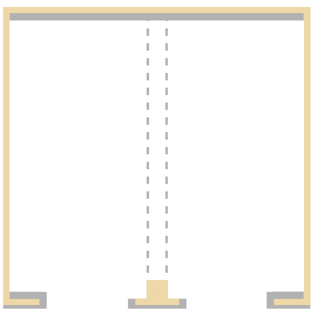
TEST 4 - configuration

Exposed surface	
ceiling	100%
beam	100%
left wall	100%
right wall	100%
front wall	100%
column	100%



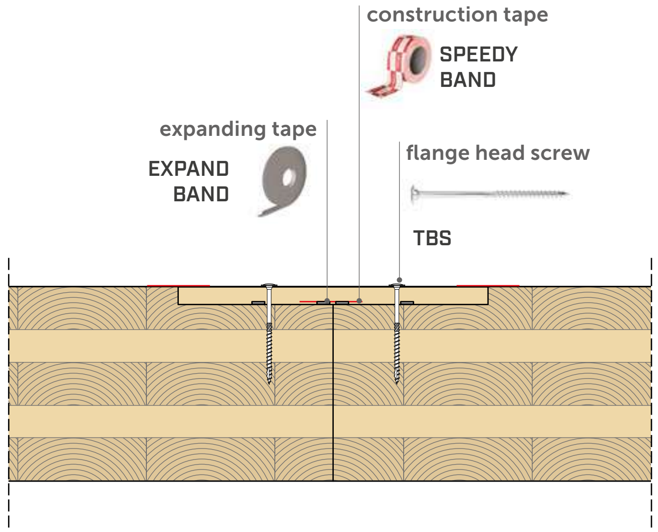
TEST 5 - configuration

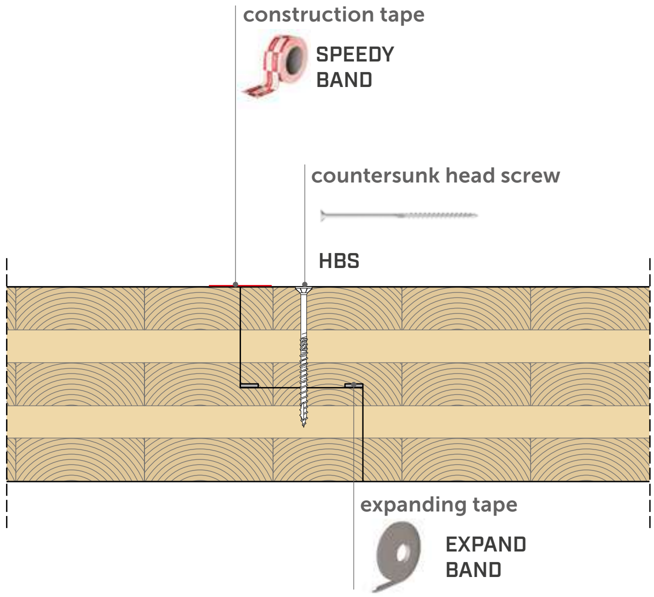
Exposed surface	
ceiling	100%
beam	100%
left wall	100%
right wall	100%
front wall	60%
column	100%

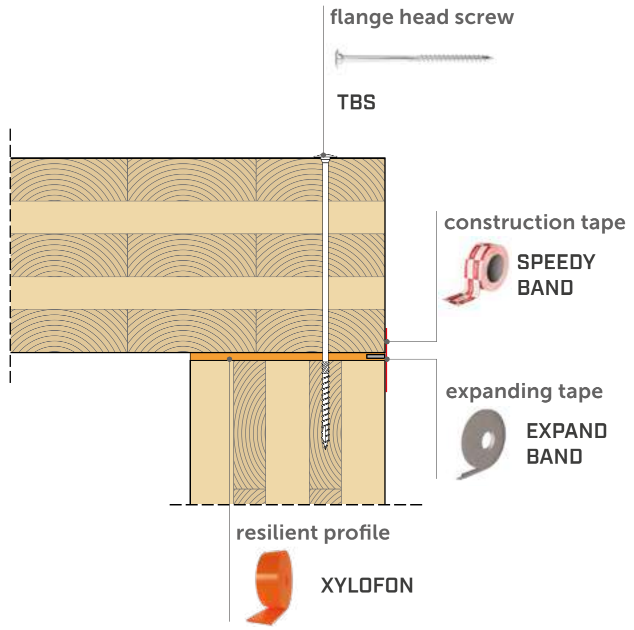


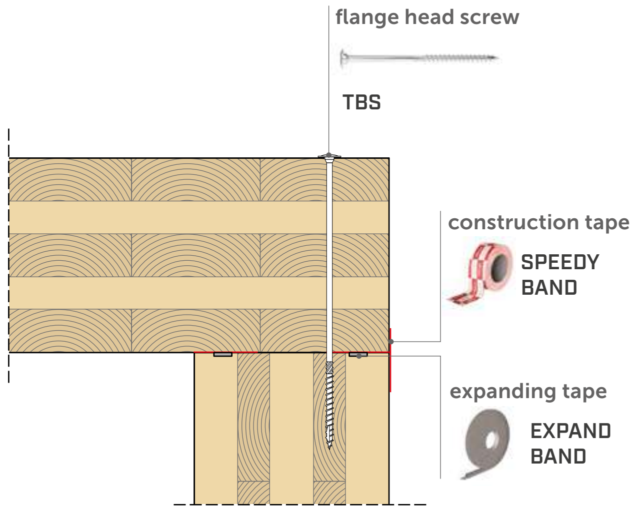
JOINTS AND INTERFACES

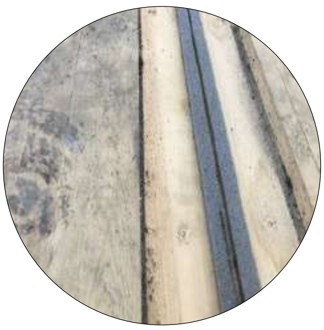
Various Rothoblaas sealants were used for the test, some of which were developed to improve air-tightness and/or acoustic performance. The test results show that these products are suitable for preventing the spread of fire through joints.







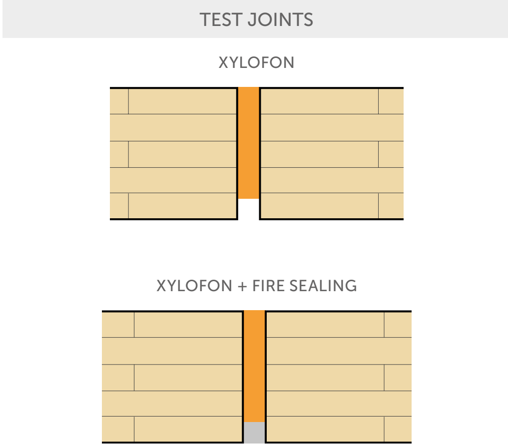




XYLOFON AND FIRE

Over the last few years, an architectural need to keep CLT visible for aesthetic reasons has developed. In this case, the XYLOFON product should be placed slightly set back from the wood surface, creating a shadow effect. In this configuration, XYLOFON contributes to the structure's fire resistance.

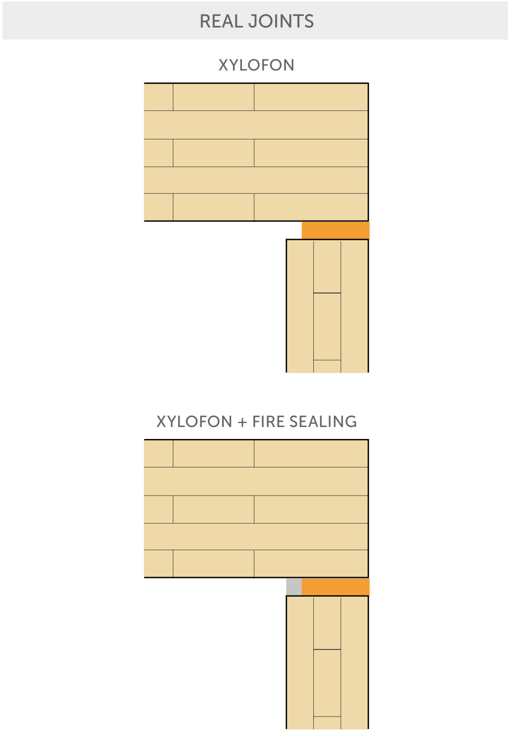
To test this feature, tests were performed to characterise its airtightness and fire insulation behaviour (EI) at ETH Zürich and the Institute of Structural Engineering (IBK) & Swiss Timber Solutions AG.



TEST SETUP

It was decided to test both XYLOFON on its own and the product with two different flame retardant sealants. The sample was prepared by dividing a laminated panel into 4 pieces, so as to create 3 openings to accommodate the 3 different configurations:

XYLOFON
XYLOFON + SEALANT 1
XYLOFON + FIRE SEALING SILICONE



During assembly, thermocouples were inserted to record the change in temperatures at various depths of the sample during the fire phase. Once the fire was started, the data was registered and the trend in the thermal change was tracked on a temperature/time graph, which was also compared to the standardised EN ISO curve. The graph at the right shows the temperatures recorded on the PT1, PT2, PT3, PT4 and PT5 thermocouples.

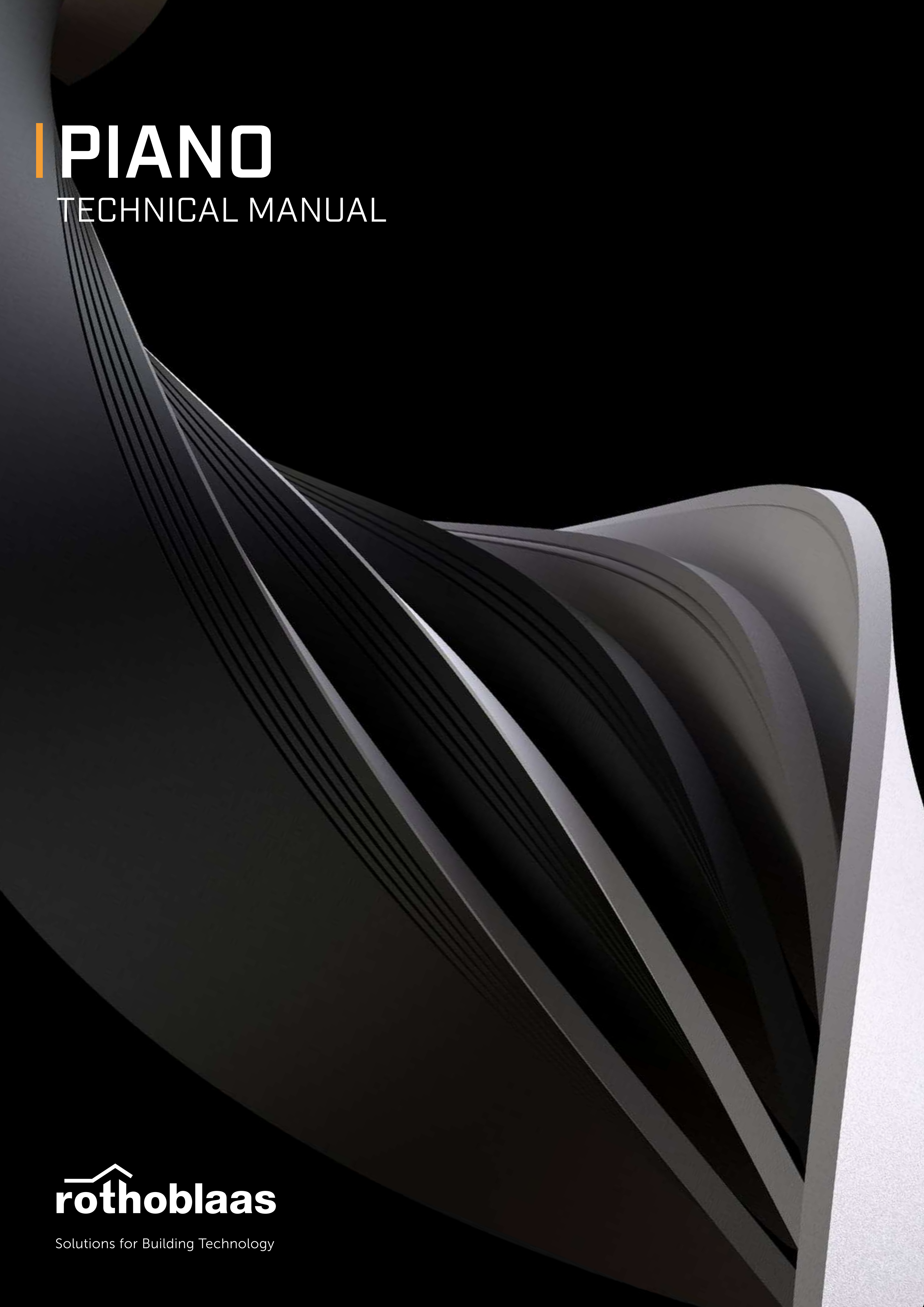
CONSIDERATIONS

The test was stopped after 60 minutes of exposure to fire, based on the EN ISO standard.
For all configurations tested, the temperature of the surface not exposed to fire remained approximately at room temperature, not showing any colour alteration.
The opening which contained solely 100 mm XYLOFON, as predicted, showed the greatest loss of thickness due to carbonisation.
The junctions with 20 mm of sealant 1 and FIRE SEALING SILICONE , together with the 100 mm XYLOFON strip showed similar temperature gradients.
The presence of XYLOFON does not affect the fire behaviour of the joint.

It can be stated that the solution with 100 mm wide **XYLOFON** can achieve **EI 60** without the need for additional flame retardant protection

PIANO

TECHNICAL MANUAL



rothoblaas

Solutions for Building Technology

CONTENTS

PIANO

RESILIENT SOUNDPROOFING PROFILE

CE
ETA-23/0193

CODES AND DIMENSIONS

CODE	B [mm]	L [m]	s [mm]	pcs
PIANOA4040	80	10	6	1
PIANOA5050	100	10	6	1
PIANOA6060	120	10	6	1
PIANOA140	140	10	6	1
PIANOB4040	80	10	6	1
PIANOB5050	100	10	6	1
PIANOB6060	120	10	6	1
PIANOB140	140	10	6	1
PIANOC080	80	10	6	1
PIANOC100	100	10	6	1
PIANOC120	120	10	6	1
PIANOC140	140	10	6	1
PIANOD080	80	10	6	1
PIANOD100	100	10	6	1
PIANOD120	120	10	6	1
PIANOD140	140	10	6	1
PIANOE080	80	10	6	1
PIANOE100	100	10	6	1
PIANOE120	120	10	6	1
PIANOE140	140	10	6	1

Mechanical performance and elastic behaviour tested according to ETA

- elastic response of the profile applied in buildings
- elastic response of the profile as vibration damping

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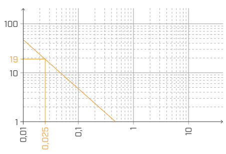

Anti-vibration

PIANO dampens vibrations in both static and dynamic conditions due to its ability to absorb and dissipate the energy of the system.

- application with static loads (e.g. buildings)
- application with dynamic loads (e.g. machines, bridges)

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K_{ij} values entered in ETA

K_{ij} tested for all hardness values and with appropriate fastening system

$\Delta_{l,ij}$ > **4 dB**

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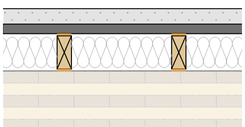

Lightweight floors

PIANO A was tested in combination with the ribbing strips of the lightweight floors.

Measured improvement **7 dB**.

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PRODUCT COMPARISON

products		thickness	acoustic improvement $\Delta_{l,ij}$ [1]	elastic modulus in compression E_c
PIANO A		**6** mm	**> 4** dB	**0,23** N/mm²
PIANO B		**6** mm	**> 4** dB	**1,08** N/mm²
PIANO C		**6** mm	**> 4** dB	**7,92** N/mm²
PIANO D		**6** mm	**> 4** dB	**22,1** N/mm²
PIANO E		**6** mm	**> 4** dB	**24,76** N/mm²

LEGEND:

load for acoustic optimisation

compression at 3 mm deformation (ultimate limit state)

dynamic elastic modulus E'_{5Hz} - E'_{50Hz}	damping factor $\tan\delta_{5Hz}$ - $\tan\delta_{50Hz}$	acoustic load / maximum applied load[2]: acoustic load [N/mm²]	acoustic load / maximum applied load[2]: maximum applied load [N/mm²]
0,5 N/mm² - 0,5 N/mm²	0,186 - 0,238	0,008 - 0,052	0,008 - 0,15
1,75 N/mm² - 2,07 N/mm²	0,308 - 0,372	0,04 - 0,286	0,04 - 0,85
9,35 N/mm² - 11,61 N/mm²	0,272 - 0,306	0,26 - 1,4	0,26 - 12,07
20,3 N/mm² - 25,81 N/mm²	0,297 - 0,349	1,2 - 2,28	1,2 - 16,9
54,8 N/mm² - 67,08 N/mm²	0,243 - 0,253	1,8 - 3,2	1,8 - 17,07

[1] $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.
[2] The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression.

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 PIANO).

TABLE OF USE[1]

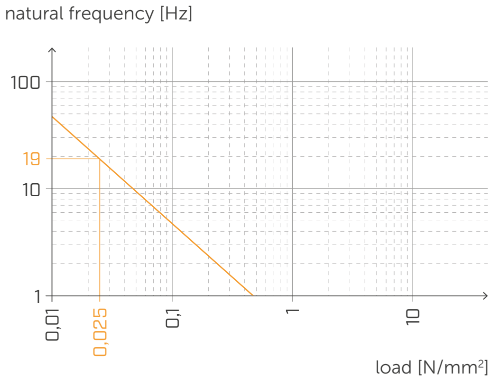
CODE	B [mm]	load for acoustic optimisation[2] [kN/m] *[lbf/ft]* min		load for acoustic optimisation[2] [kN/m] *[lbf/ft]* max		compression for acoustic optimisation[2] [N/mm²] *[psi]* min	compression for acoustic optimisation[2] [N/mm²] *[psi]* max	reduction [mm] *[mil]* min	reduction [mm] *[mil]* max	*compressive stress at 3 mm (ultimate limit state) [N/mm²] [psi]*
PIANOA4040	80	0,64	*472*	4,16	*3068*	0,008 *1.2*	0,052 *7.5*	0,2 *8*	1,35 *53*	*0,15 22*
	40 (divided)	0,32	*236*	2,08	*1534*					
PIANOA5050	100	0,8	*590*	5,2	*3835*					
	50 (divided)	0,4	*295*	2,6	*1918*					
PIANOA6060	120	0,96	*708*	6,24	*4602*					
	60 (divided)	0,48	*354*	3,12	*2301*					
PIANOA140	140	1,12	*826*	7,28	*5369*					

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 0,025 N/mm² acting on the profile. In this case, we used the PIANO A product, because the load is not particularly high. Reading the graph, it can be seen that the profile has a resonance frequency of around 19 Hz.

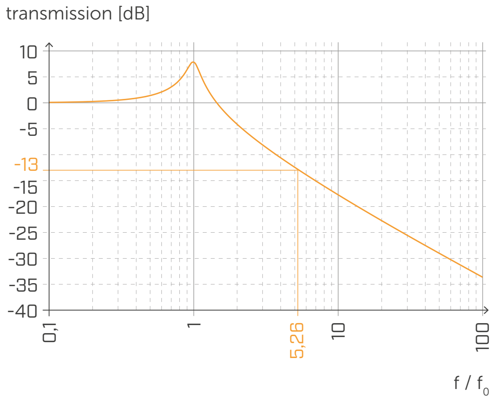


At this point, the degree of transmission for the product under these load conditions can be calculated, referring to the design frequency of 100 Hz.

$$\text{transmission} = f/f_0 = 5{,}26$$

Then the transmission graph is used, placing the value 5,26 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 -13 dB.

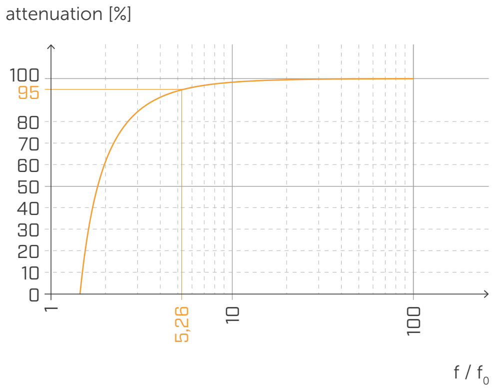
TRANSMISSION IS POSITIVE WHEN THE MATERIAL TRANSMITS AND IS NEGATIVE WHEN THE PROFILE BEGINS TO INSULATE. This means this figure shows that the product, loaded in this way, insulates 13 dB at a reference frequency of 100 Hz.



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.

$$\text{attenuation} = f/f_0 = 5{,}26$$

The graph is used by placing the calculated value of 5,26 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 95 % 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.

EUROPEAN TECHNICAL ASSESSMENT (ETA)

The European Technical Assessment (ETA) provides an **independent procedure at European level** for assessing the essential performance characteristics of non-standard construction products.

OBJECTIVITY AND INDEPENDENCE

Only independent Technical Assessment Bodies (TAB) can issue ETAs. Third-party evaluation enhances the credibility of product performance information, improves **market transparency**, and ensures that the stated values are tested to **precise standards** appropriate for the intended use of the product.

TRANSPARENCY

ETAs provide **reliable product performance information** that can be compared across Europe on the basis of harmonised technical specifications, the European Assessment Documents (EADs). ETAs have made construction products **comparable throughout the European Economic Area** through the provision of detailed product performance information.

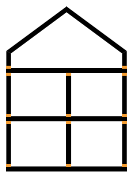
PARAMETERS TESTED ACCORDING TO ETA

STATIC AND DYNAMIC MODULUS OF ELASTICITY

Many products on the market have been tested to determine the dynamic elastic modulus and damping factor in order to provide transmissibility graphs according to the natural frequency of the resilient profile.

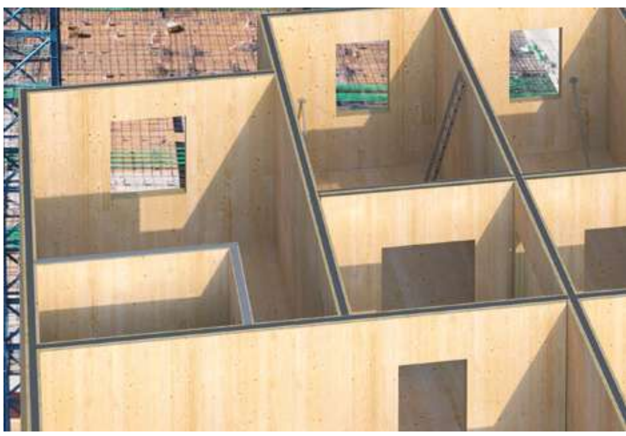
Since there is no common standard, each manufacturer follows a different procedure, and often the standard used and the test setup are not stated.

Considering the intended use of **PIANO**, the dynamic elastic modulus and damping factor must be determined in compression (there would be no point in defining them according to other deformation methods).
Dynamic elastic modulus and damping factor are measured under dynamic conditions and are relevant for vibration reduction in service equipment or other vibration sources.



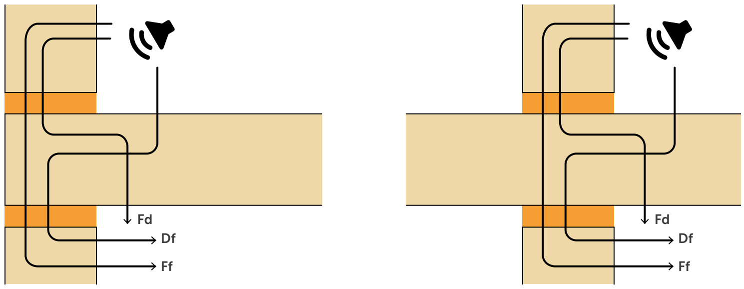
In buildings, **PIANO** is subject to static and quasi-static loading, so the dynamic elastic modulus is not as representative of the product's actual behaviour.

Tests show that profile friction could affect the elastic modulus value, and that is why it is necessary to always perform measurements with and without a lubricant to have a value that is independent of boundary conditions (without friction) and a value that is representative of the in situ operating conditions (with friction).



VIBRATION REDUCTION INDEX - $\mathbf{K_{ij}}$

Due to the lack of a common standard, each manufacturer provides K_{ij} values tested in a different configuration (type of joint, number of fastening systems, etc.). Clarifying the test setup and boundary conditions being used is important because the result is strongly influenced by the many variables that define the joint.

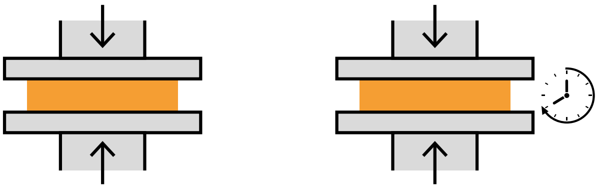


In the European Technical Assessment, the results are expressed clearly to avoid ambiguity in the configuration.

STRESS AND DEFORMATION IN COMPRESSION

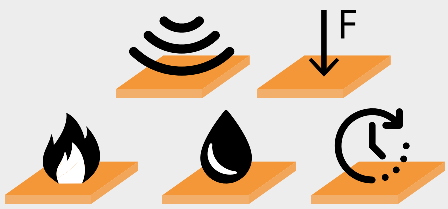
From a static point of view, it is important to provide the **compressive stress according to the deformation** (e.g., 1 mm, 2 mm and 3 mm compression) so as to limit the maximum deformation and possible structural failure.

Resilient profiles are subjected to constant loading during their working life, so it is important to estimate the **long-term behaviour** for both static reasons (to avoid differential failure in the structure) and acoustic reasons (a flattened resilient strip does not have the same elastic response and consequently the acoustic performance declines).



For the same reason, it is important to assess the **final thickness of the product** after compression for a given time and after a recovery period.

Rothoblaas has invested in the development of solutions that follow a multidisciplinary approach and take into account the real conditions of the construction site. Laboratory measurements, static tests and moisture control checks allow the designer to benefit from real performance data and not just theoretical values that have limited practical applications.



PIANO A

TABLE OF USE[1]

CODE	B [mm]	load for acoustic optimisation[2] [kN/m] from	to	compression for acoustic optimisation[2] [N/mm²] from	to	deformation [mm] from	to	*compression at 3 mm deformation (ultimate limit state)* [N/mm²]
PIANOA4040	80	0,64	4,16	0,008	0,052	0,2	1,35	*0,15*
	40 (divided)	0,32	2,08					
PIANOA5050	100	0,8	5,2					
	50 (divided)	0,4	2,6					
PIANOA6060	120	0,96	6,24					
	60 (divided)	0,48	3,12					
PIANOA140	140	1,12	7,28					

(1) The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression. 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.
(2) 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 $\Delta_{l,ij}$[3]	ISO 10848	> 4 dB
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	0,23 MPa (0,19 MPa)
Dynamic elastic modulus E'_{1Hz} - E''_{1Hz}	ISO 4664-1	0,4 - 0.07 MPa
Dynamic elastic modulus E'_{5Hz} - E''_{5Hz}	ISO 4664-1	0,50 - 0.08 MPa
Dynamic elastic modulus E'_{10Hz} - E''_{10Hz}	ISO 4664-1	0,5 - 0.09 MPa
Dynamic elastic modulus E'_{50Hz} - E''_{50Hz}	ISO 4664-1	0,5 - 0.13 MPa
Damping factor tan δ_{1Hz}	ISO 4664-1	0,177
Damping factor tan δ_{5Hz}	ISO 4664-1	0,186
Damping factor tan δ_{10Hz}	ISO 4664-1	0,192
Damping factor tan δ_{50Hz}	ISO 4664-1	0,238
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,24
Compression set c.s.	ISO 1856	26,4%
Compression at 1 mm deformation σ_{1mm}	ISO 844	0,04 N/mm²
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	0,08 N/mm²
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	0,15 N/mm²
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	4,25%

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[3] : **> 4** dB

Maximum applicable load (deformation 3 mm):

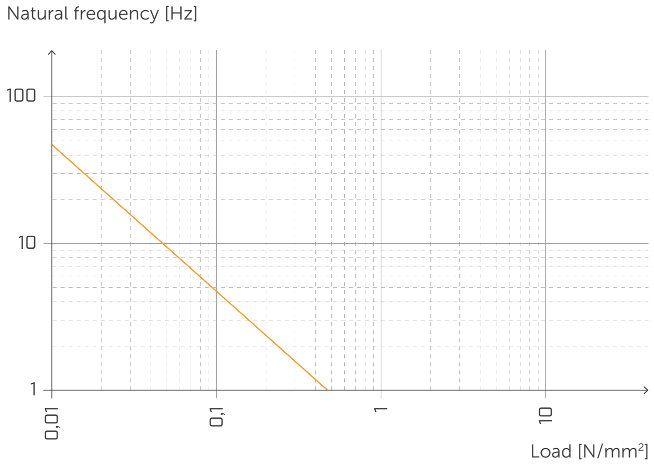
0,15 N/mm²

Acoustic service load:

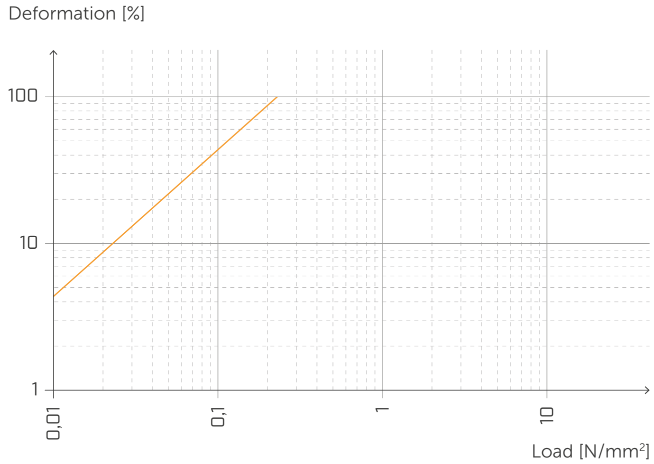
from **0,008** to **0,052** N/mm²

STATIC LOAD
(buildings)

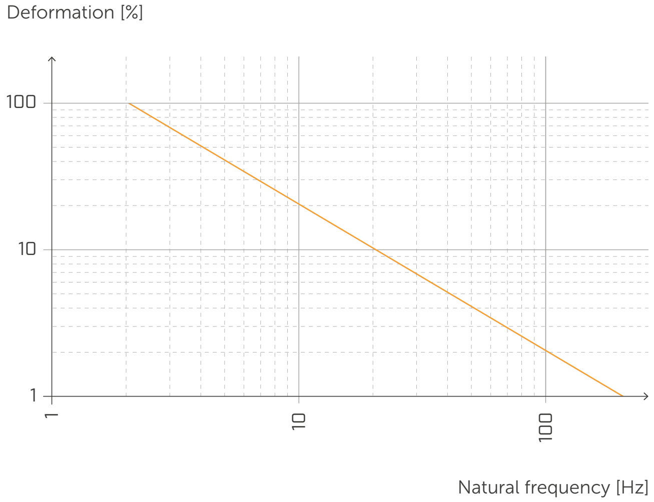
NATURAL FREQUENCY AND LOAD



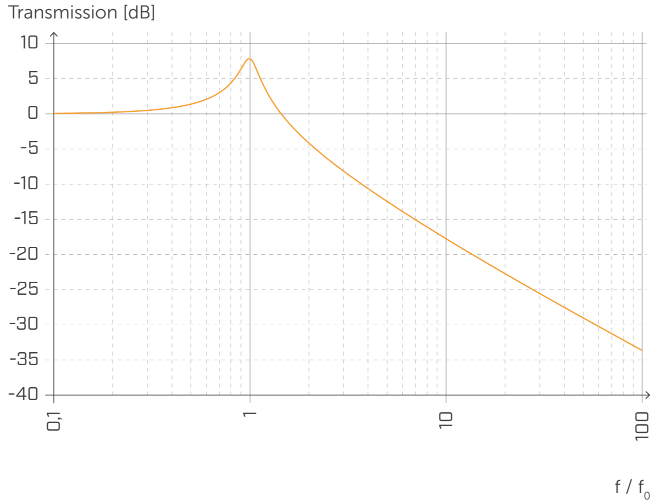
DEFORMATION AND LOAD



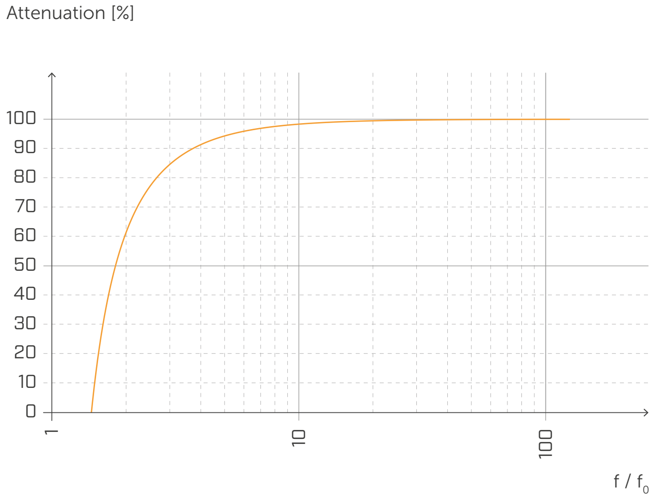
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

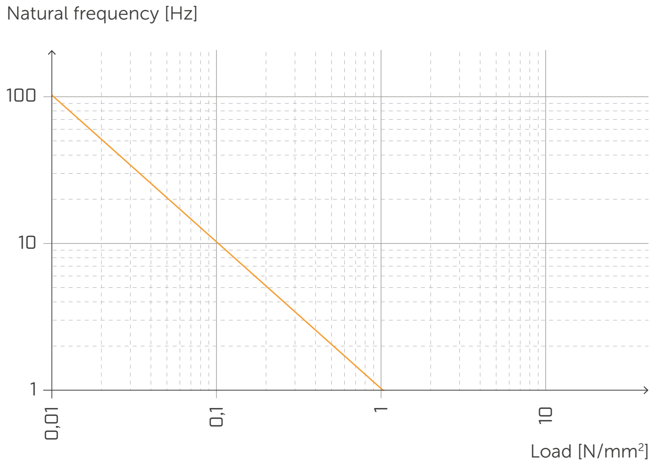


Normalised with respect to the resonance frequency with f = 20 Hz.

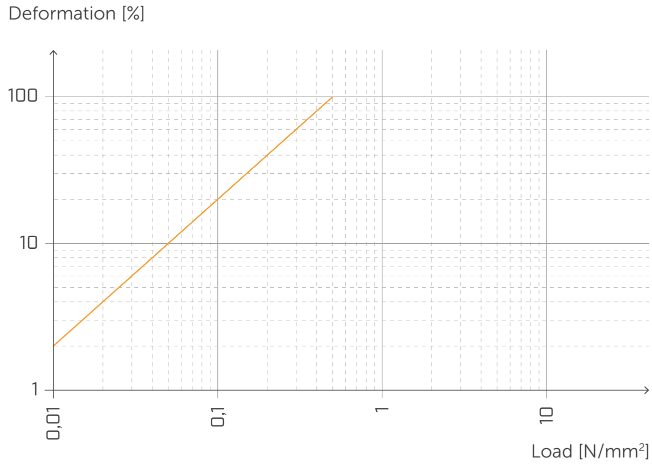
DYNAMIC LOAD
(machines and vibration)

5 Hz

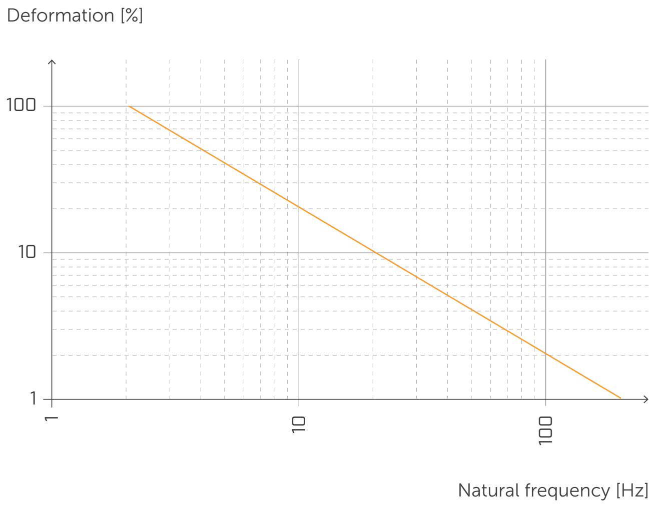
NATURAL FREQUENCY AND LOAD



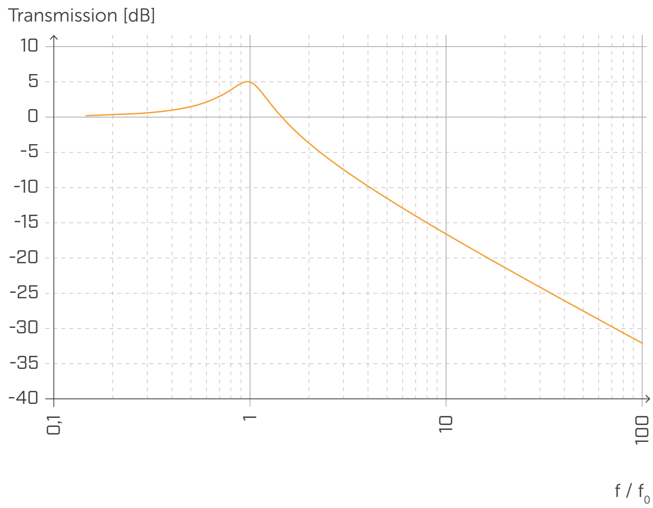
DEFORMATION AND LOAD



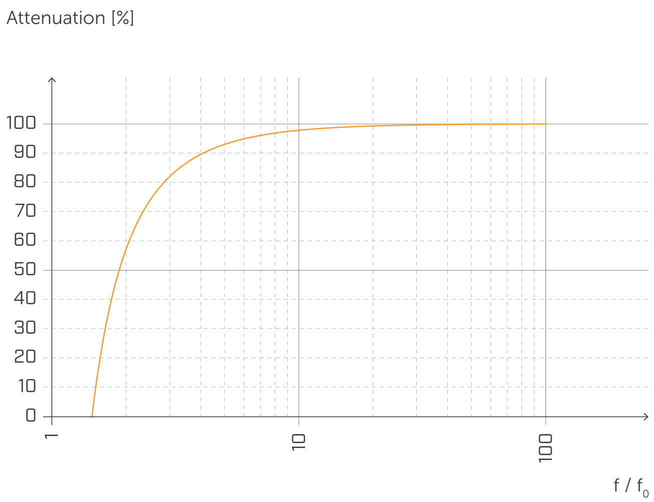
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



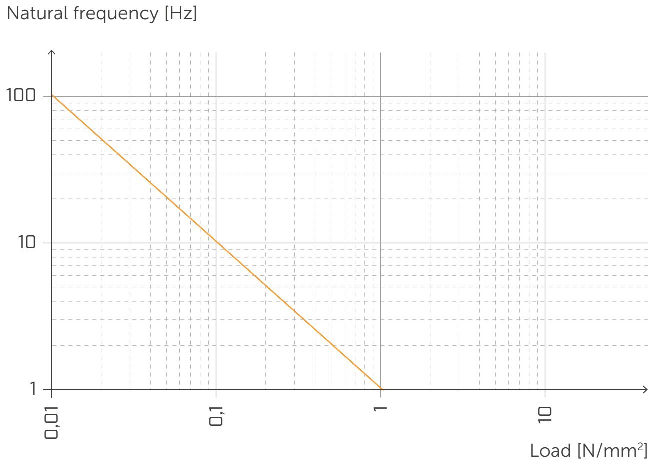
Normalised with respect to the resonance frequency with f = 6 Hz.

DYNAMIC LOAD

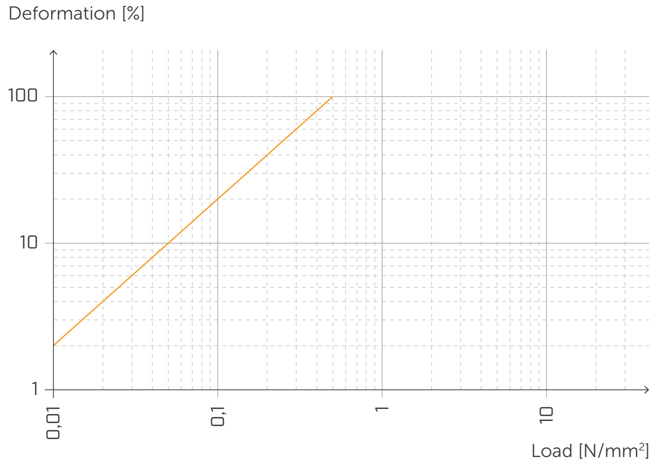
(machines and vibration)

50 Hz

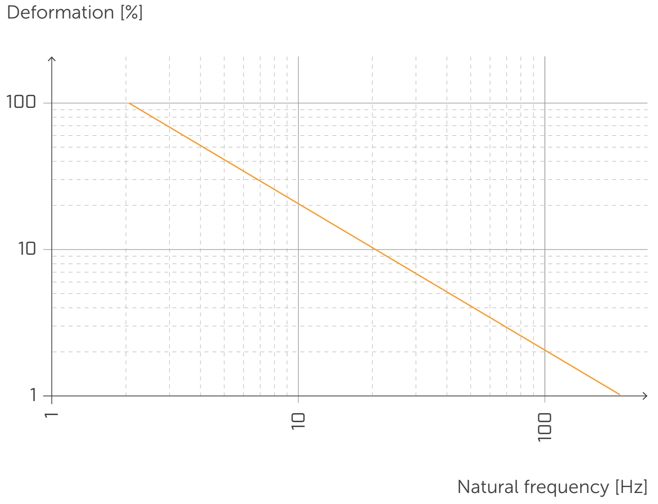
NATURAL FREQUENCY AND LOAD



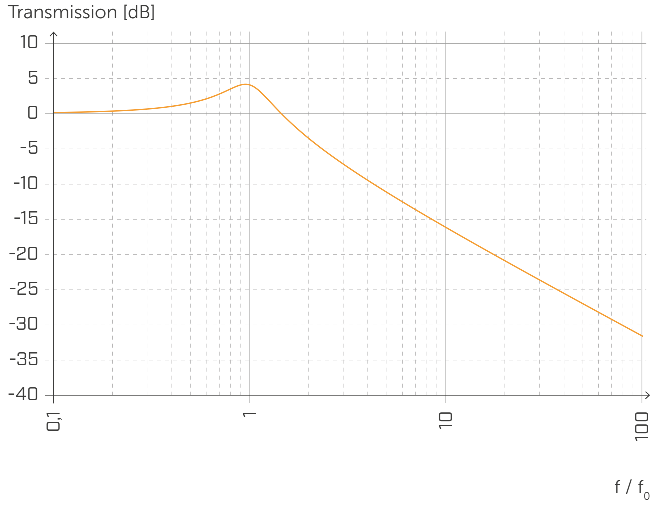
DEFORMATION AND LOAD



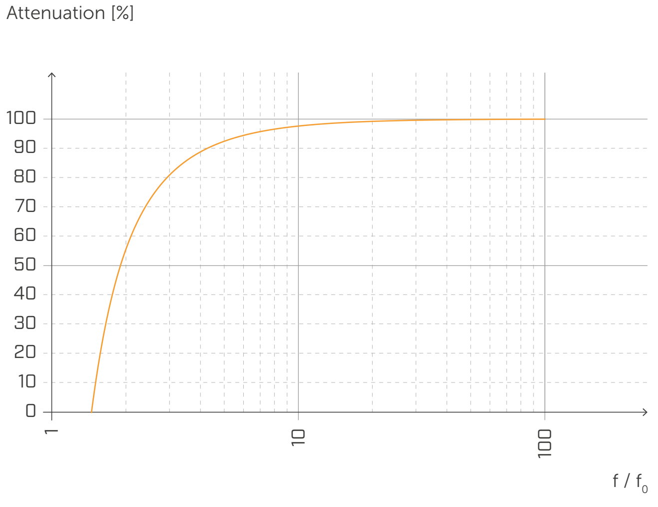
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 6 Hz.

PIANO B

TABLE OF USE[1]

CODE	B [mm]	load for acoustic optimisation[2] [kN/m] from	to	compression for acoustic optimisation[2] [N/mm²] from	to	deformation [mm] from	to	*compression at 3 mm deformation (ultimate limit state)* [N/mm²]
PIANOB4040	80	3,2	21,6	0,04	0,27	0,2	1,49	*0,85*
	40 (divided)	1,6	10,8					
PIANOB5050	100	4	27					
	50 (divided)	2	13,5					
PIANOB6060	120	4,8	32,4					
	60 (divided)	2,4	16,2					
PIANOA140	140	5,6	37,8					

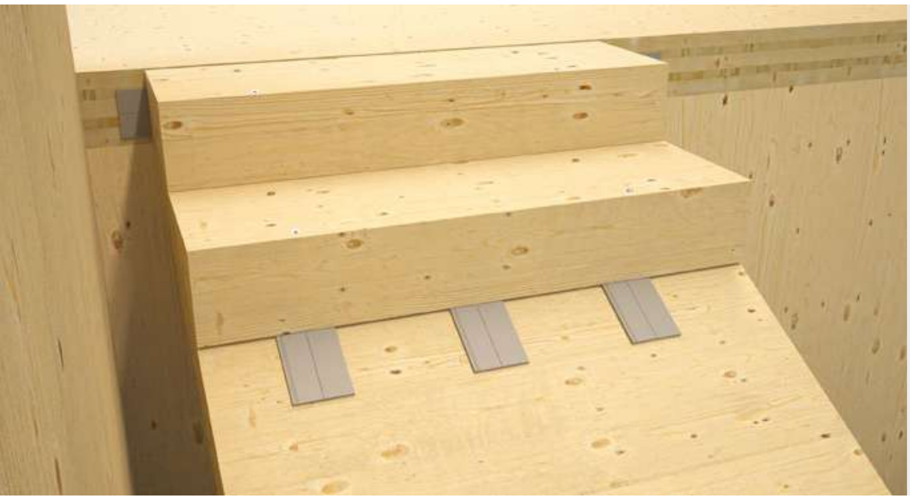
(1) The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression. It is possible to use profiles with loads outside the indicated range if the resonance frequency of the system and the deformation of the profile at the ultimate limit state are assessed.

(2) 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 $\Delta_{l,ij}$[3]	ISO 10848	> 4 dB
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	1,08 MPa (1,08 MPa)
Dynamic elastic modulus E'_{1Hz} - E''_{1Hz}	ISO 4664-1	1,54 - 0.42 MPa
Dynamic elastic modulus E'_{5Hz} - E''_{5Hz}	ISO 4664-1	1,75 - 0.55 MPa
Dynamic elastic modulus E'_{10Hz} - E''_{10Hz}	ISO 4664-1	1,87 - 0.59 MPa
Dynamic elastic modulus E'_{50Hz} - E''_{50Hz}	ISO 4664-1	2,07 - 0.79 MPa
Damping factor tan δ_{1Hz}	ISO 4664-1	0,270
Damping factor tan δ_{5Hz}	ISO 4664-1	0,308
Damping factor tan δ_{10Hz}	ISO 4664-1	0,314
Damping factor tan δ_{50Hz}	ISO 4664-1	0,372
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,34
Compression set c.s.	ISO 1856	37,5%
Compression at 1 mm deformation σ_{1mm}	ISO 844	0,14 N/mm²
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	0,31 N/mm²
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	0,85 N/mm²
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	1,50%

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.



PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[3] : **> 4** dB

Maximum applicable load (deformation 3 mm):

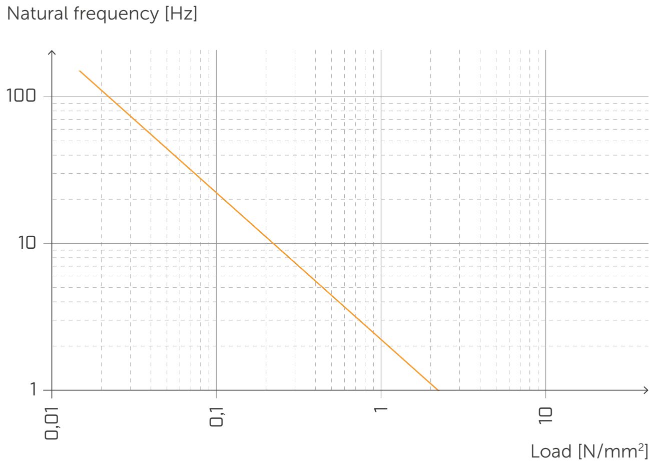
0,85 N/mm²

Acoustic service load:

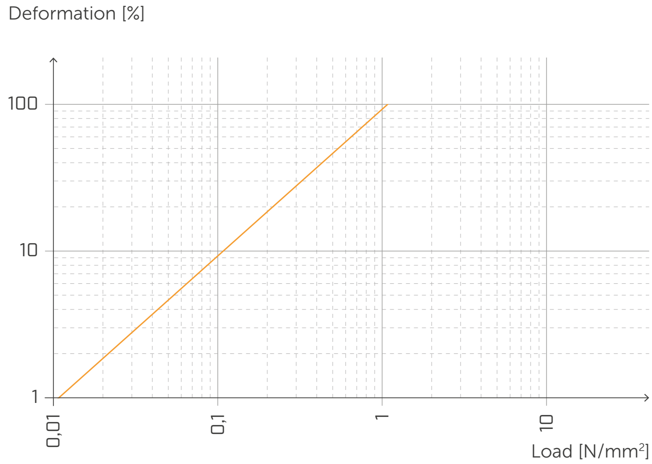
from **0,04** to **0,27** N/mm²

STATIC LOAD
(buildings)

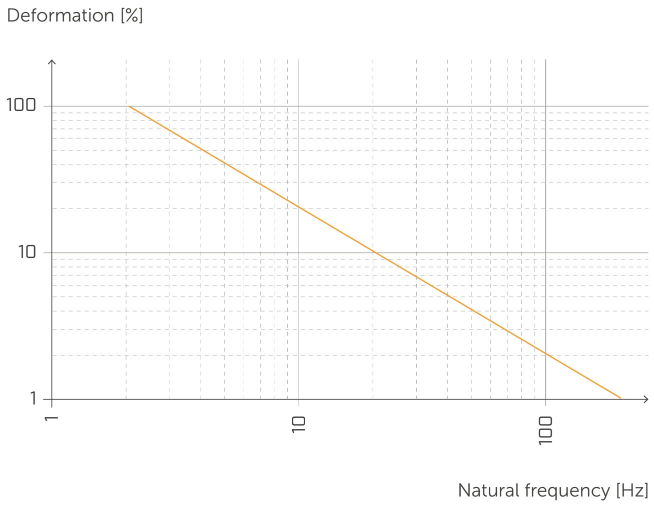
NATURAL FREQUENCY AND LOAD



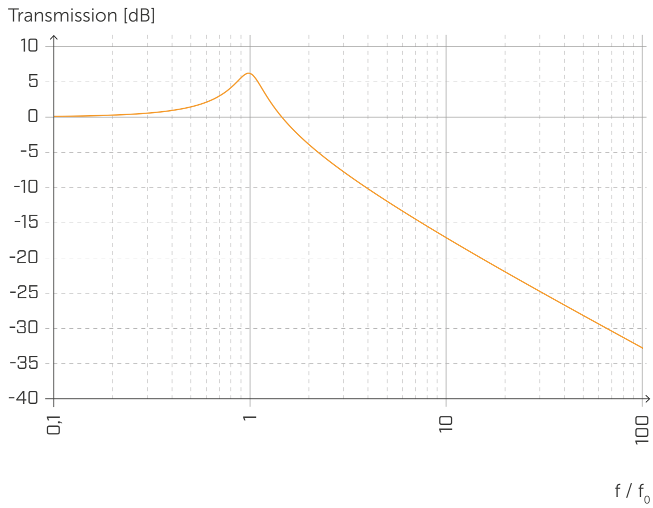
DEFORMATION AND LOAD



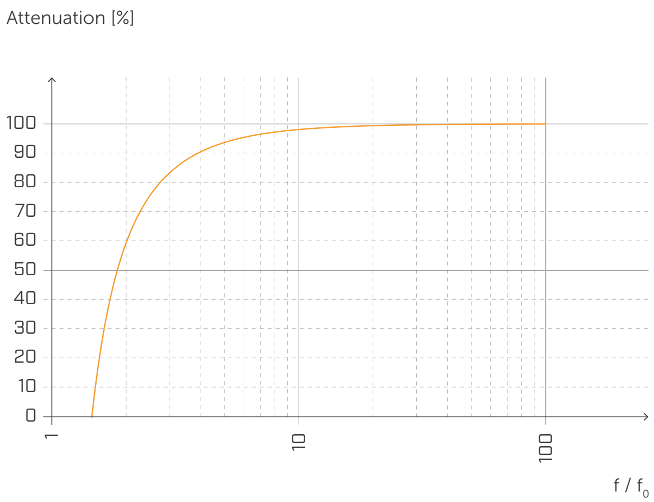
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

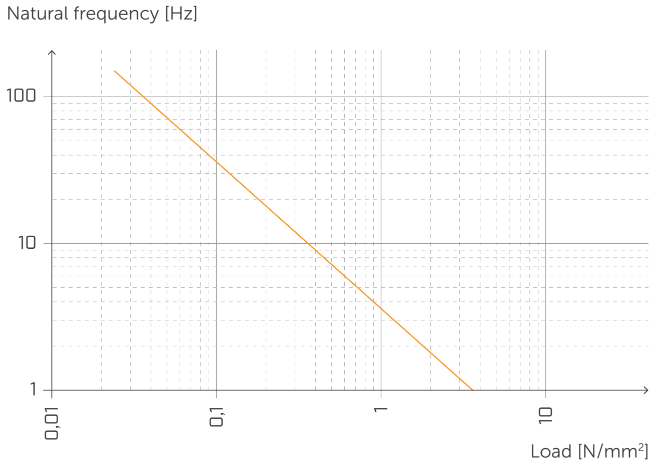


Normalised with respect to the resonance frequency with f = 20 Hz.

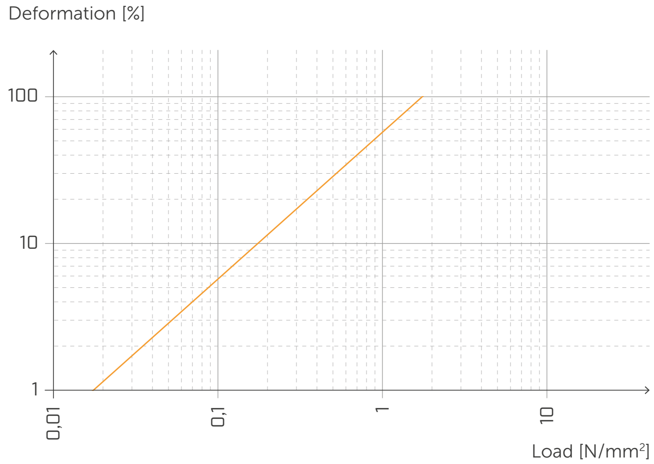
DYNAMIC LOAD
(machines and vibration)

5 Hz

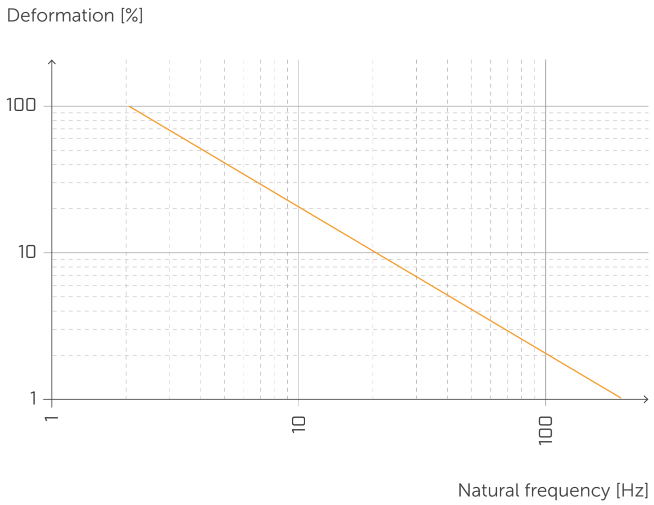
NATURAL FREQUENCY AND LOAD



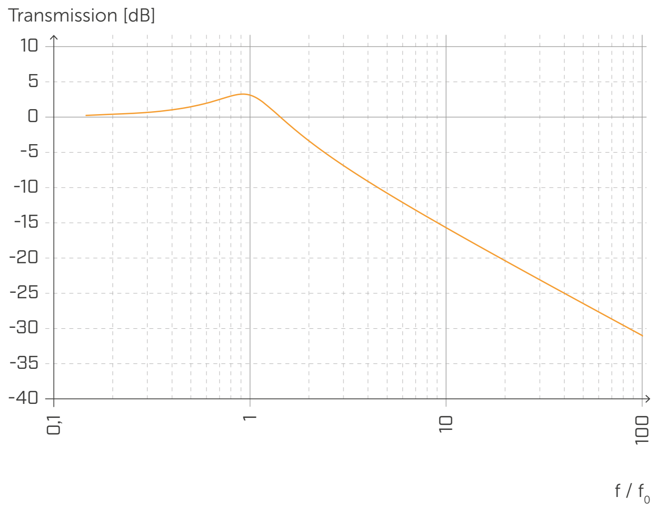
DEFORMATION AND LOAD



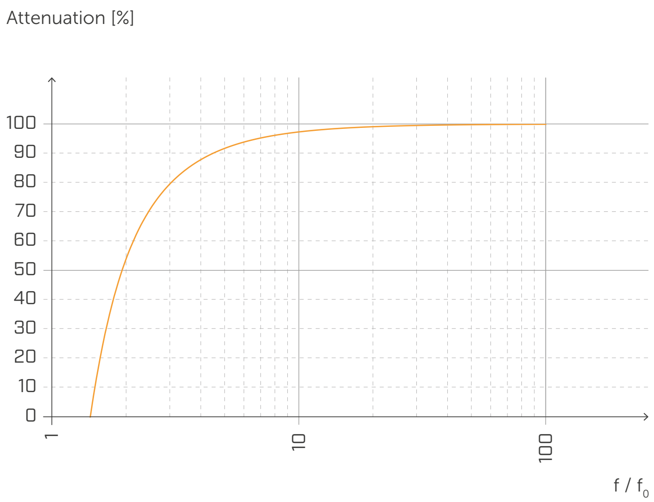
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

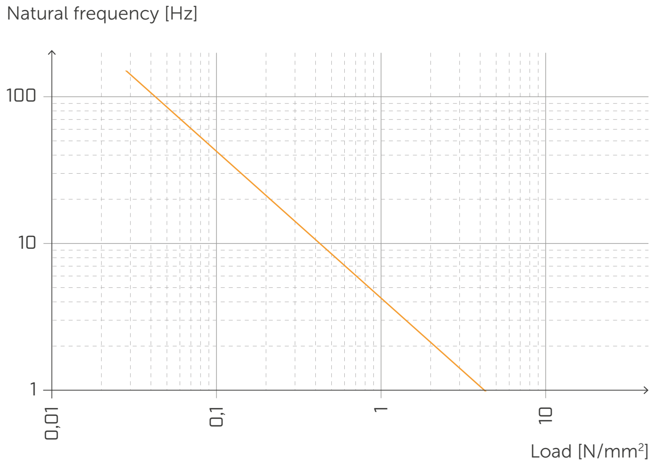


Normalised with respect to the resonance frequency with f = 6 Hz.

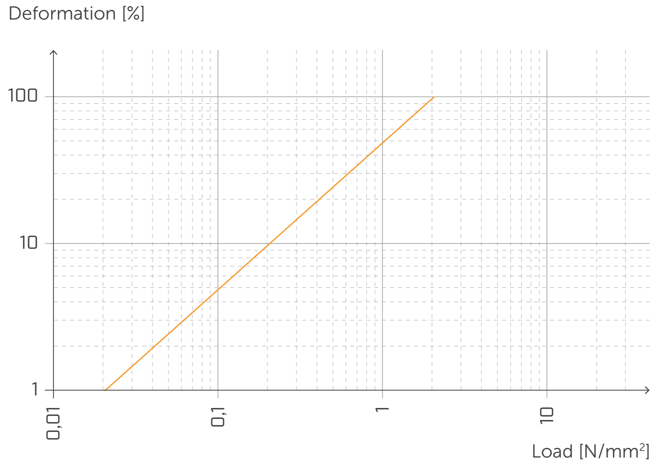
DYNAMIC LOAD
[machines and vibration]

50 Hz

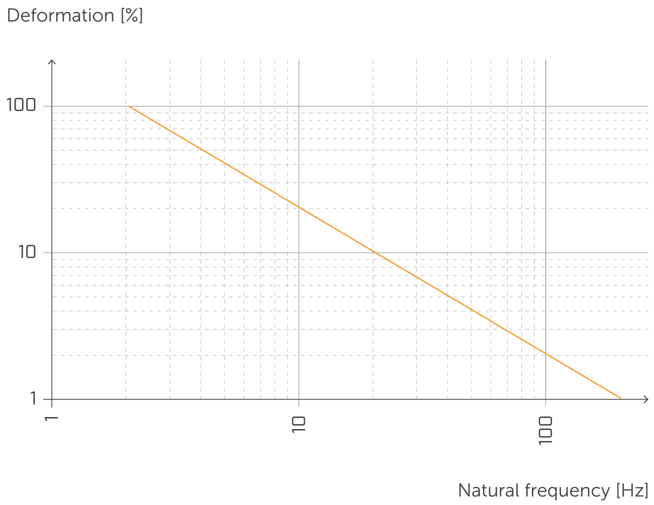
NATURAL FREQUENCY AND LOAD



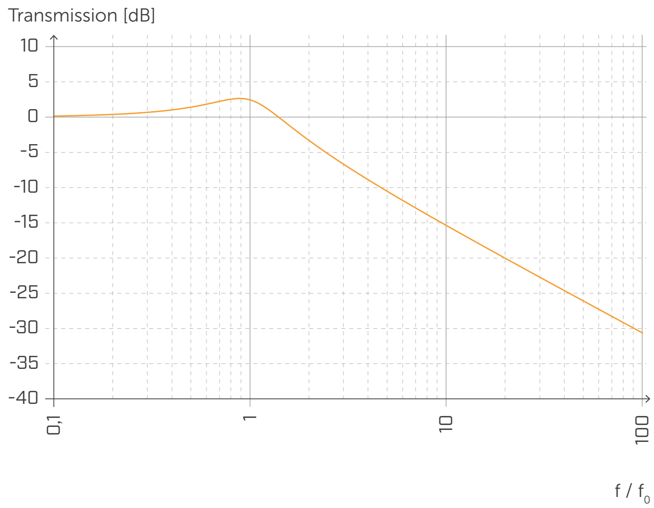
DEFORMATION AND LOAD



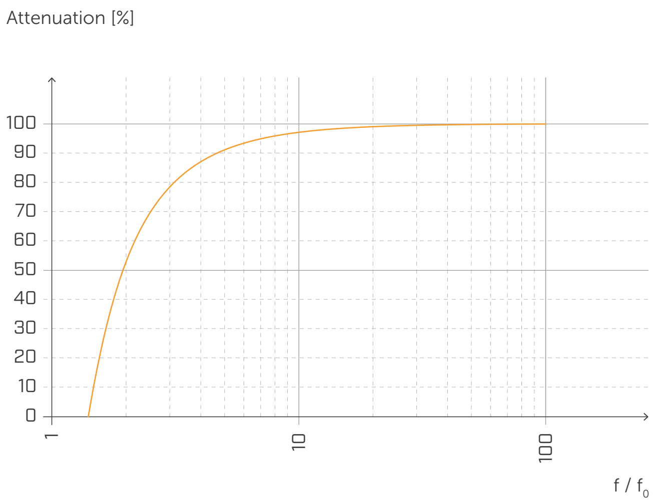
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 6 Hz.

PIANO C

TABLE OF USE[1]

CODE	B	load for acoustic optimisation[2] [kN/m]		compression for acoustic optimisation[2] [N/mm²]		deformation [mm]		*compression at 3 mm deformation (ultimate limit state)* [N/mm²]
	[mm]	from	to	from	to	from	to	
PIANOC080	80	9,6	112	0,12	1,4	0,12	0,63	*9,23*
PIANOC100	100	12	140					
PIANOC120	120	14,4	168					
PIANOC140	140	16,8	196					

(1) The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression. 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.

(2) 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 $\Delta_{l,ij}$[3]	ISO 10848	> 4 dB
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	7,92 MPa (3,67 MPa)
Dynamic elastic modulus E'_{1Hz} - E''_{1Hz}	ISO 4664-1	8,35 - 2.15 MPa
Dynamic elastic modulus E'_{5Hz} - E''_{5Hz}	ISO 4664-1	9,35 - 2.55 MPa
Dynamic elastic modulus E'_{10Hz} -E''_{10Hz}	ISO 4664-1	9,91 - 2.81 MPa
Dynamic elastic modulus E'_{50Hz} -E'_{50Hz}	ISO 4664-1	11,61 - 3.56 MPa
Damping factor tan δ_{1Hz}	ISO 4664-1	0,258
Damping factor tan δ_{5Hz}	ISO 4664-1	0,272
Damping factor tan δ_{10Hz}	ISO 4664-1	0,283
Damping factor tan δ_{50Hz}	ISO 4664-1	0,306
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,18
Compression set c.s.	ISO 1856	11,95%
Compression at 1 mm deformation σ_{1mm}	ISO 844	1,50 N/mm²
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	3,55 N/mm²
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	9,23 N/mm²
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	< 1 %

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[3] : **> 4** dB

Maximum applicable load (deformation 3 mm):

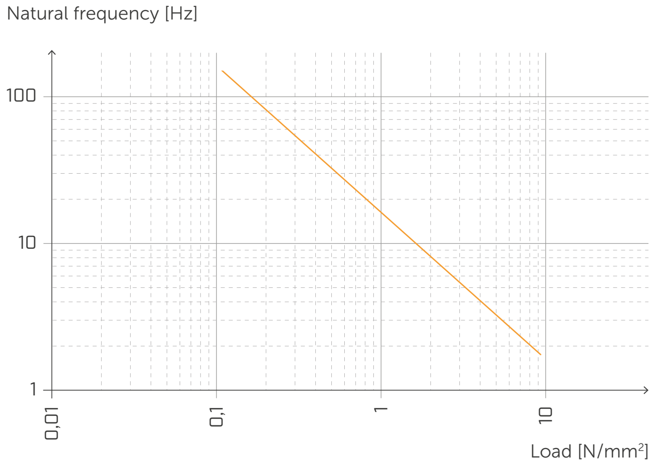
12,07 N/mm²

Acoustic service load:

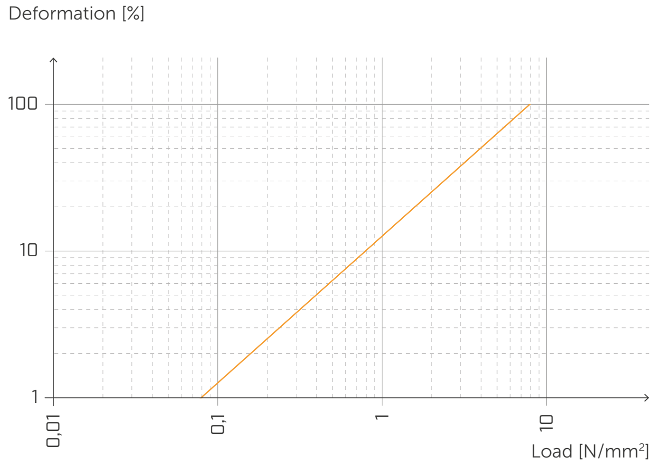
from **0,12** to **1,4** N/mm²

STATIC LOAD
(buildings)

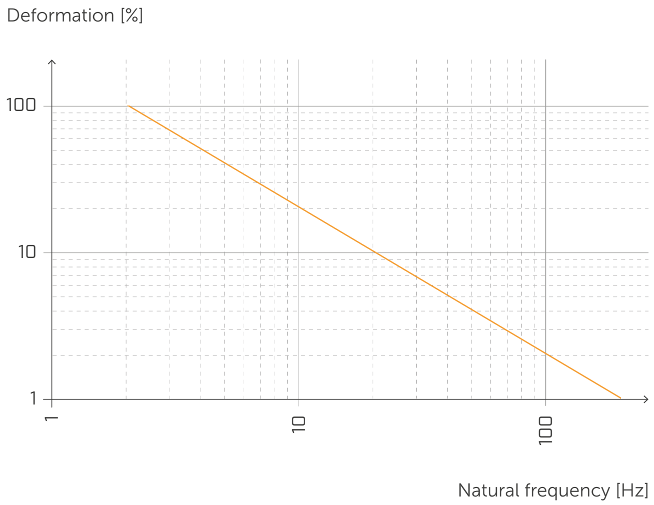
NATURAL FREQUENCY AND LOAD



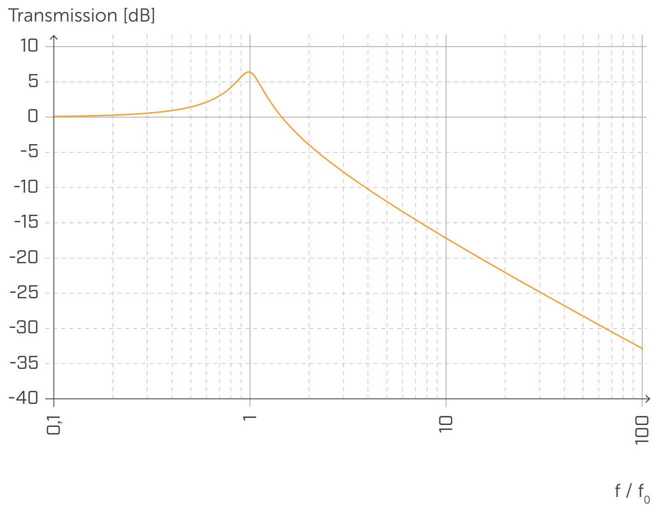
DEFORMATION AND LOAD



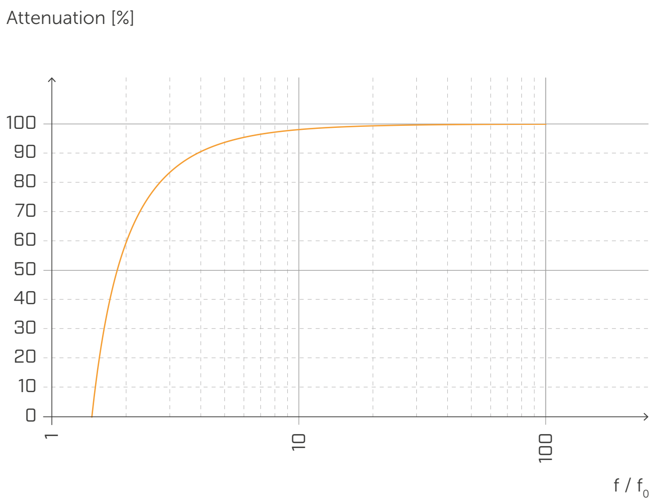
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



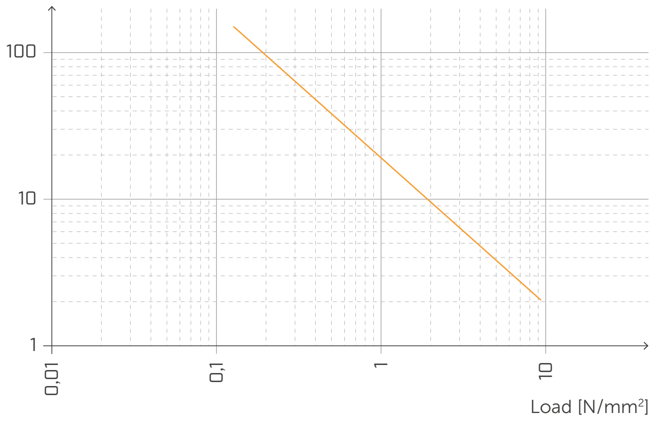
Normalised with respect to the resonance frequency with f = 20 Hz.

DYNAMIC LOAD
(machines and vibration)

5 Hz

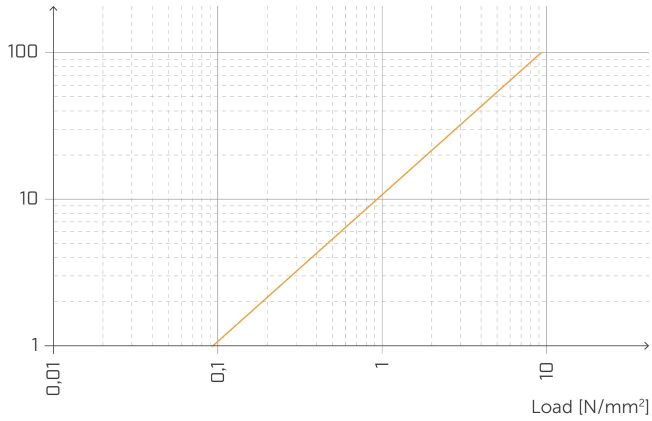
NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



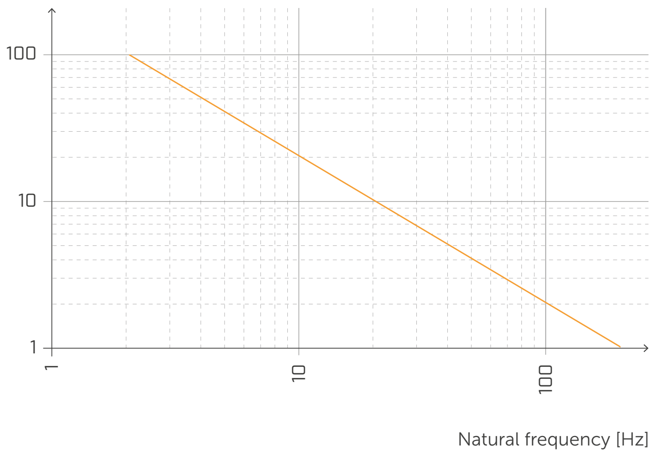
DEFORMATION AND LOAD

Deformation [%]



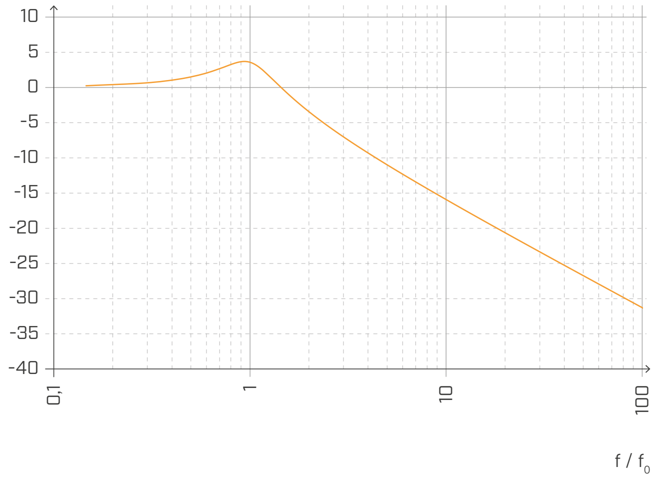
DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



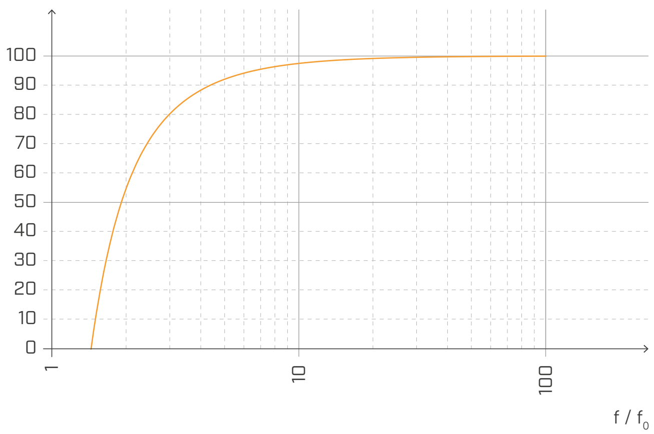
TRANSMISSIBILITY

Transmission [dB]



ATTENUATION

Attenuation [%]

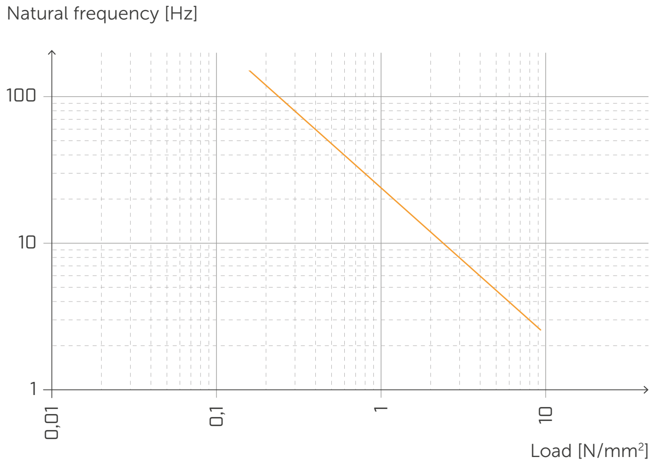


Normalised with respect to the resonance frequency with f = 6 Hz.

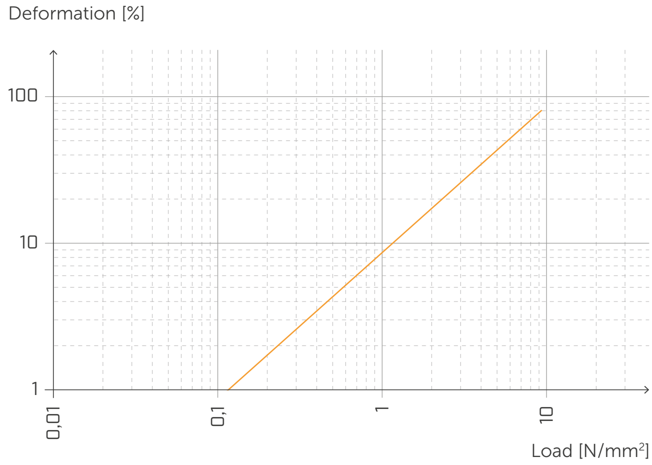
DYNAMIC LOAD
(machines and vibration)

50 Hz

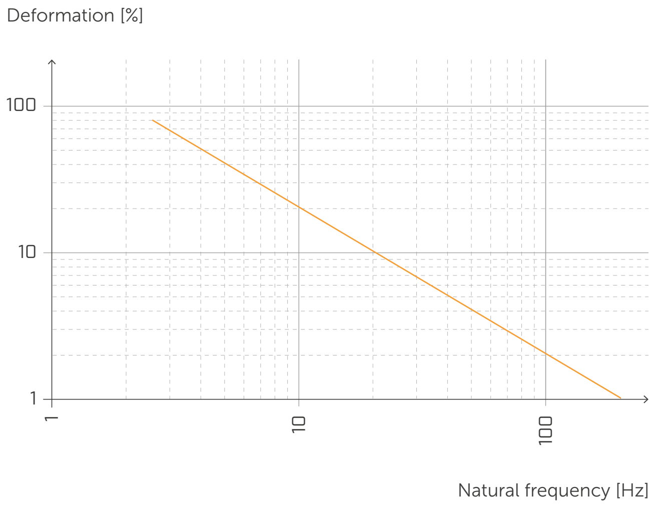
NATURAL FREQUENCY AND LOAD



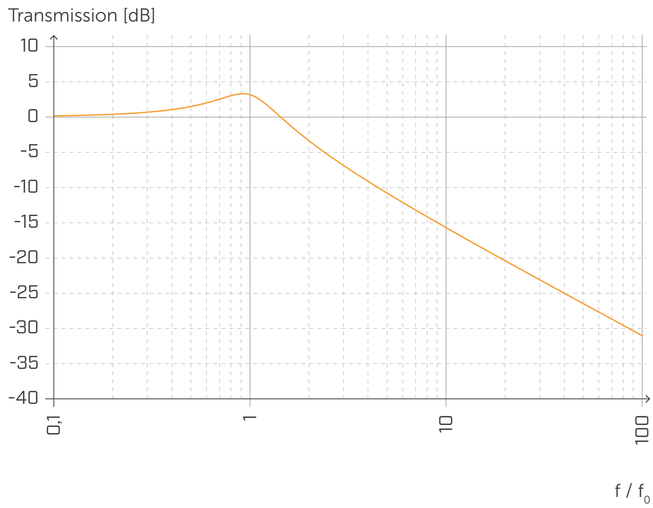
DEFORMATION AND LOAD



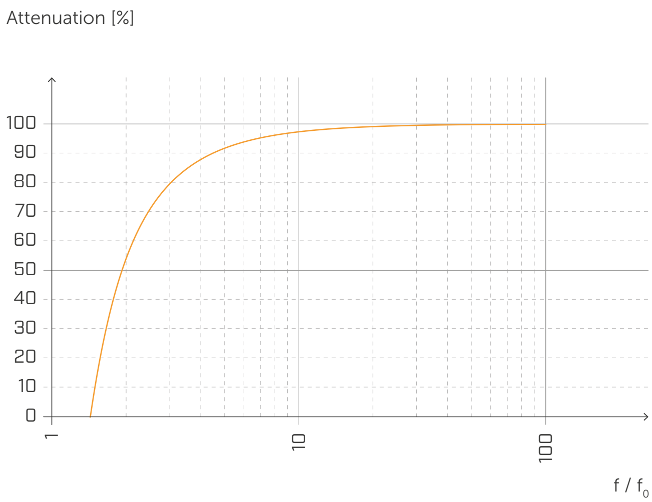
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 6 Hz.

PIANO D

TABLE OF USE[1]

CODE	B	load for acoustic optimisation[2] [kN/m]		compression for acoustic optimisation[2] [N/mm²]		deformation [mm]		*compression at 3 mm deformation (ultimate limit state)* [N/mm²]
	[mm]	from	to	from	to	from	to	
PIANOD080	80	96	182,4	1,2	2,28	0,33	0,62	*16,9*
PIANOD100	100	120	228					
PIANOD120	120	144	273,6					
PIANOD140	140	168	319,2					

(1) The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression. 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.

(2) 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 $\Delta_{l,ij}$[3]	ISO 10848	> 4 dB
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	22,10 MPa (7,92 MPa)
Dynamic elastic modulus E'_{1Hz} - E''_{1Hz}	ISO 4664-1	18,23 - 4.97 MPa
Dynamic elastic modulus E'_{5Hz} - E''_{5Hz}	ISO 4664-1	20,30 - 6.03 MPa
Dynamic elastic modulus E'_{10Hz} - E''_{10Hz}	ISO 4664-1	21,62 - 6.71 MPa
Dynamic elastic modulus E'_{50Hz} - E''_{50Hz}	ISO 4664-1	25,81 - 9.01 MPa
Damping factor tan δ_{1Hz}	ISO 4664-1	0,273
Damping factor tan δ_{5Hz}	ISO 4664-1	0,297
Damping factor tan δ_{10Hz}	ISO 4664-1	0,31
Damping factor tan δ_{50Hz}	ISO 4664-1	0,349
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,45
Compression set c.s.	ISO 1856	14,75%
Compression at 1 mm deformation σ_{1mm}	ISO 844	4,40 N/mm²
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	10,49 N/mm²
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	16,9 N/mm²
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	< 1 %

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$(3) : **> 4** dB

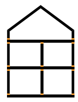
Maximum applicable load (deformation 3 mm):

16,9 N/mm²

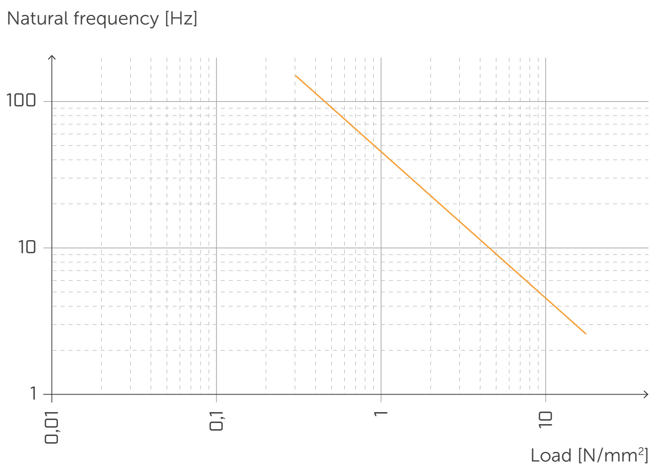
Acoustic service load:

from **1,2** to **2,28** N/mm²

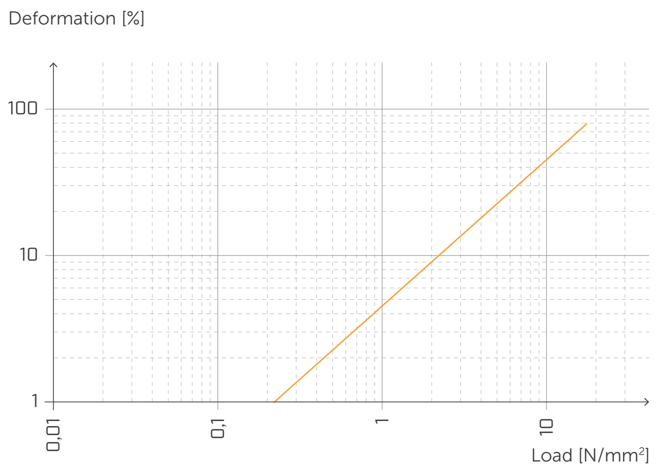
STATIC LOAD
(buildings)



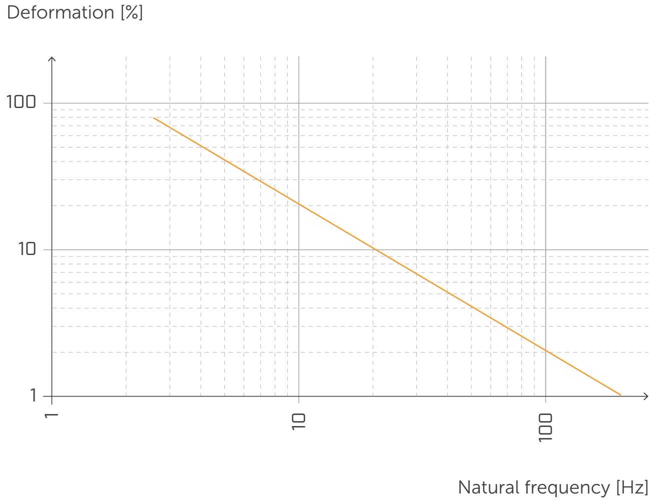
NATURAL FREQUENCY AND LOAD



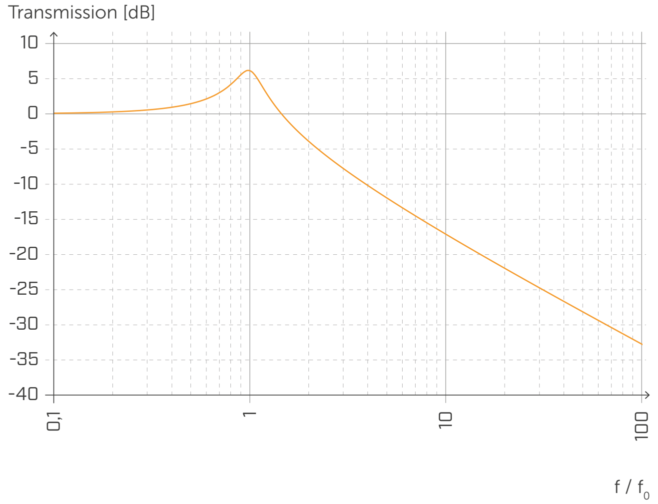
DEFORMATION AND LOAD



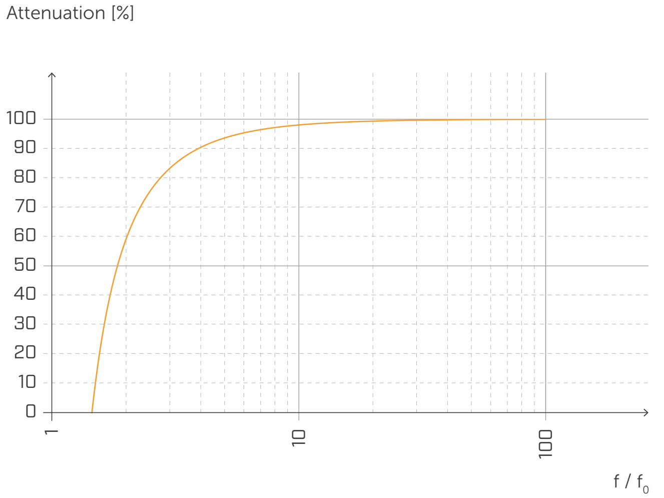
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



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

DYNAMIC LOAD
(machines and vibration)

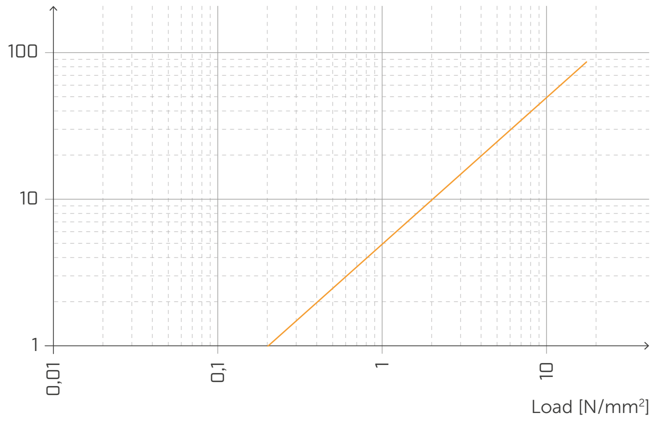
5 Hz

NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]

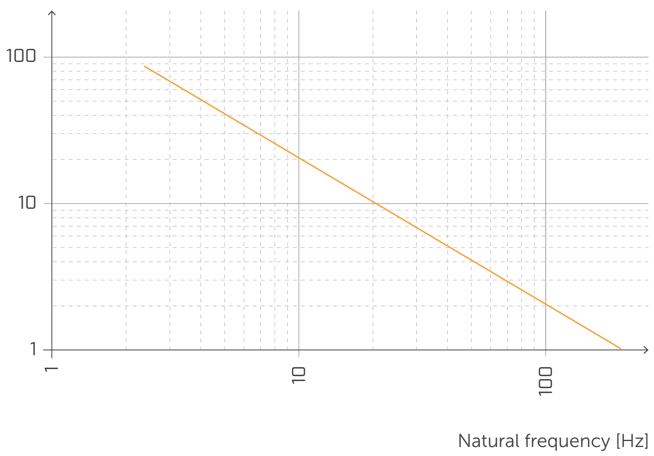
DEFORMATION AND LOAD

Deformation [%]



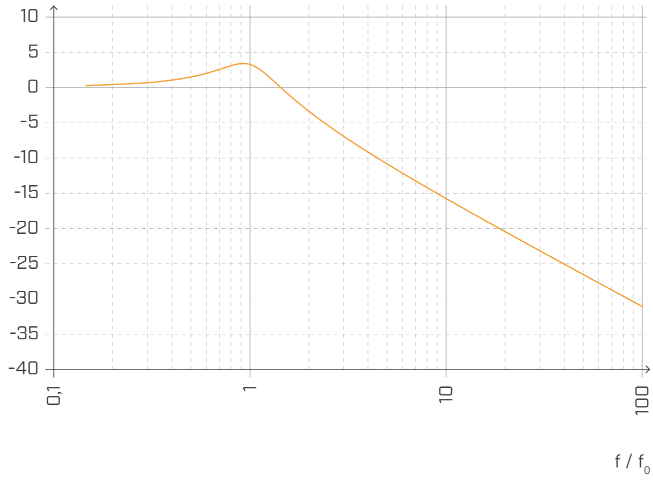
DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



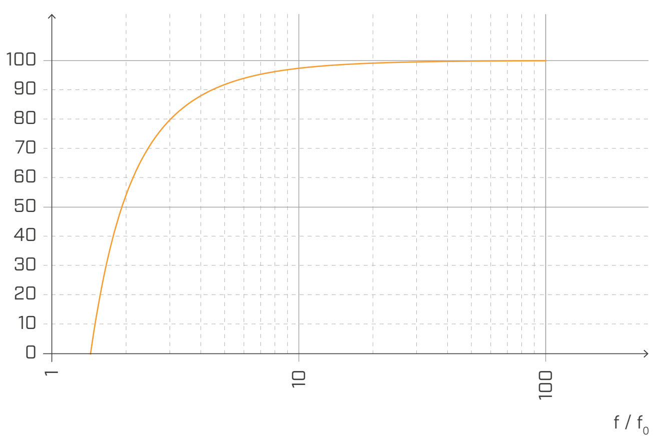
TRANSMISSIBILITY

Transmission [dB]



ATTENUATION

Attenuation [%]

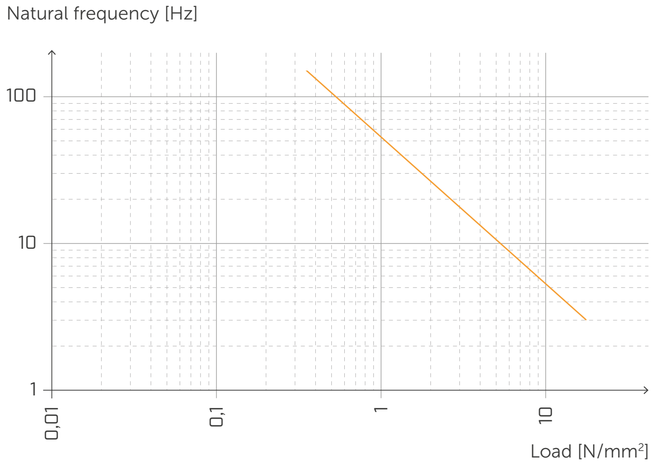


Normalised with respect to the resonance frequency with f = 6 Hz.

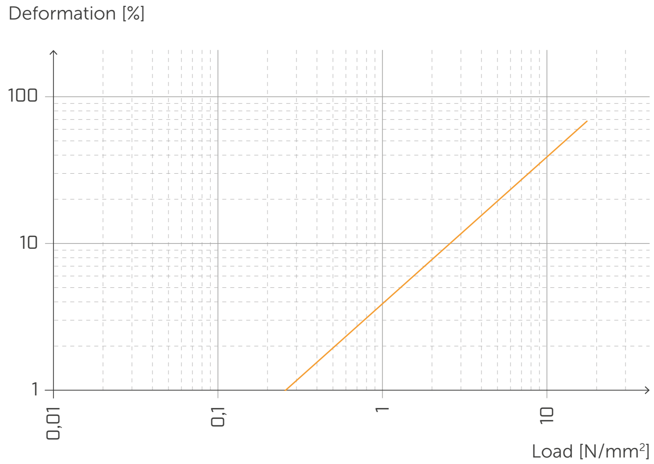
DYNAMIC LOAD
(machines and vibration)

50 Hz

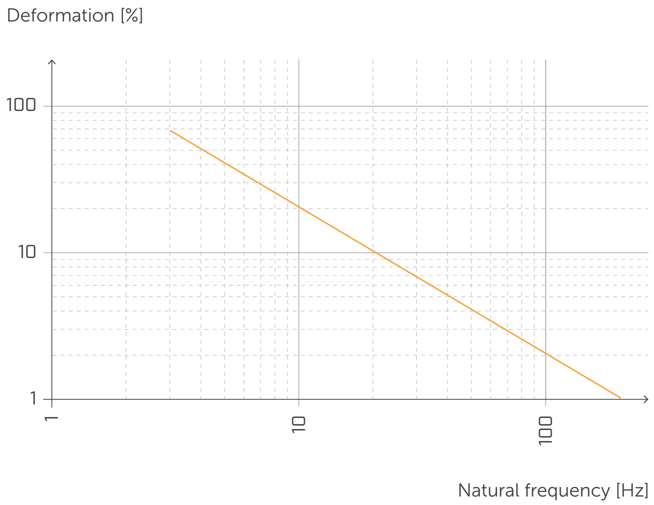
NATURAL FREQUENCY AND LOAD



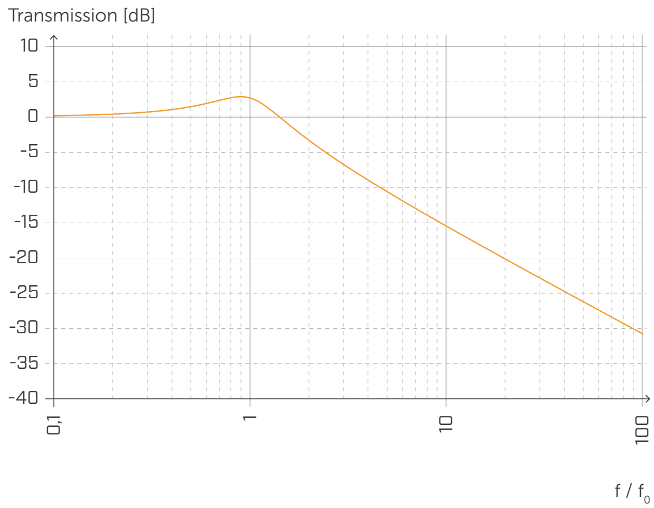
DEFORMATION AND LOAD



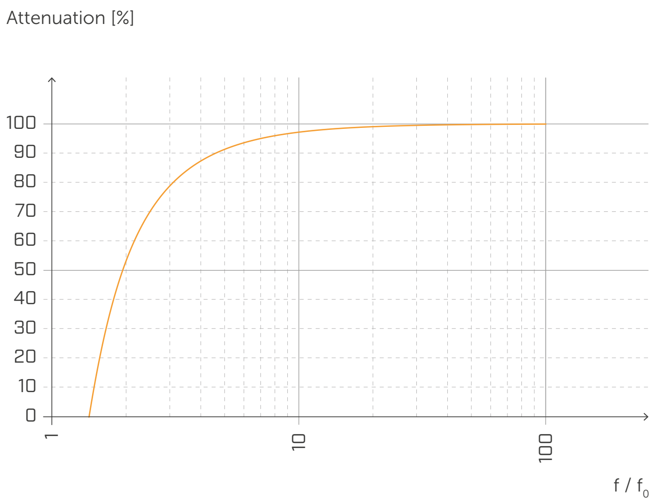
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 6 Hz.

PIANO E

TABLE OF USE[1]

CODE	B	load for acoustic optimisation[2] [kN/m]		compression for acoustic optimisation[2] [N/mm²]		deformation [mm]		*compression at 3 mm deformation (ultimate limit state)* [N/mm²]
	[mm]	from	to	from	to	from	to	
PIANOE080	80	144	256	1,8	3,2	0,44	0,77	*17,07*
PIANOE100	100	180	320					
PIANOE120	120	216	384					
PIANOE140	140	252	448					

(1) The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression. 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.

(2) 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 $\Delta_{l,ij}$[3]	ISO 10848	> 4 dB
Elastic modulus in compression E_c (without friction $E_{c,lubricant}$)	ISO 844	24,76 MPa (12,03 MPa)
Dynamic elastic modulus E'_{1Hz} - E''_{1Hz}	ISO 4664-1	48,83 - 11.99 MPa
Dynamic elastic modulus E'_{5Hz} - E''_{5Hz}	ISO 4664-1	54,80 - 13.24 MPa
Dynamic elastic modulus E'_{10Hz} - E''_{10Hz}	ISO 4664-1	58,35 - 14.04 MPa
Dynamic elastic modulus E'_{50Hz} - E''_{50Hz}	ISO 4664-1	67,08 - 16.85 MPa
Damping factor tan δ_{1Hz}	ISO 4664-1	0,247
Damping factor tan δ_{5Hz}	ISO 4664-1	0,243
Damping factor tan δ_{10Hz}	ISO 4664-1	0,242
Damping factor tan δ_{50Hz}	ISO 4664-1	0,253
Creep $\Delta\varepsilon/\varepsilon_1$	ISO 8013/ ISO 16534	0,24
Compression set c.s.	ISO 1856	42,08%
Compression at 1 mm deformation σ_{1mm}	ISO 844	3,81 N/mm²
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	8,36 N/mm²
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	17,07 N/mm²
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	< 1 %

(3) $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$.

PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$[3] : **> 4** dB

Maximum applicable load (deformation 3 mm):

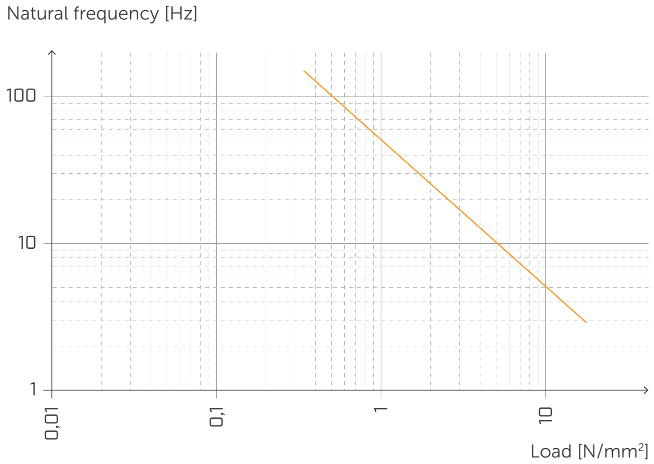
17,07 N/mm²

Acoustic service load:

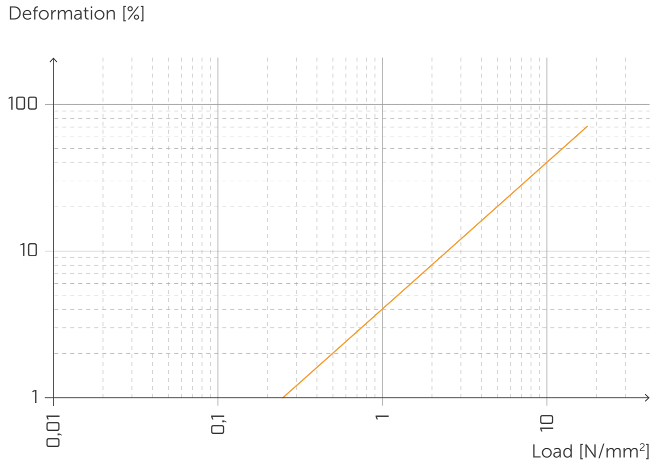
from **1,8** to **3,2** N/mm²

STATIC LOAD
(buildings)

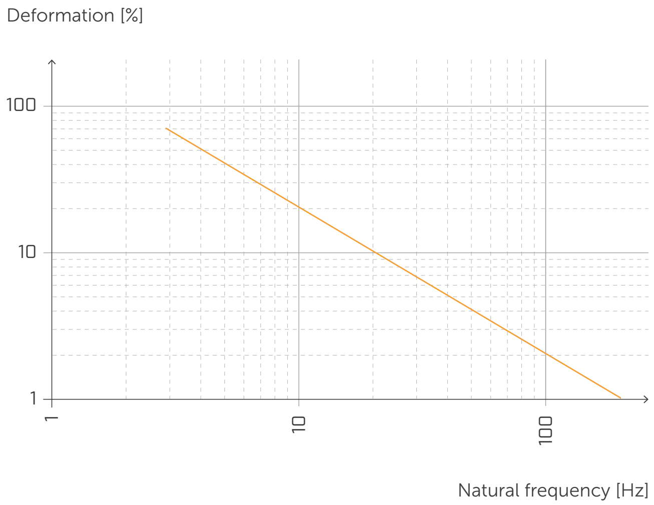
NATURAL FREQUENCY AND LOAD



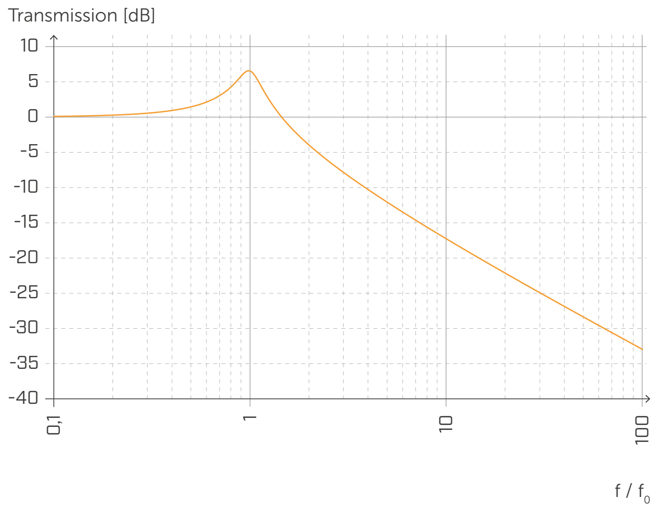
DEFORMATION AND LOAD



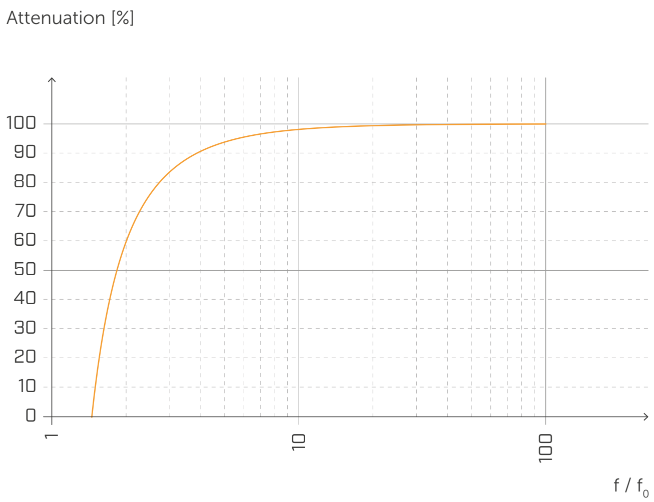
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



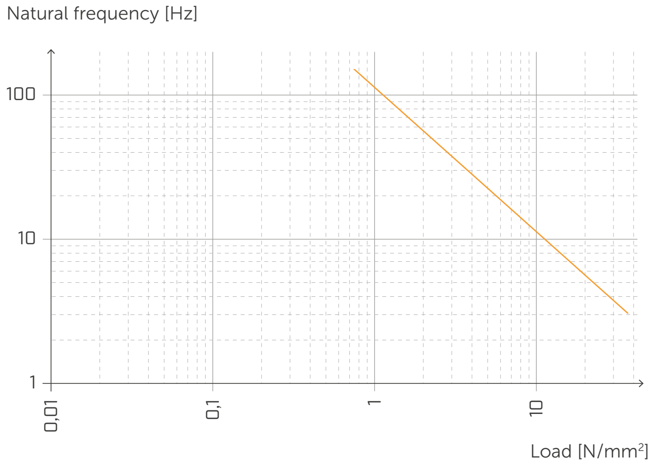
Normalised with respect to the resonance frequency with f = 20 Hz.

DYNAMIC LOAD

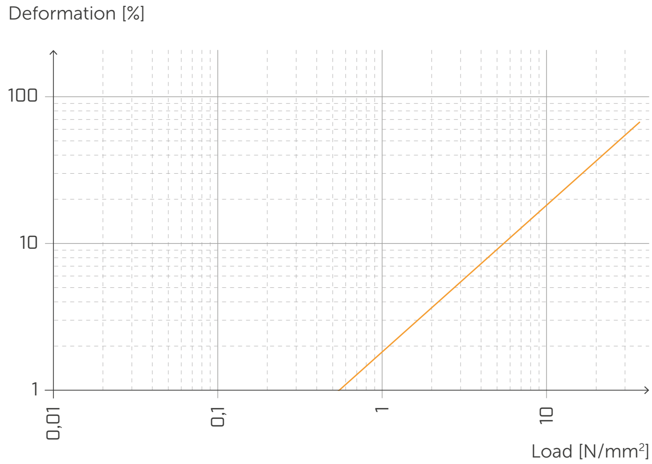
(machines and vibration)

5 Hz

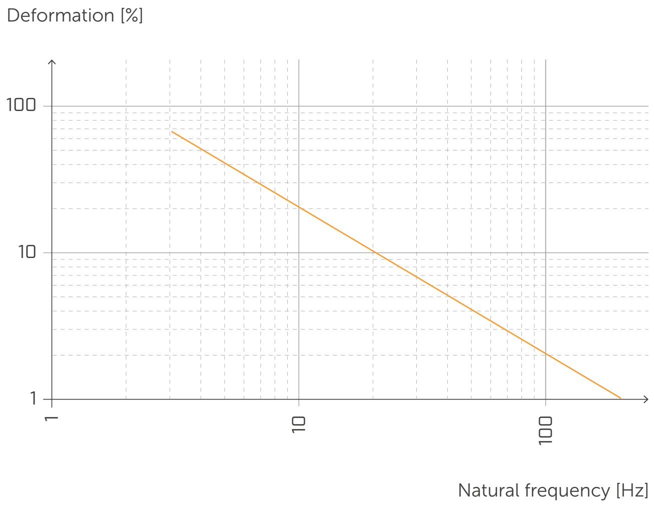
NATURAL FREQUENCY AND LOAD



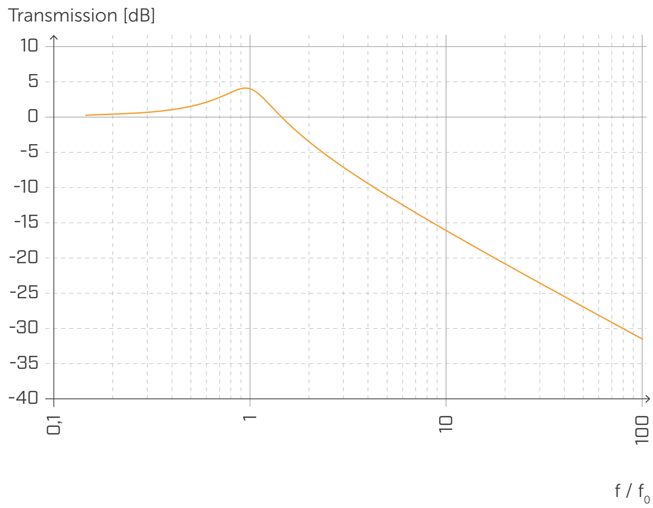
DEFORMATION AND LOAD



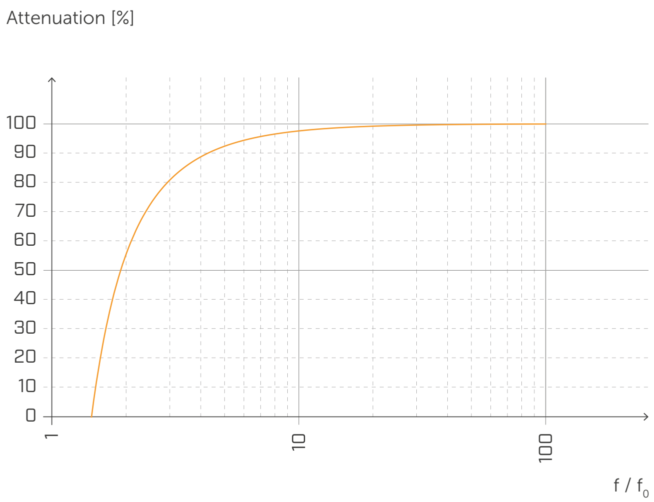
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

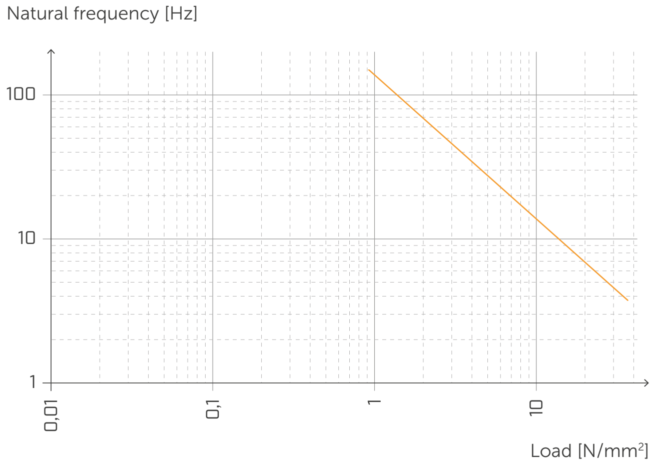


Normalised with respect to the resonance frequency with f = 6 Hz.

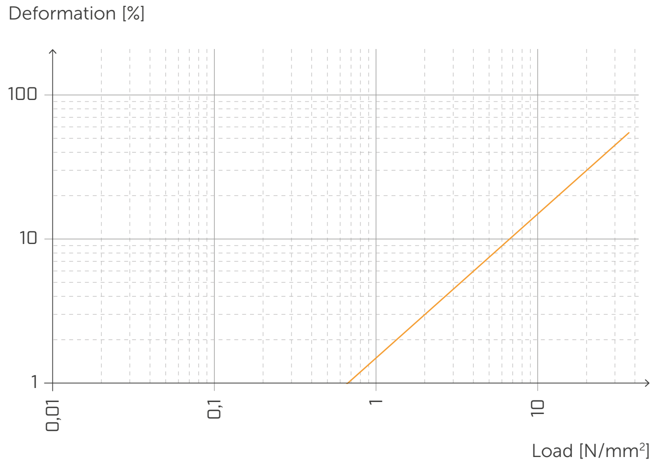
DYNAMIC LOAD
(machines and vibration)

50 Hz

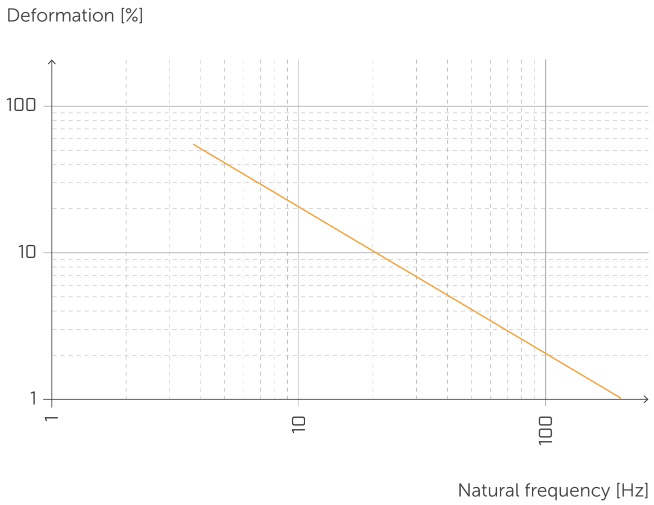
NATURAL FREQUENCY AND LOAD



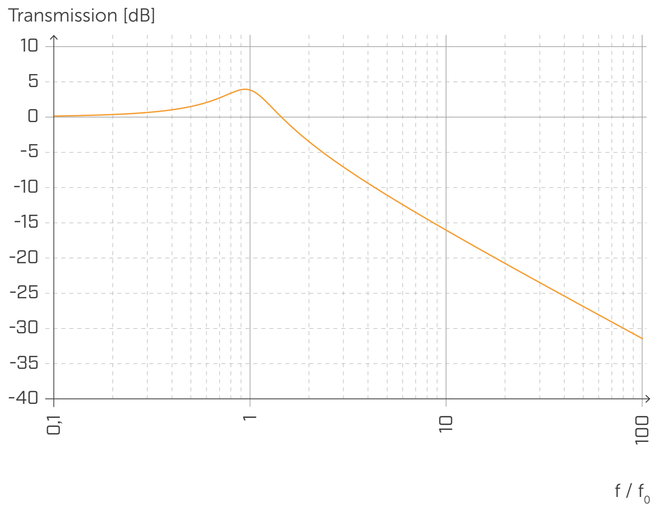
DEFORMATION AND LOAD



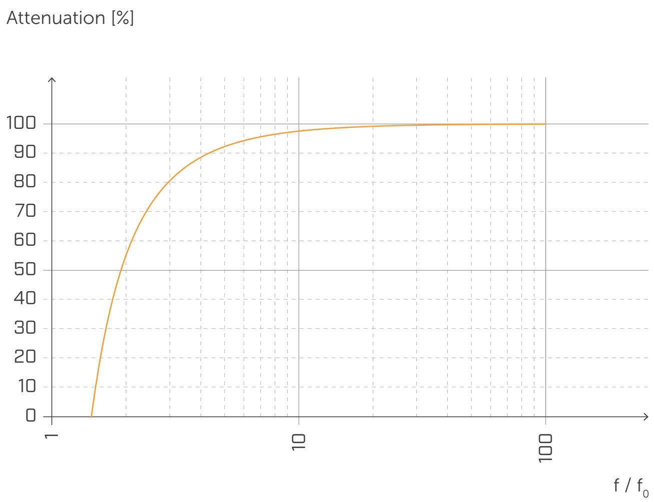
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



Normalised with respect to the resonance frequency with f = 6 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 $R_{ij,w}$.

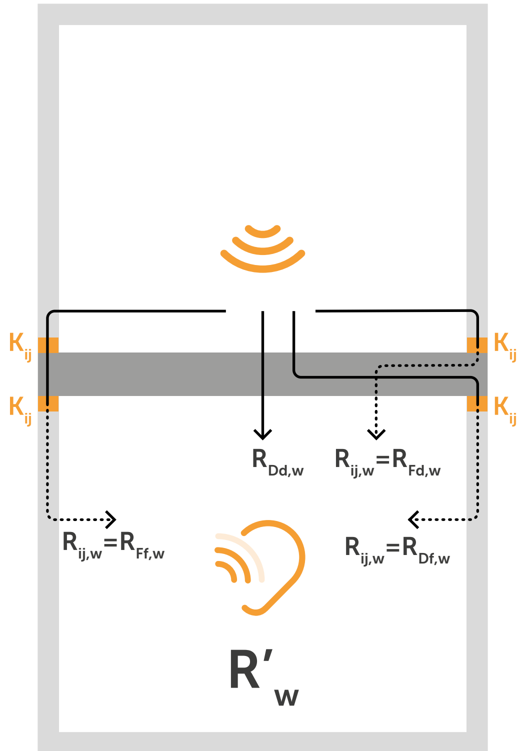
$$R'_w = -10\log\left[10^{-\frac{R_{Dd,w}}{10}} + \sum_{i,j=1}^{n} 10^{-\frac{R_{ij,w}}{10}} + \frac{A_0}{S_s}\sum_{j=1}^{n} 10^{-\frac{D_{n,j,w}}{10}}\right] (dB)$$

The sound reduction index for flanking transmission paths Rij,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.

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

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

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

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.

Kij 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 ΔLmin = 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

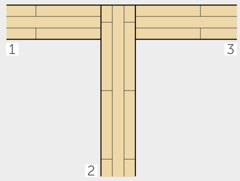
determined by the connecting elements.
In the case of CLT structures weakly bound together, the side transmission contribution can be determined according to the following relations, valid if $0,5 < (m_1/m_2) < 2$.

METHOD 1 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

$K_{13} = 5,7 + 14,1\ M + 5,7\ M^2$ dB

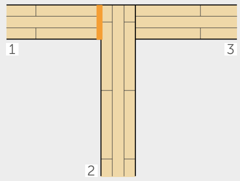
$K_{12} = 5,7 + 5,7\ M^2 = K_{23}$ dB



Solution 2 - T-SHAPED JOINT with resilient layer

$K_{23} = 5,7 + 14,1\ M + 5,7\ M^2$ dB

$K_{12} = 5,7 + 5,7\ M^2 = K_{23}$ dB



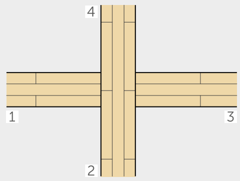
Solution 3 - X-SHAPED JOINT

$K_{13} = 8,7 + 17,1\ M + 5,7\ M^2$ dB

$K_{12} = 8,7 + 5,7\ M^2 = K_{23}$ dB

$K_{24} = 3,7 + 14,1\ M + 5,7\ M^2$ dB

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



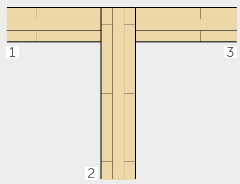
METHOD 2 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

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

f_k=500 Hz

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



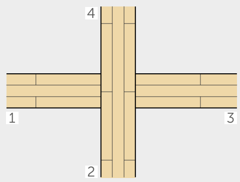
Solution 1 - X-SHAPED JOINT

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

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

f_k=500 Hz

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



THE SIMPLIFIED METHOD

A CALCULATION EXAMPLE USING EN ISO 12354

INPUT DATA

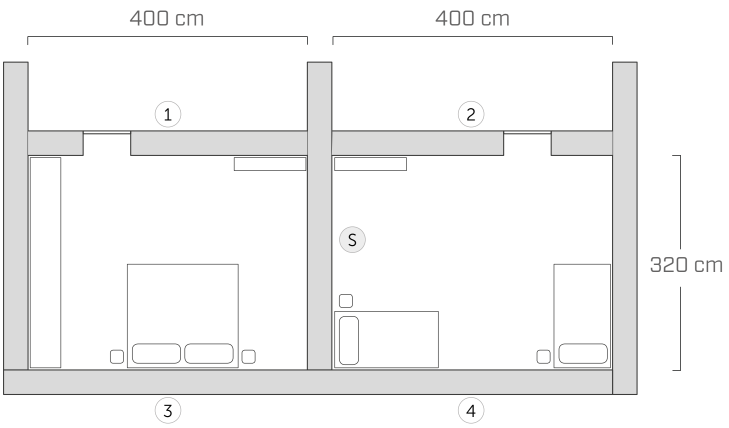
The EN ISO 12354 norms provide two methods to calculate the acoustic performance of a partition: a detailed method and the simplified method.

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.

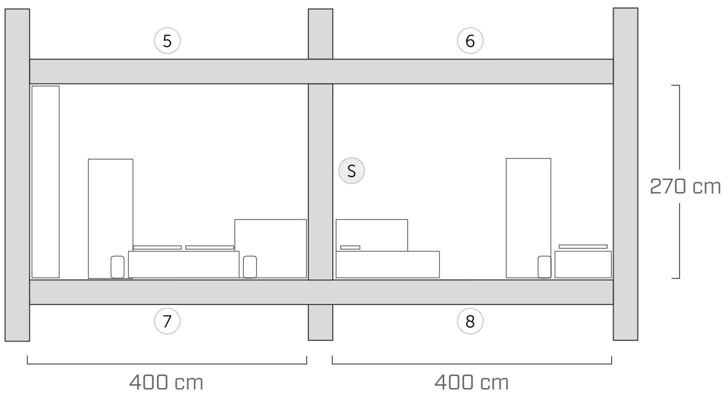
In order to determine the acoustic performance of assembly from the acoustic performance of its components, it is important to determine for every junction element:

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

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 assemblies i-j, for a total of 12 Rij 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

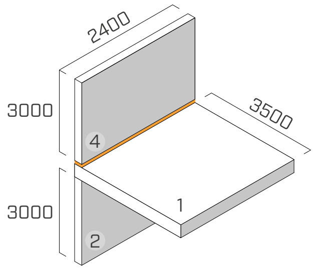
JOINT 3-4-S
T-shaped joint,
detail 5

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

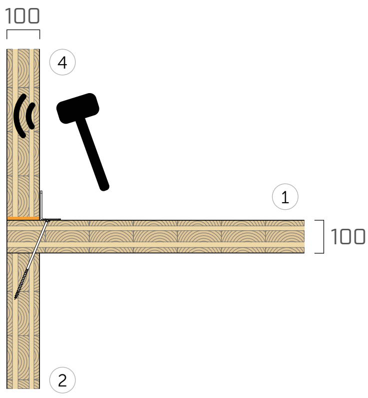
T-JOINT | PERIMETER WALLS
EN ISO 10848-1/4

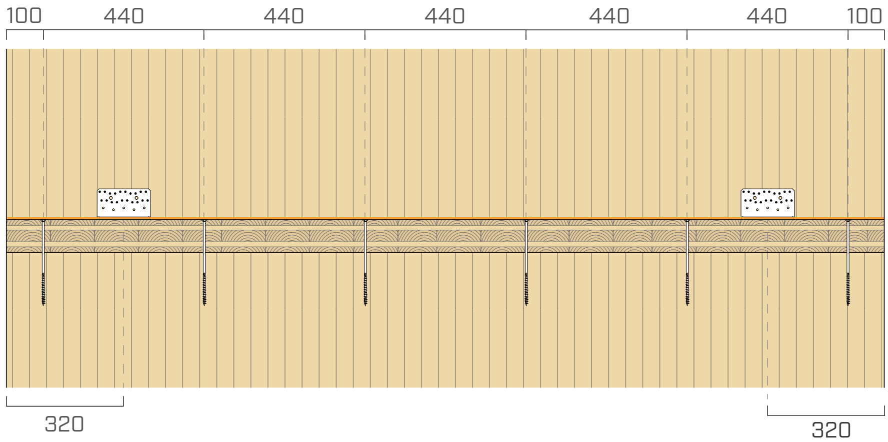


STRUCTURE
upper wall: CLT 5 layers (s: 100 mm) (2,4 m x 3 m)
floor: CLT 5 layers (s: 100 mm) (2,4 m x 3,5 m)
lower wall: CLT 5 layers (s: 100 mm) (2,4 m x 3 m)

FASTENING SYSTEM
6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm
fastening pattern on CLT: 31 screws 5 x 50 mm

RESILIENT PROFILE
PIANO A
position: between the upper wall and the floor
dimensions: width = 100 mm thickness = 6 mm length = 2,40 m
contact area: continuous strip (same width as the wall)
applied load [N/m²]: 22000





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	13,5	19,0	13,3	13,4	15,4	17,5	17,8	14,9	19,3	18,5	24,8	26,2	22,6	20,8	21,0	21,6

$\overline{K_{14}}$ = **18,7 dB** $\overline{K_{14,0}}$ = **14,4 dB** $\Delta_{l,14}$ = **4,4 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	15,1	18,5	13,2	10,1	14,2	12,0	13,0	10,0	13,9	10,9	15,0	15,4	16,6	17,8	18,0	20,0

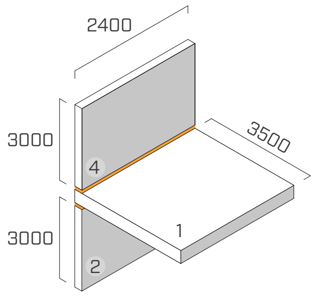
$\overline{K_{12}}$ = **13,9 dB** $\overline{K_{12,0}}$ = **14,6 dB** $\Delta_{l,12}$ = **-0,7 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	15,1	25,5	23,3	22,1	17,9	20,9	17,3	16,9	21,3	25,1	30,0	32,6	30,7	31,8	31,4	31,0

$\overline{K_{24}}$ = **24,3 dB** $\overline{K_{24,0}}$ = **20,4 dB** $\Delta_{l,24}$ = **3,9 dB**

T-JOINT | PERIMETER WALLS

EN ISO 10848-1/4



STRUCTURE

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

FASTENING SYSTEM

6 **HBS** partially threaded screws Ø8 x 240 mm (HBS8240), spacing 440 mm
2 angle brackets **NINO** (NINO15080) with resilient profile **XYLOFON PLATE** (XYL3555150) , 146 x 55 x 77 x 2,5 mm, spacing 1760 mm
fastening pattern on CLT: 31 screws 5 x 50

RESILIENT PROFILE

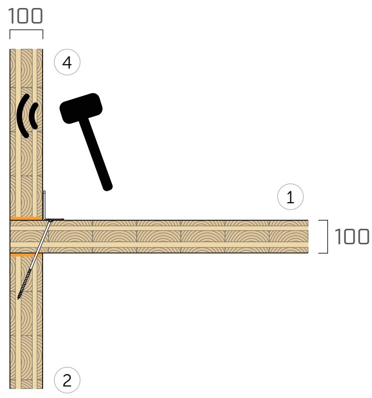
PIANO C

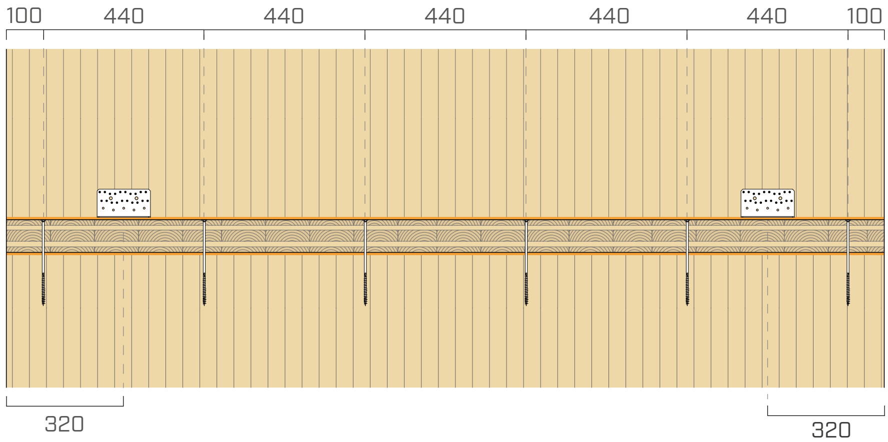
position: between the upper wall and the floor + between the floor and the lower wall

dimensions: width = 100 mm thickness = 6 mm length = 2,40 m

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

applied load [kN/m²]: 1300





f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{14} [dB]	15,5	16,0	16,1	17,7	16,9	19,1	18,0	16,6	17,6	18,8	17,1	19,1	19,8	16,1	17,8	21,1

$\overline{K_{14}}$ = **17,6 dB** $\overline{K_{14,0}}$ = **13,3 dB** $\Delta_{l,14}$ = **4,3 dB**

f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	16,4	17,2	12,6	18,4	16,5	16,3	19,2	14,9	17,1	17,5	16,1	19,8	23,6	19,3	21,1	26,5

$\overline{K_{12}}$ = **17,6 dB** $\overline{K_{12,0}}$ = **14,5 dB** $\Delta_{l,12}$ = **3,1 dB**

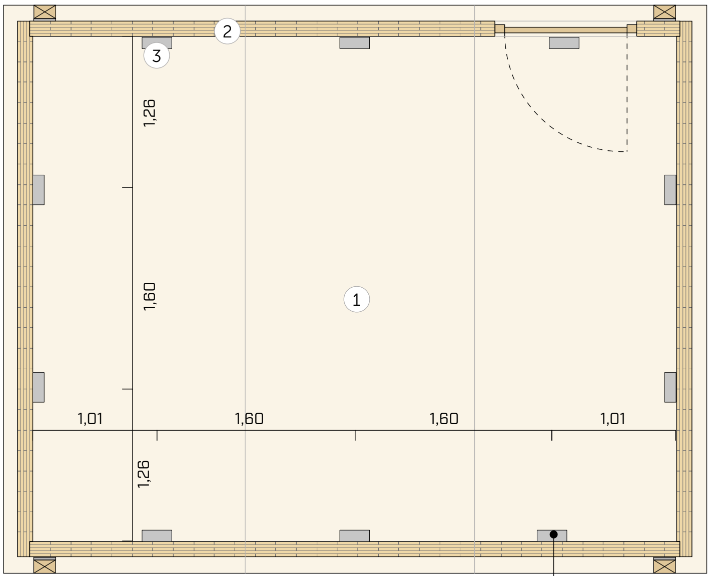
f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{24} [dB]	15,4	26,0	18,0	20,1	21,5	23,4	21,3	16,4	19,3	23,5	23,5	31,1	30,3	30,4	31,7	29,7

$\overline{K_{24}}$ = **23,4 dB** $\overline{K_{24,0}}$ = **17,3 dB** $\Delta_{l,24}$ = **6,1 dB**

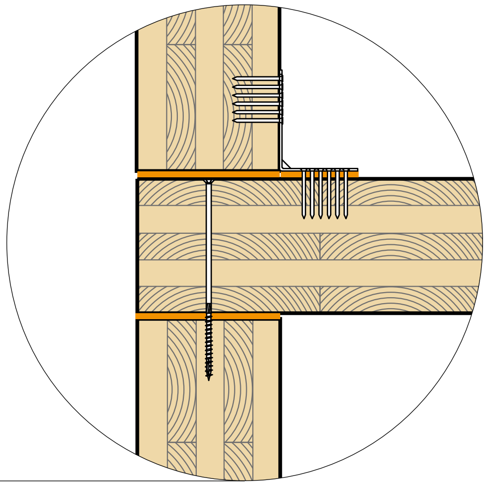
SOLUTIONS FOR LIGHTWEIGHT FLOORS

PIANO A is a resilient profile that works with reduced loads, which can be used to reduce vibrations even in floors with little construction mass.
Its effectiveness has also been tested at the University of Innsbruck as a desolidarising profile for ribs in dry floors.

SET UP

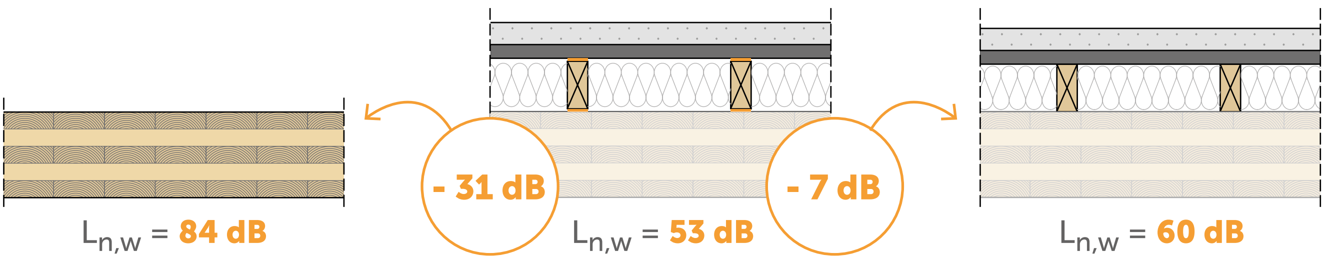


The receiving and transmitting rooms have a floor area of 21.5 m^2 (5.24 m lenght; 4.10 m width).
The volume of the transmitting room is 53.0 m^3, and the volume of the receiving room 85.0 m^3.



addition of the dry system
with PIANO

addition of dry system
without PIANO



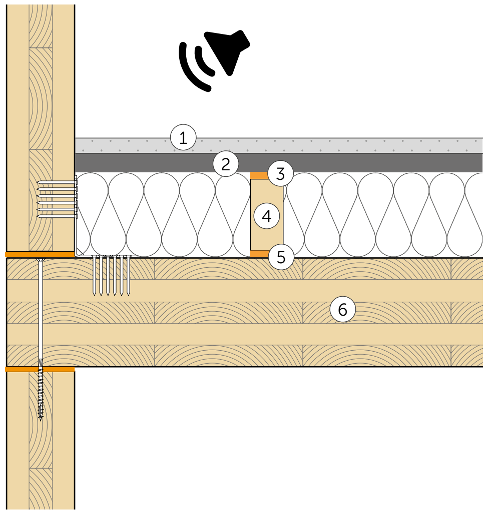
$L_{n,w}$ = **84 dB**
IIC = ***26***

$L_{n,w}$ = **53 dB**
IIC = ***57***

$L_{n,w}$ = **60 dB**
IIC = ***50***

LABORATORY MEASUREMENT | DRY FLOOR SLAB_1

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 16283-1

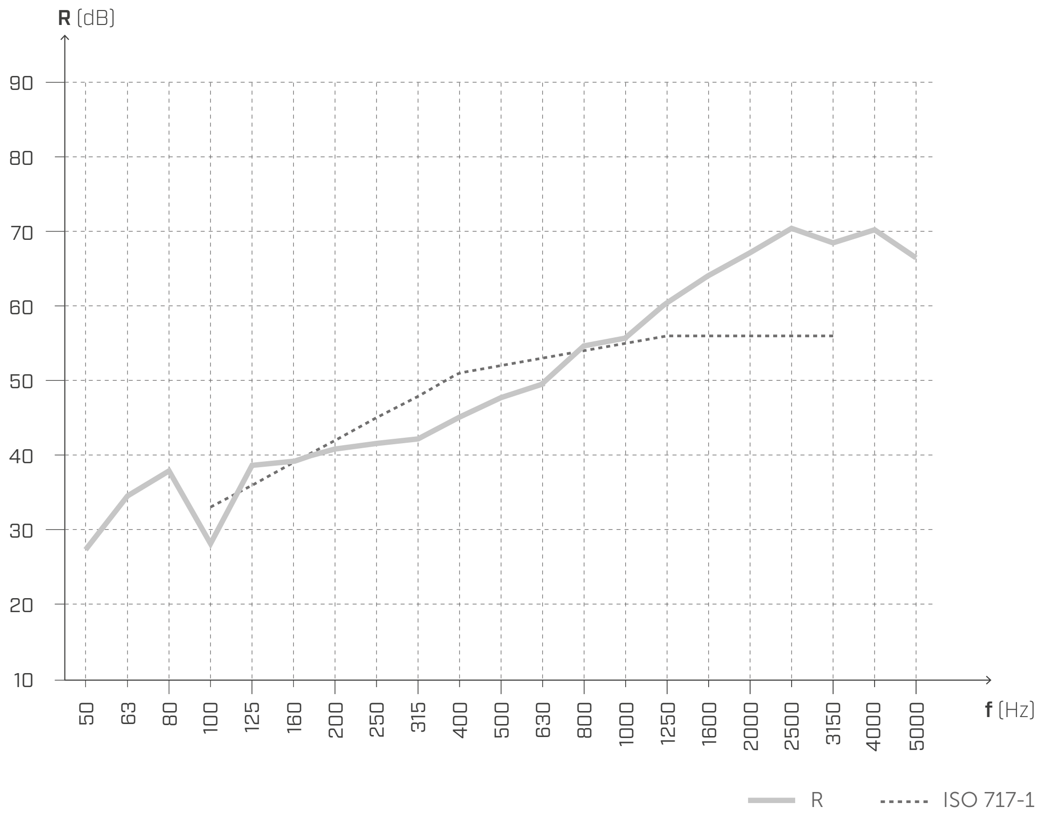


FLOOR SLAB

Surface = 21,5 m^2
Mass = 167 kg/m^2
Receiving room volume = 75,52 m^3

(1) reinforced gypsum-fibre board (44 kg/m^2) (thickness: 32 mm)
(2) high density cardboard and sand panels (34,6 kg/m^2) (thickness: 30 mm)
(3) PIANO A
(4) wood batten 50 x 100 mm
(5) PIANO A
(6) CLT (thickness: 160 mm)

AIRBORNE SOUND INSULATION



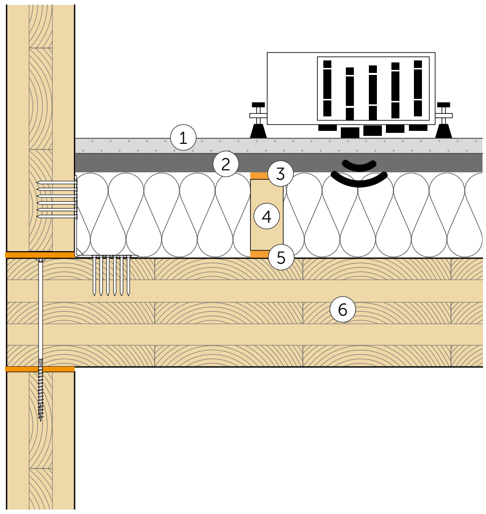
f [Hz]	R [dB]
50	27,2
63	34,7
80	37,9
100	27,9
125	38,7
160	39,3
200	40,8
250	41,6
315	42,2
400	45,1
500	47,7
630	49,5
800	54,6
1000	55,7
1250	60,4
1600	64,0
2000	67,1
2500	70,4
3150	68,4
4000	70,2
5000	66,5

R_w ($C;C_{tr}$) = **52 (0; -7) dB**

Testing laboratory: Universität Innsbruck Arbeitsbereich für Holzbau Technikerstraße 13A - 602 Innsbruck.
Test protocol: M02_L_220906_Balkenaufbau-Entkoppelung_oben_unten.

LABORATORY MEASUREMENT | DRY FLOOR SLAB_2

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD ISO 10140-3

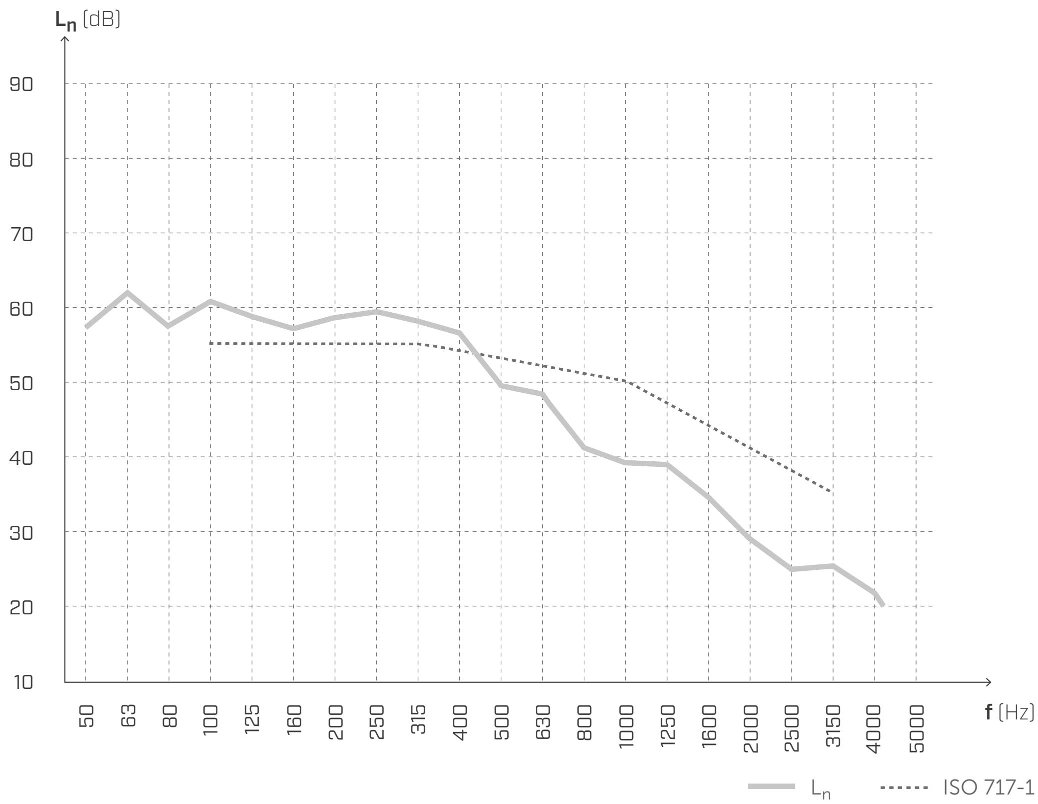


FLOOR SLAB

Surface = 21,5 m^2
Mass = 167 kg/m^2
Receiving room volume = 75,52 m^3

1. reinforced gypsum-fibre board (44 kg/m^2) (thickness: 32 mm)
2. high density cardboard and sand panels (34,6 kg/m^2) (thickness: 30 mm)
3. **PIANO A**
4. wood batten 50 x 100 mm
5. **PIANO A**
6. CLT (thickness: 160 mm)

IMPACT SOUND INSULATION



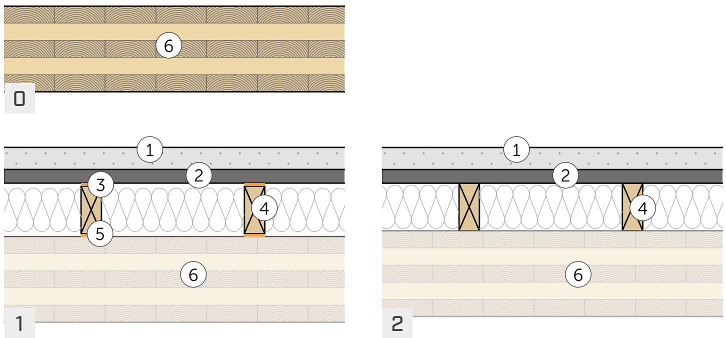
f [Hz]	L_n [dB]
50	57,1
63	62,1
80	57,3
100	60,8
125	58,8
160	57,2
200	58,6
250	59,4
315	58,2
400	56,6
500	49,6
630	48,4
800	41,2
1000	39,2
1250	39,0
1600	34,6
2000	29,0
2500	24,9
3150	25,4
4000	21,9
5000	13,0

$L'_{n,w,PIANO}$ (C_I) = **53 (-1) dB**   IIC = **57**

Testing laboratory: Universität Innsbruck Arbeitsbereich für Holzbau Technikerstraße 13A - 602 Innsbruck.
Test protocol: M02_L_220906_Balkenaufbau-Entkoppelung_oben_unten.

COMPARATIVE ANALYSIS | DRY FLOOR SLAB_2

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD ISO 10140-3



FLOOR SLAB

Surface = 21,5 m^2
Mass = 167 kg/m^2
Receiving room volume = 75,52 m^3

① reinforced gypsum-fibre board (44 kg/m^2) (thickness: 32 mm)
② high density cardboard and sand panels (34,6 kg/m^2) (thickness: 30 mm)
③ PIANO A
④ wood batten 50 x 100 mm
⑤ PIANO A
⑥ CLT (thickness: 160 mm)

IMPACT SOUND INSULATION

f [Hz]	$L_n^{(0)}$ [dB]	$L_n^{(1)}$ [dB]	$L_n^{(2)}$ [dB]
50	66,1	57,1	62,3
63	72,1	62,1	62,7
80	74,1	57,3	56,2
100	76,7	60,8	68,2
125	76,8	58,8	66,7
160	78,2	57,2	66,1
200	78,9	58,6	65,4
250	81,9	59,4	63,5
315	84,5	58,2	62,6
400	84,9	56,6	59,7
500	86,2	49,6	61,8
630	86,1	48,4	60,5
800	86,9	41,2	58,0
1000	86,6	39,2	54,2
1250	84,1	39,0	52,5
1600	81,2	34,6	47,8
2000	75,1	29,0	45,4
2500	67,1	24,9	39,4
3150	63,5	25,4	36,9
4000	61,7	21,9	34,8
5000	59,6	13,0	27,3

CLT (thickness: 160 mm)

$L'_{n,w,0}$ $(C_I)^{(0)}$ = **84 (-4) dB**
IIC_0 = **26**

$L'_{n,w,PIANO}$ $(C_I)^{(1)}$ = **53 (-1) dB**
IIC = **57**

Dry floor without PIANO

$L'_{n,w}$ $(C_I)^{(2)}$ = **60 (-1) dB**
IIC = **50**

Testing laboratory: Universität Innsbruck Arbeitsbereich für Holzbau Technikerstraße 13A - 602 Innsbruck.
Test protocol: M02_L_220906_Balkenaufbau-Entkoppelung_oben_unten.

ALADIN

TECHNICAL MANUAL

rothoblaas

Solutions for Building Technology

CONTENTS

FLANKSOUND
EN ISO 10848

ALADIN

RESILIENT SOUNDPROOFING PROFILE

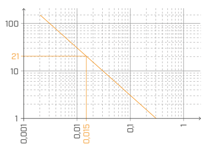
CODES AND DIMENSIONS

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

page 7

FLANKSOUND PROJECT

K_{ij} measured according to ISO EN 10848

page 16

On site measurements

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

page 21

Static to acoustic interaction

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

page 24

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				

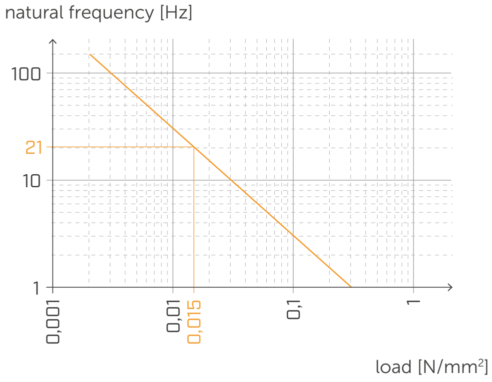
To properly evaluate the product using MyProject, simply follow the step-by-step instructions provided by the software.

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/mm^2 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.

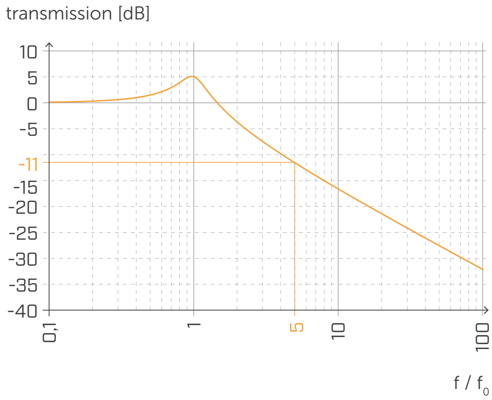


At this point, the degree of transmission for the product under these load conditions can be calculated, referring to the design frequency of 100 Hz.

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

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.

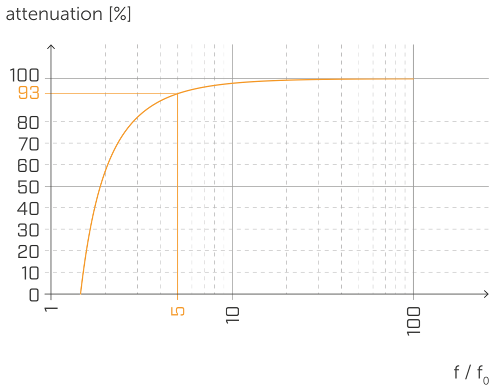
TRANSMISSION IS POSITIVE WHEN THE MATERIAL TRANSMITS AND IS NEGATIVE WHEN THE PROFILE BEGINS TO INSULATE. This means this figure shows that the product, loaded in this way, insulates 11 dB at a reference frequency of 100 Hz.



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

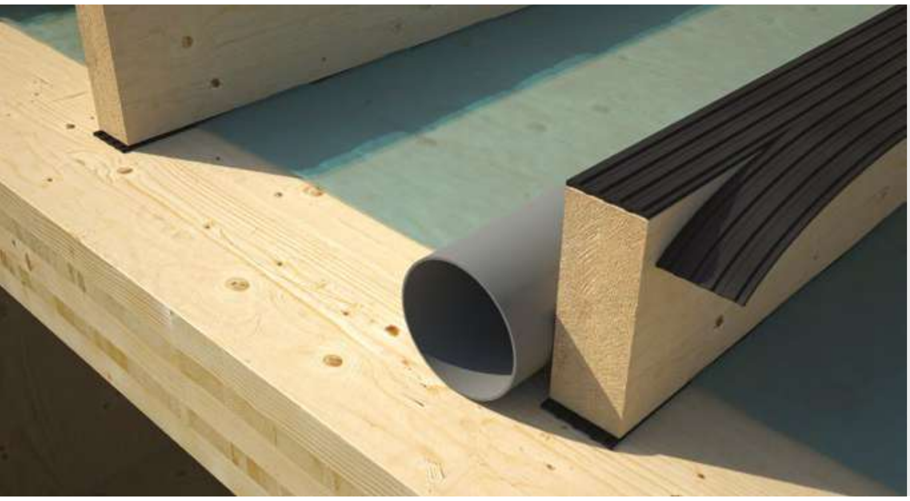
CODE	B [mm]	load for acoustic optimisation[1] [kN/m] from	load for acoustic optimisation[1] [kN/m] to	compression for acoustic optimisation[1] [N/mm^2] from	compression for acoustic optimisation[1] [N/mm^2] to	deformation [mm] from	deformation [mm] to
ALADIN115	115	4	18	0,035	0,157	0,7	2
	57,5 (divided)	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	$\leq$ 25%
Compression set 50% (22h, 40°C)	EN ISO 815	$\leq$ 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).



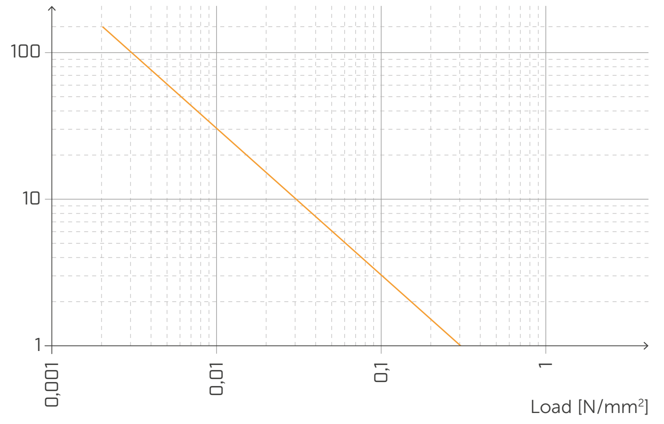
HIGH PERFORMANCE

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)

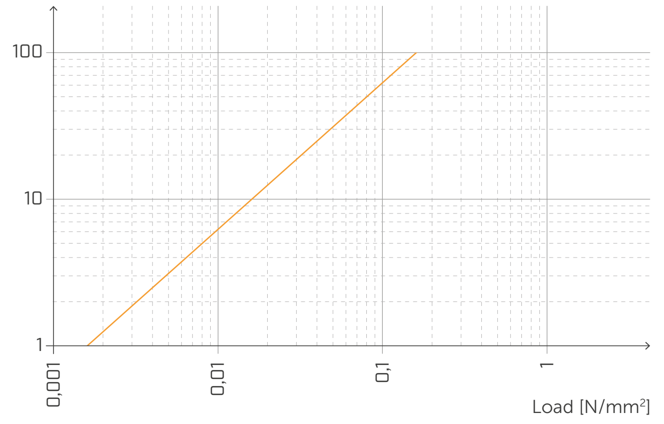
NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



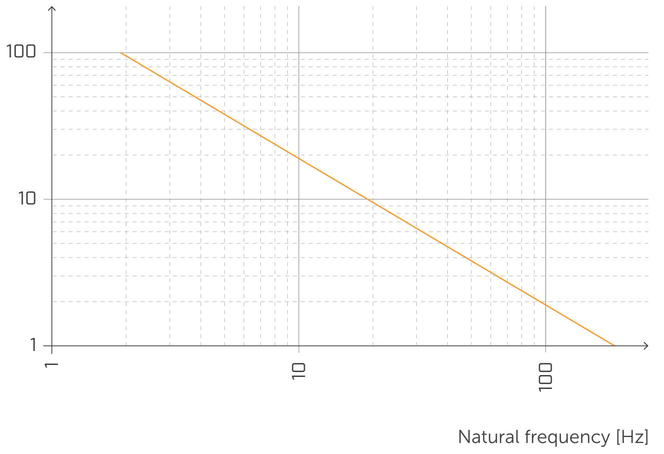
DEFORMATION AND LOAD

Deformation [%]



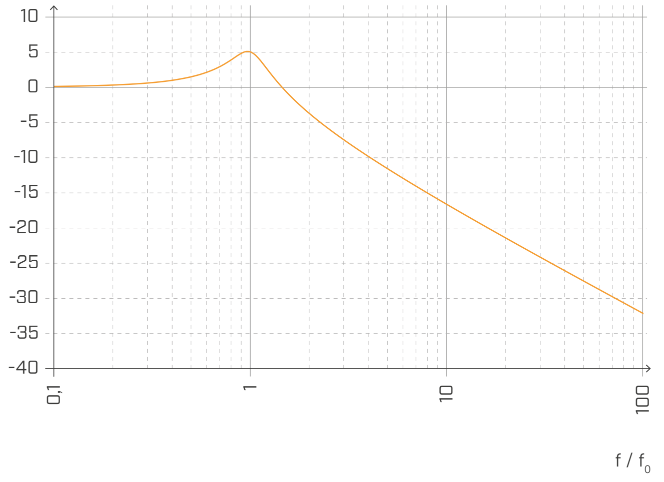
DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



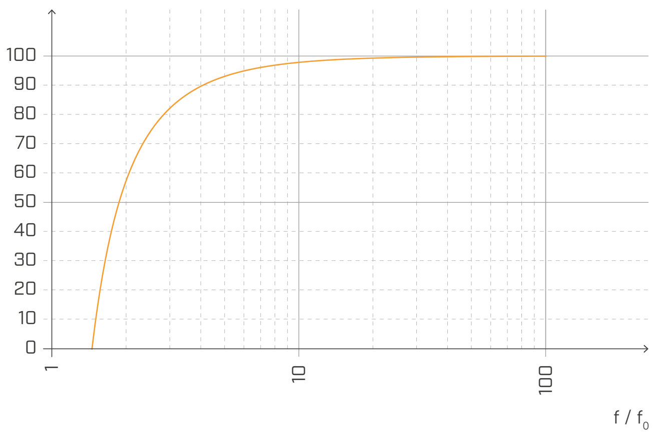
TRANSMISSIBILITY

Transmission [dB]



ATTENUATION

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/m³
Dynamic stiffness s' (non-airtight condition)[2]	UNI 29052	115 MN/m³
Density	ASTM D 297	1,1 g/cm³
Compression set 50% (22h, 70°C)	EN ISO 815	50%
Tensile strength	EN ISO 37	≥ 9 N/mm²
Elongation at failure	EN ISO 37	≥ 500%
Water absorption 48h	-	< 1 %
Reaction to fire	EN 13501-1	class E
Max processing temperature	-	100°C

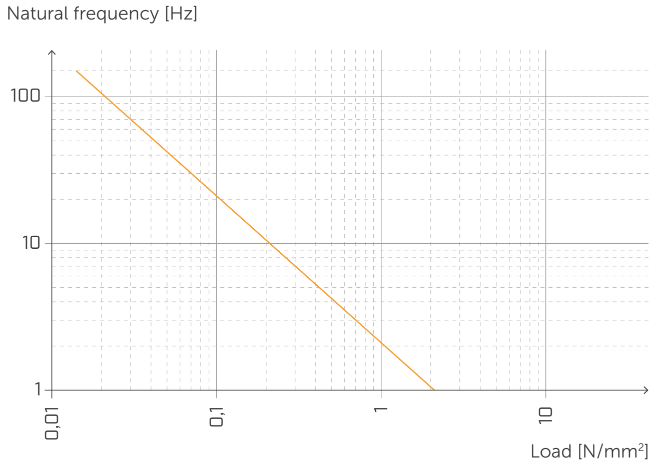
[2] ISO standards require for measurement with loads between 0,4 and 4 kPa and not with the product operating load. The contribution of air is not calculated because the product is extremely impermeable to air (extremely high flow resistance figures).

RELIABLE

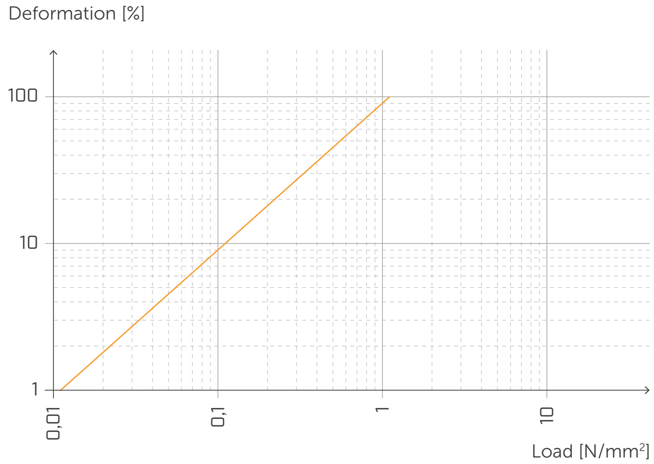
Extruded EPDM compound to optimise sound absorption. It also offers high chemical stability and is VOC-frees.

STATIC LOAD
(buildings)

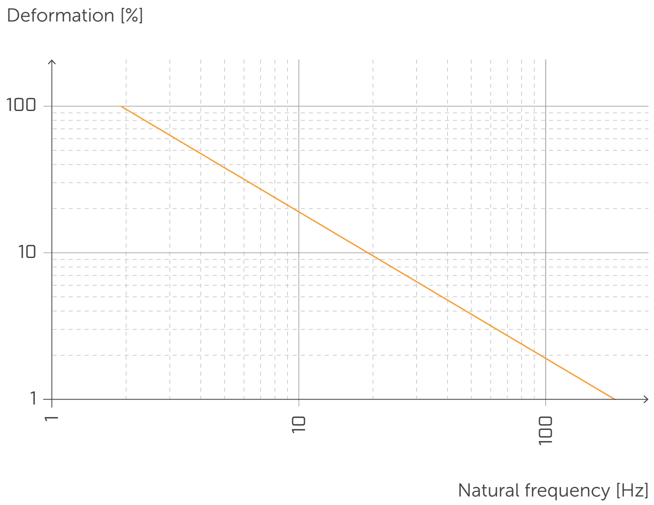
NATURAL FREQUENCY AND LOAD



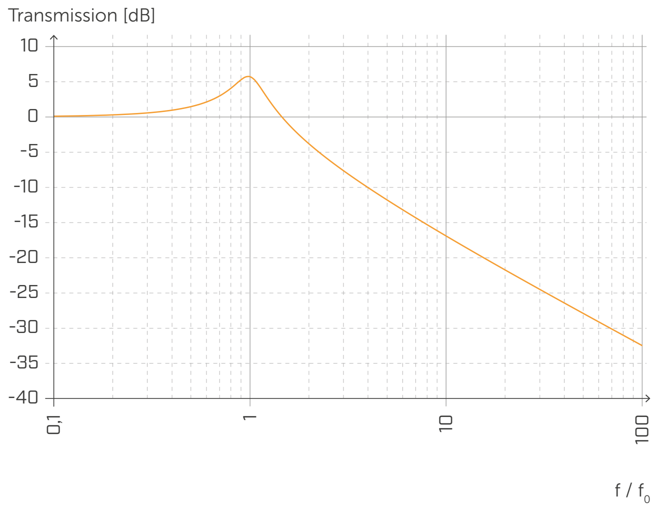
DEFORMATION AND LOAD



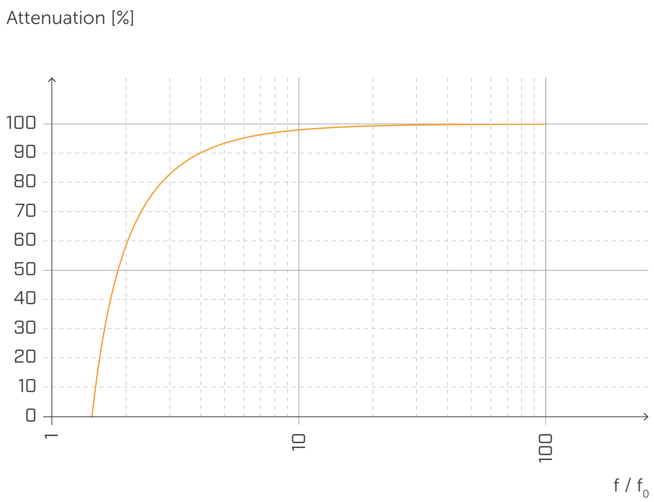
DEFORMATION AND NATURAL FREQUENCY



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:

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

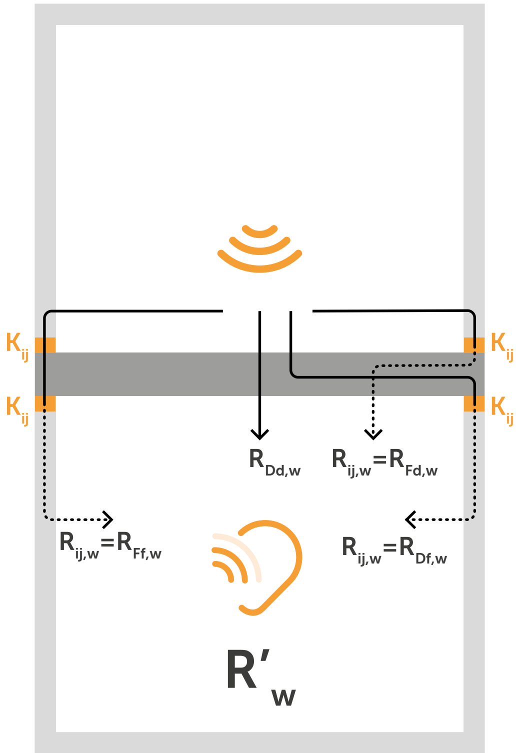
where:

$R_{i,w}$ 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.

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

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

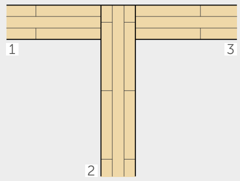
determined by the connecting elements.
In the case of CLT structures weakly bound together, the side transmission contribution can be determined according to the following relations, valid if $0,5 < (m_1/m_2) < 2$.

METHOD 1 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

$K_{13} = 5,7 + 14,1\ M + 5,7\ M^2$ dB

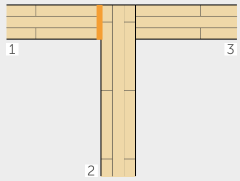
$K_{12} = 5,7 + 5,7\ M^2 = K_{23}$ dB



Solution 2 - T-SHAPED JOINT with resilient layer

$K_{23} = 5,7 + 14,1\ M + 5,7\ M^2$ dB

$K_{12} = 5,7 + 5,7\ M^2 = K_{23}$ dB



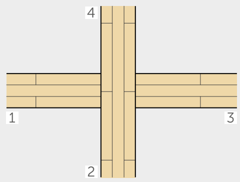
Solution 3 - X-SHAPED JOINT

$K_{13} = 8,7 + 17,1\ M + 5,7\ M^2$ dB

$K_{12} = 8,7 + 5,7\ M^2 = K_{23}$ dB

$K_{24} = 3,7 + 14,1\ M + 5,7\ M^2$ dB

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



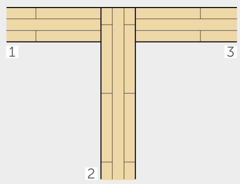
METHOD 2 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

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

f_k=500 Hz

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



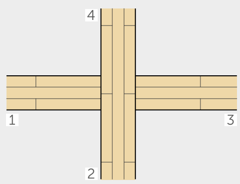
Solution 1 - X-SHAPED JOINT

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

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

f_k=500 Hz

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



THE SIMPLIFIED METHOD

A CALCULATION EXAMPLE USING EN ISO 12354

INPUT DATA

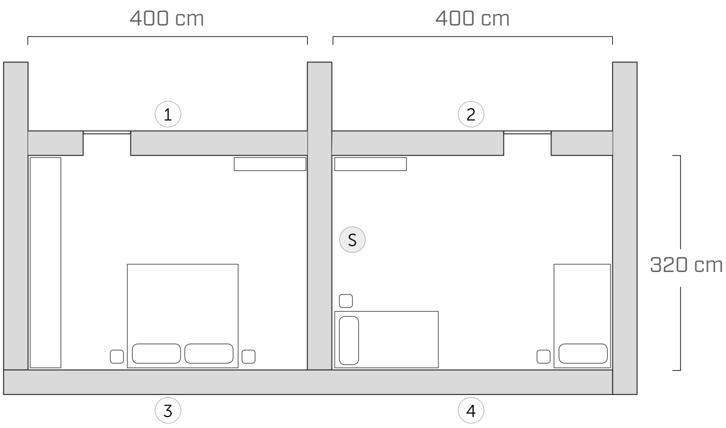
The EN ISO 12354 norms provide two methods to calculate the acoustic performance of a partition: a detailed method and the simplified method.

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.

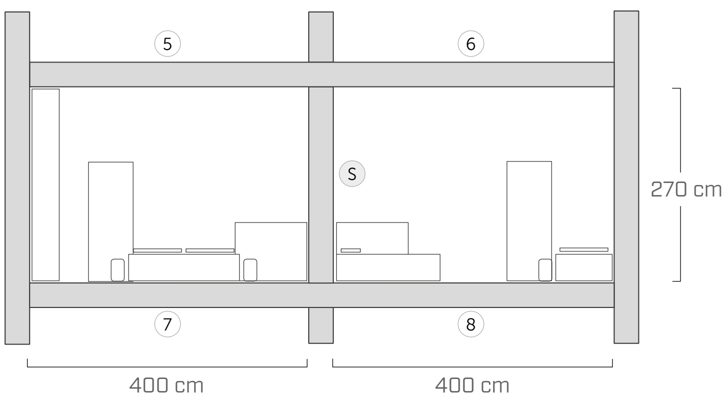
In order to determine the acoustic performance of assembly from the acoustic performance of its components, it is important to determine for every junction element:

- 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

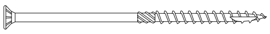



K_{ij} for different types of joint

- 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

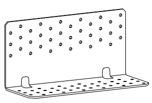
FASTENING

HBS
countersunk screw

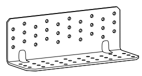


VGZ
fully threaded screw
with cylindrical head

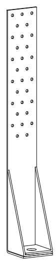
TITAN N
angle bracket for shear loads in solid walls



TITAN F
angle bracket for shear loads on frame walls

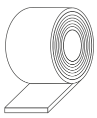


WHT
angle bracket for tensile loads

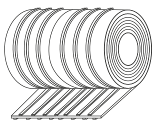


SOUNDPROOFING

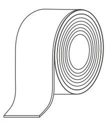
XYLOFON
high performance
resilient profile



ALADIN
resilient profile

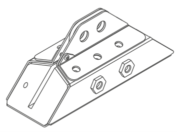


CONSTRUCTION SEALING
airtight profile

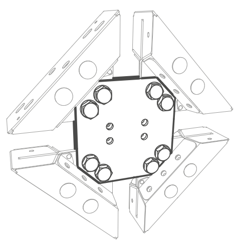


X-RAD

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

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

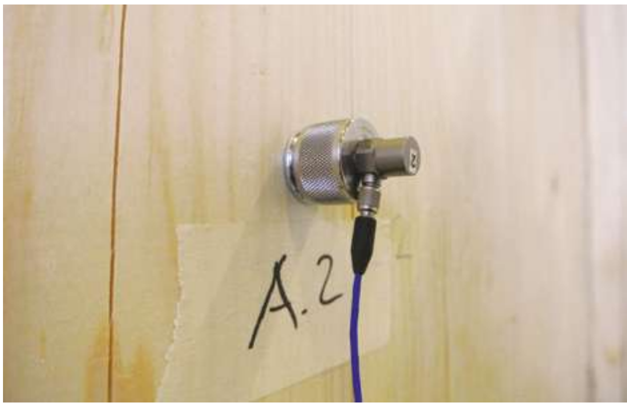
S is the panel surface

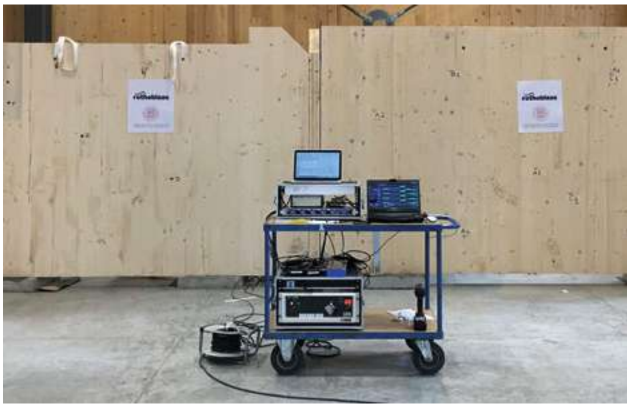
f is the frequency

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.

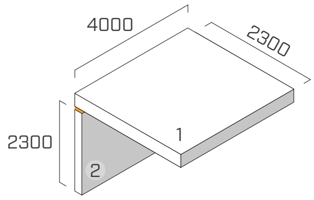
L. Barbaresi, F. Morandi, J. Belcari, A. Zucchelli, Alice Speranza, "**Optimising the mechanical characterisation of a resilient interlayer for the use in timber construction**" in Proceedings of the International congress on sound and vibration 2017, London, July 2017.

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

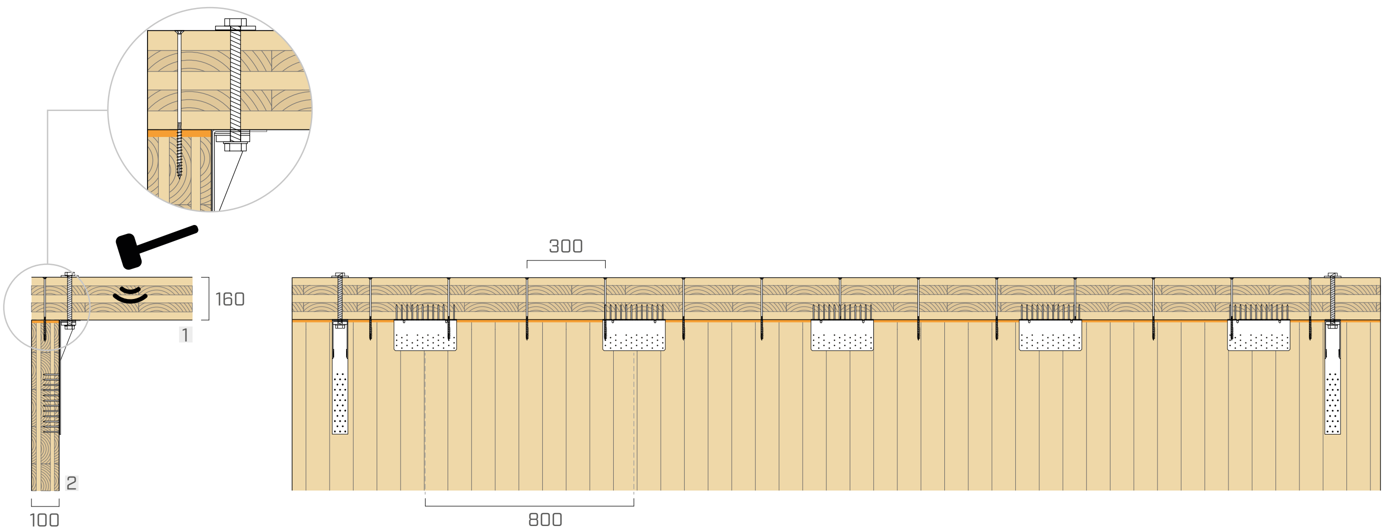
ALADIN SOFT

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

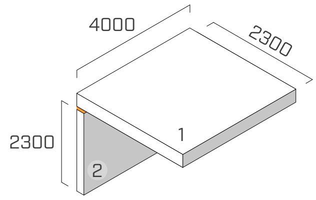


f [Hz]	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**
K_{12} [dB]	8,7	14,4	8,7	10,0	10,7	9,5	6,1	9,8	9,4	14,1	16,1	18,1	18,1	17,8	21,3	19,1

$\overline{K_{12}}$ = **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
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fastening pattern: total nailing 72 screws 5 x 50
2 hold down **WHT** (WHT440)

RESILIENT PROFILE

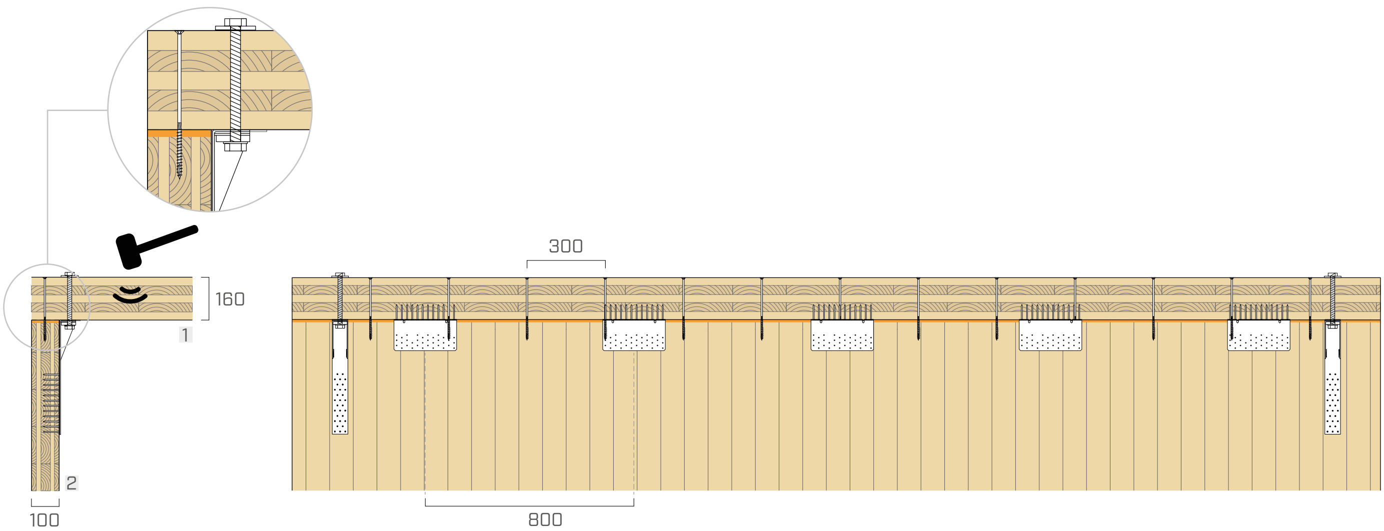
ALADIN SOFT

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

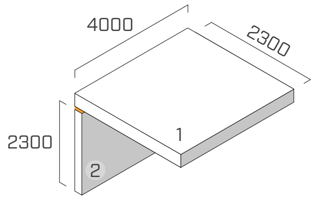


f [Hz]	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150
K_{12} [dB]	9,5	13,6	8,7	11,8	9,0	10,1	7,2	8,7	10,4	14,2	17,0	16,5	18,4	20,0	23,1	19,7

$\overline{K_{12}}$ = **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

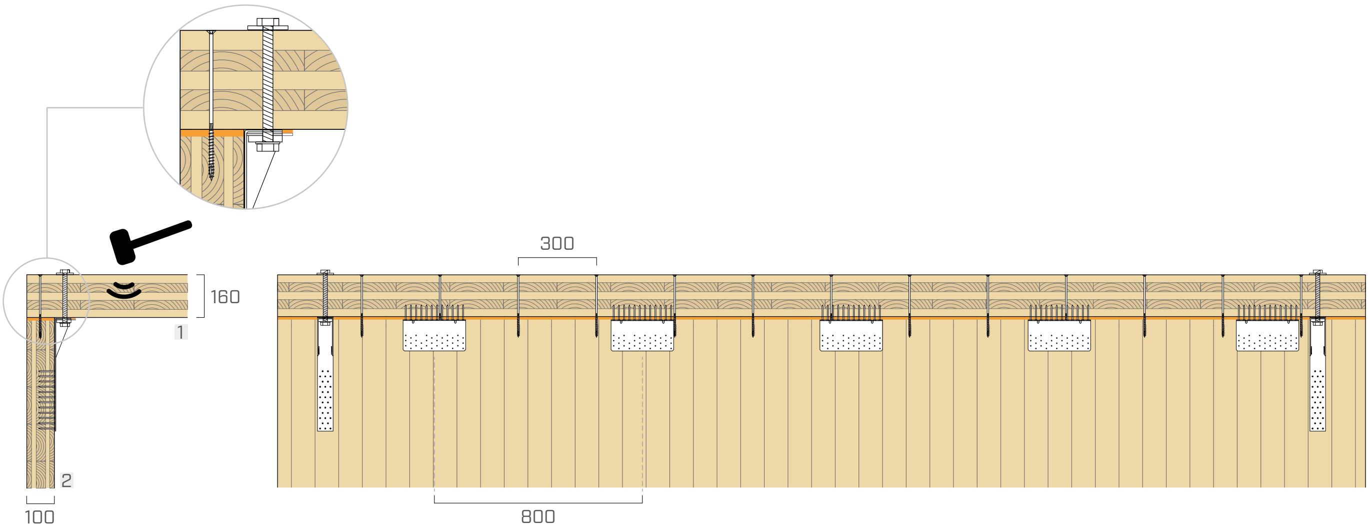
ALADIN SOFT

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

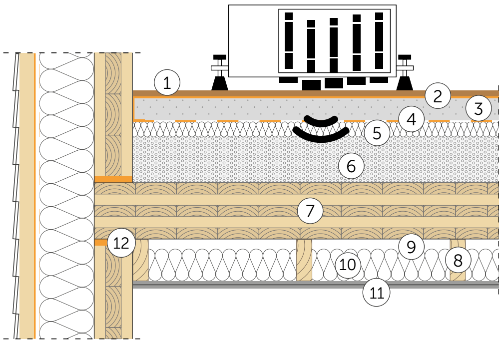
MULTI-STOREY BUILDING

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

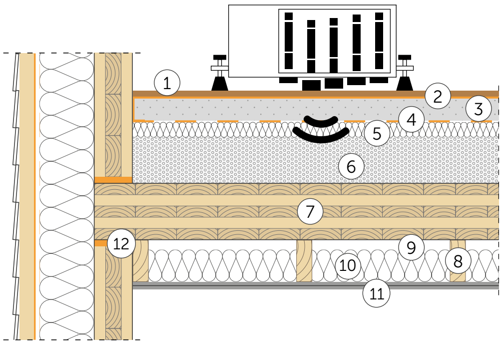
with ALADIN EXTRA SOFT

$L'_{nT,w,ALADIN}$ (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

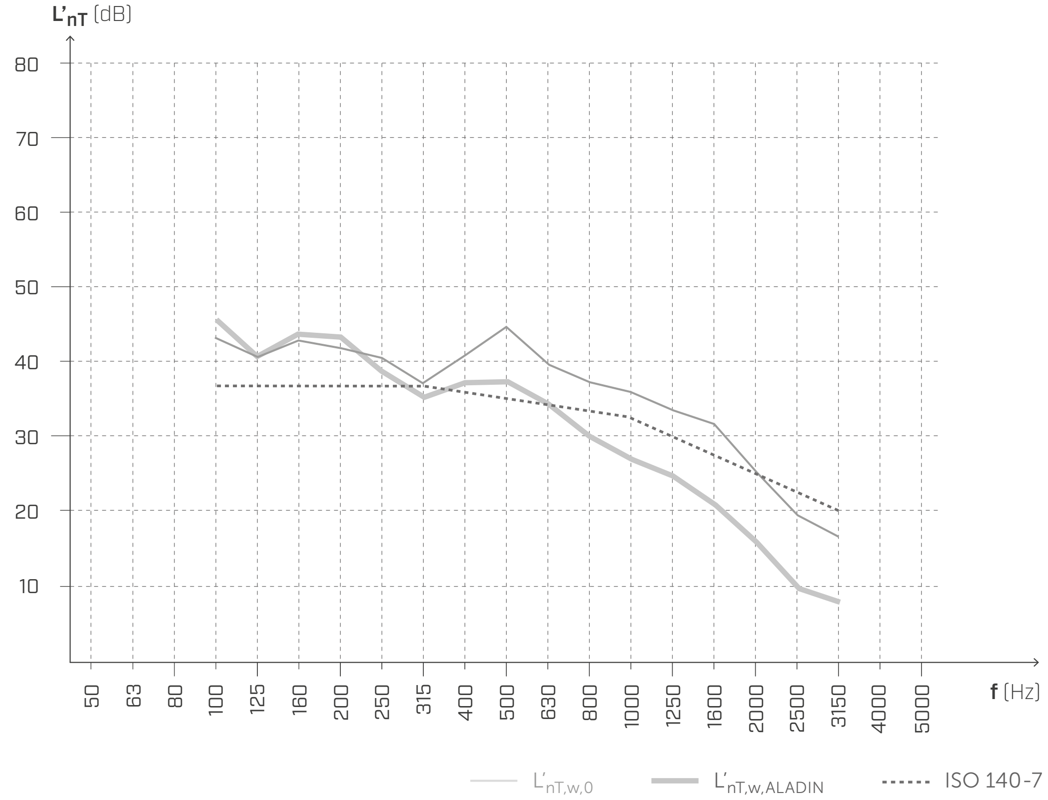


FLOOR SLAB

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′ ≤ 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

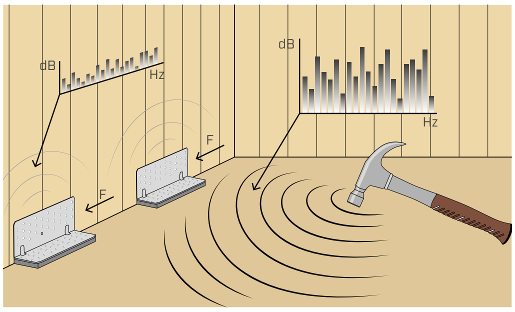
$L'_{nT,w,ALADIN}$ (C_I) = **35 (0) dB**

$NISR_{ASTM}$ = 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.



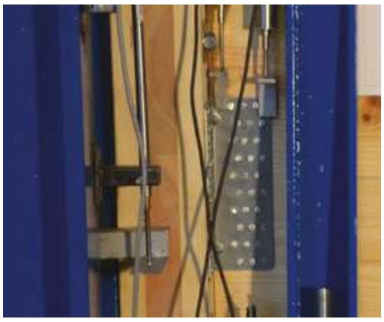
EXPERIMENTAL INVESTIGATION: MECHANICAL BEHAVIOUR

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

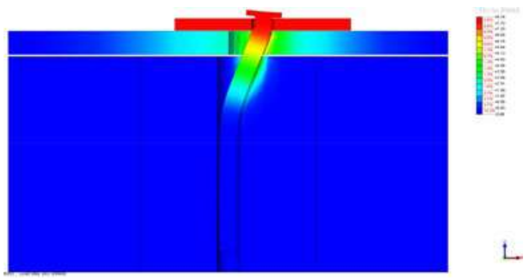
Monotonic shear tests were carried out, in the first experimental phase, using linear loading procedures in displacement control, aimed at evaluating the variation in ultimate strength and stiffness offered by the TTF200 connection with LBA Ø4 x 60 mm nails.

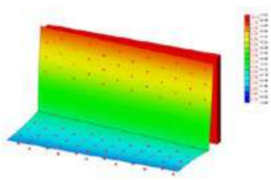
Test samples:
CLT panels
TITAN TTF200 angle bracket



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

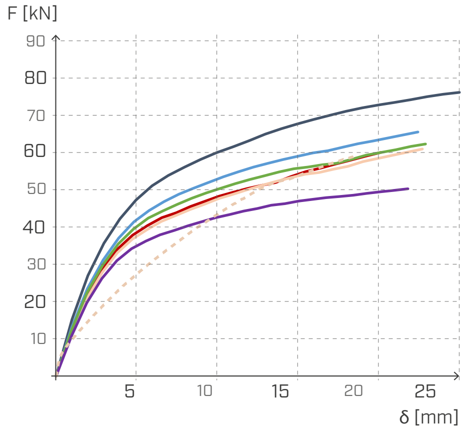
VARIATION OF MECHANICAL SHEAR STRENGTH AS A FUNCTION OF SOUNDPROOFING PROFILE

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 %

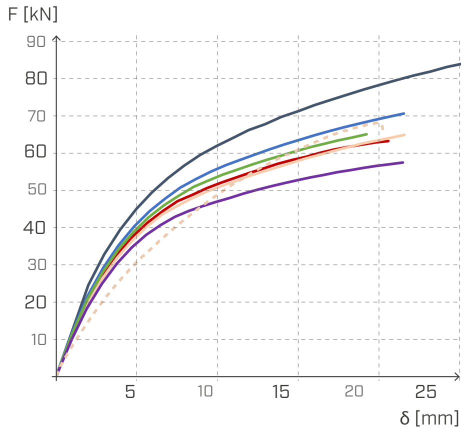
* Reduced thickness: reduced profile height due to the trapezoidal section and consequent crushing induced by the head of the nail during operation.



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.

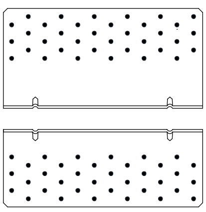
TITAN

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

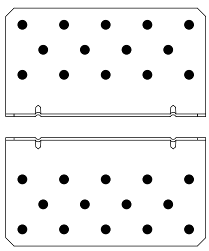
TTN240



36 LBA nails/LBS screws

36 LBA nails/LBS screws

TTS240

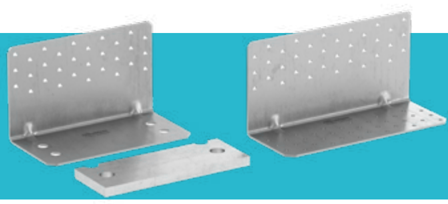


14 LBA nails/LBS screws

14 LBA nails/LBS screws

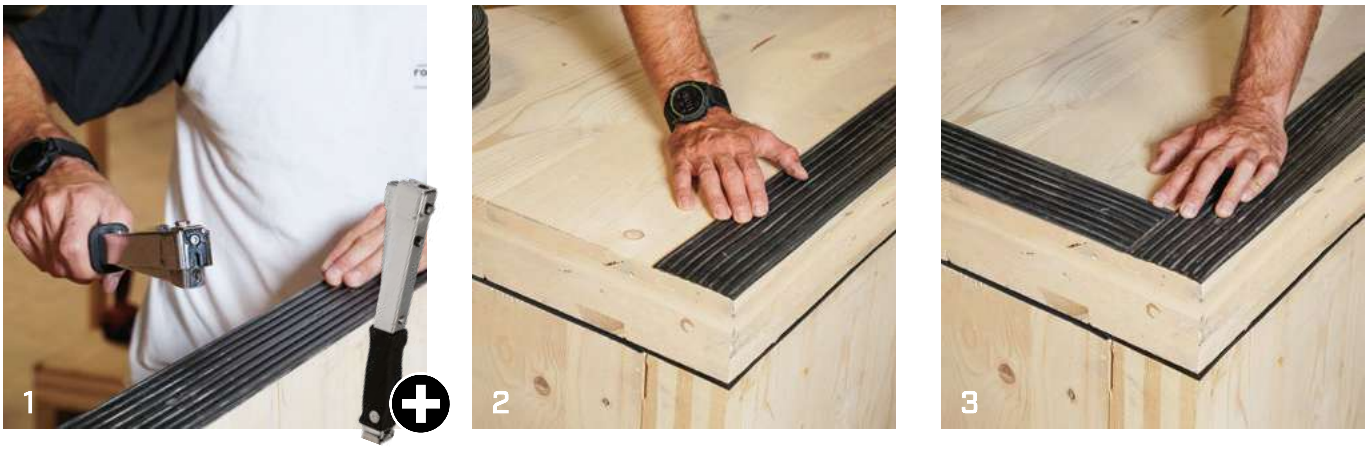
Discover the complete **TITAN** range on our website or request the catalogue from your salesman.

www.rothoblaas.com



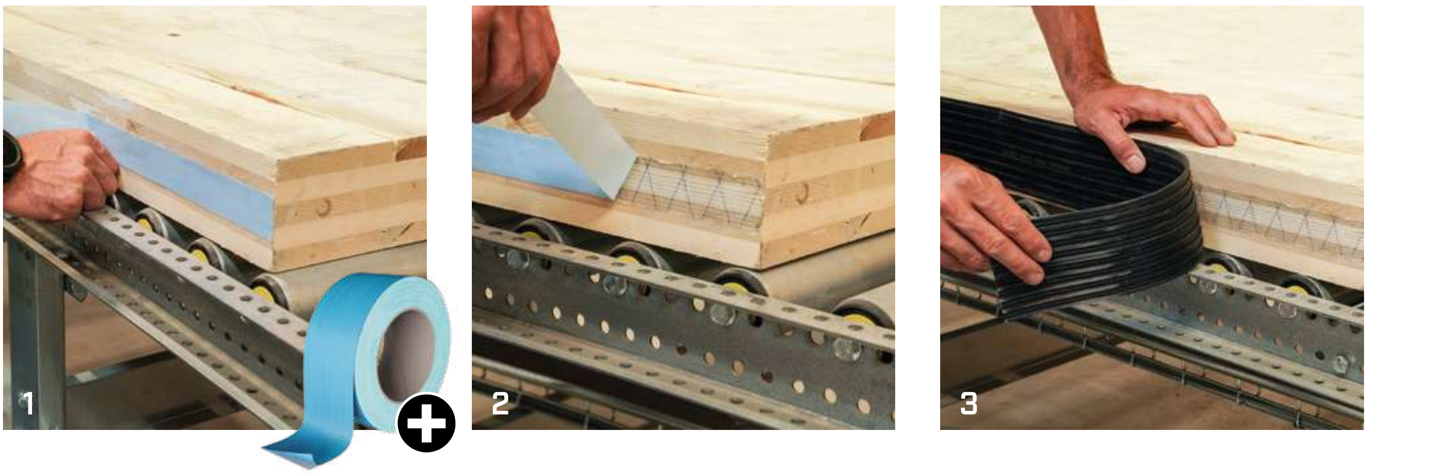
ALADIN | RECOMMENDATIONS FOR INSTALLATION

APPLICATION WITH STAPLES



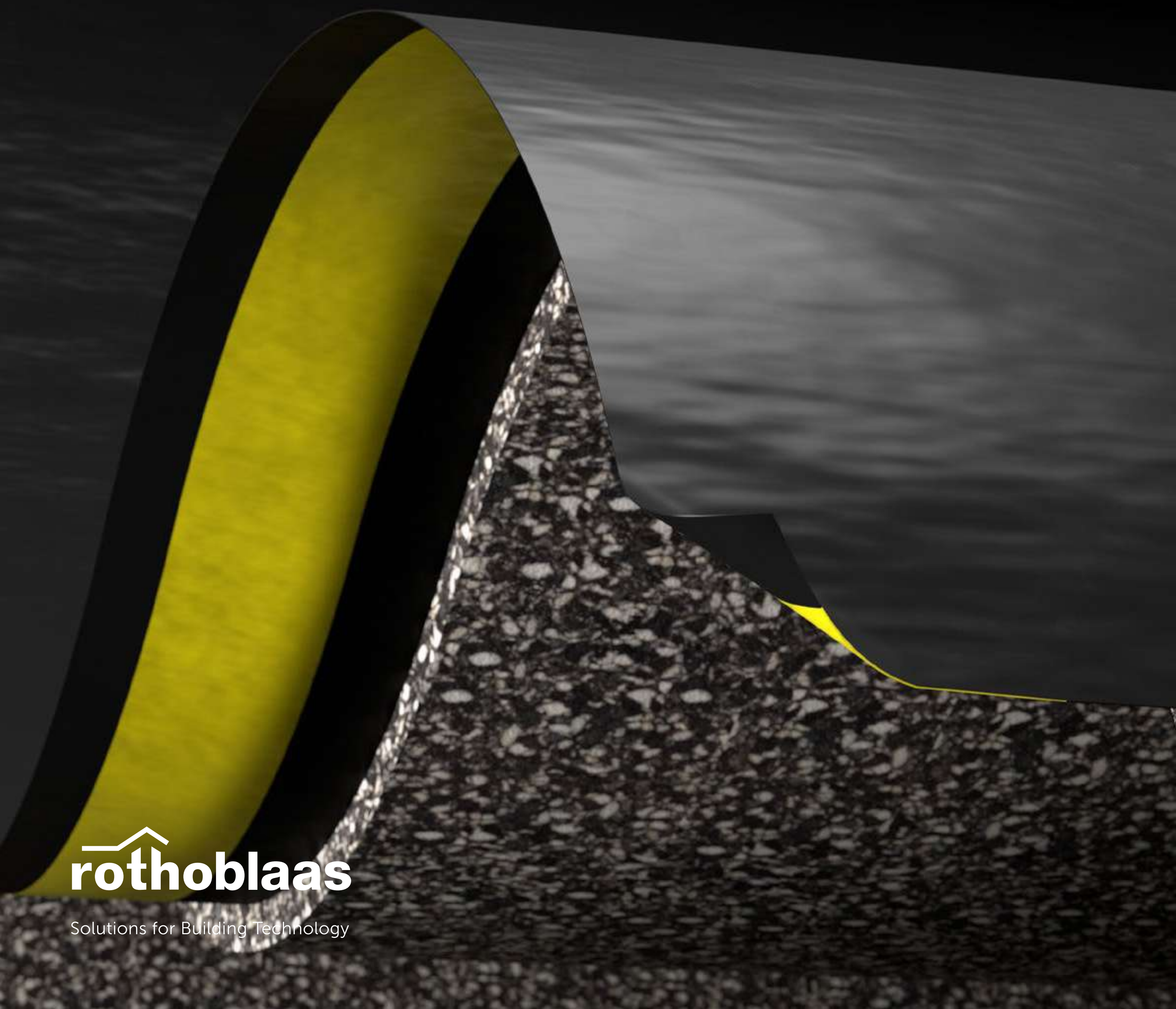
APPLICATION WITH PRIMER SPRAY

APPLICATION WITH DOUBLE BAND



SILENT FLOOR PUR

TECHNICAL MANUAL

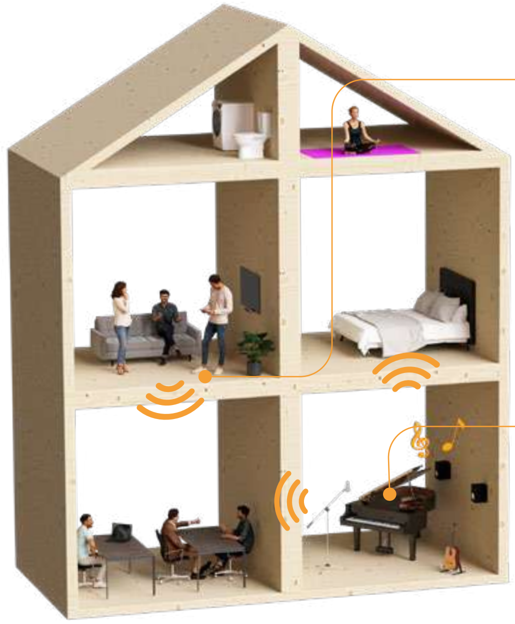


rothoblaas

Solutions for Building Technology

CONTENTS

ACOUSTIC PROBLEMS OF FLOORS



WHAT IS IMPACT NOISE?

When it comes to floors, impact noise is the main acoustic problem because it constantly affects them. When a body impacts on the floor structure, the noise quickly spreads throughout the building either by air, affecting the nearest rooms, or by structure, propagating into the most distant rooms.

WHAT IS AIRBORNE NOISE?

Airborne noise is generated in the air and, after an initial airborne phase, is transported both by air and by structure. This is a problem that affects both walls and floors, but if we are talking about floors, the most important problem is certainly impact noise.

HERE IS THE SOLUTION

In order to be able to minimise the discomfort caused by impact noise, a stratigraphic package should be designed consisting of layers of different materials that are disconnected from each other and are able to dissipate the energy transmitted by the impact.

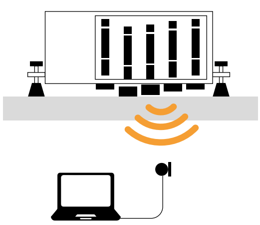
MASS-SPRING-MASS SYSTEM

A floating screed system such as the one shown in the images below can be schematised with a mass-spring-mass system, in which the structural floor represents the mass, the impact-absorbing product is equivalent to the spring, and the upper screed with the floor constitutes the second mass of the system. In this context, “resilient layer” is defined as the element with the spring function characterised by its own *dynamic stiffness s'*.

HOW IS THE IMPACT NOISE LEVEL MEASURED?

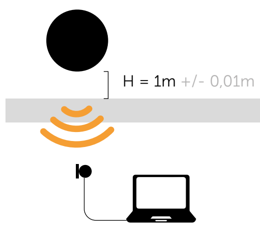
The impact noise level is a measure of the disturbance perceived in a room when an impact noise source is activated in the upper room. It can be measured both on site and in the laboratory. Clearly, ideal conditions exist in the laboratory for the effects of lateral transmission to be neglected, as the laboratory itself is constructed so that the walls are decoupled from the ceiling.

TAPPING MACHINE method



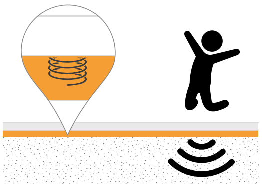
The TAPPING MACHINE is used to simulate "light" and "hard" impacts, such as walking with heeled shoes or the impact caused by falling objects.

RUBBER BALL method



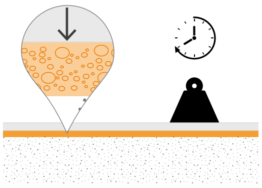
The RUBBER BALL is used to simulate "soft" and "heavy" impacts, such as a barefoot walk or a child jumping.

HOW TO CHOOSE THE BEST PRODUCT



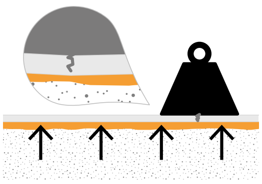
DYNAMIC STIFFNESS – **s'**

Expressed in MN/m³, it is measured according to EN 29052-1 and expresses the deformation capacity of a material that is subjected to a dynamic stress. Consequently, it indicates the ability to dampen the vibrations generated by an impact noise.
The measurement method involves, first, measuring the *apparent dynamic stiffness* s'_t of the material and then correcting it, if necessary, to obtain the *real dynamic stiffness s'*. Dynamic stiffness depends in fact on the *flow resistivity r*, which is measured in the lateral direction of the sample. If the material has specific flow resistivity values, the apparent dynamic stiffness must be corrected by adding the contribution of the gas contained within the material: air.



VISCOUS SLIDING UNDER COMPRESSION – **CREEP**

Expressed as a percentage, it is measured according to EN 1606 and represents the long-term deformation of a material under constant load to be simulated. The measurement in the laboratory must be carried out over a period of at least 90 days.

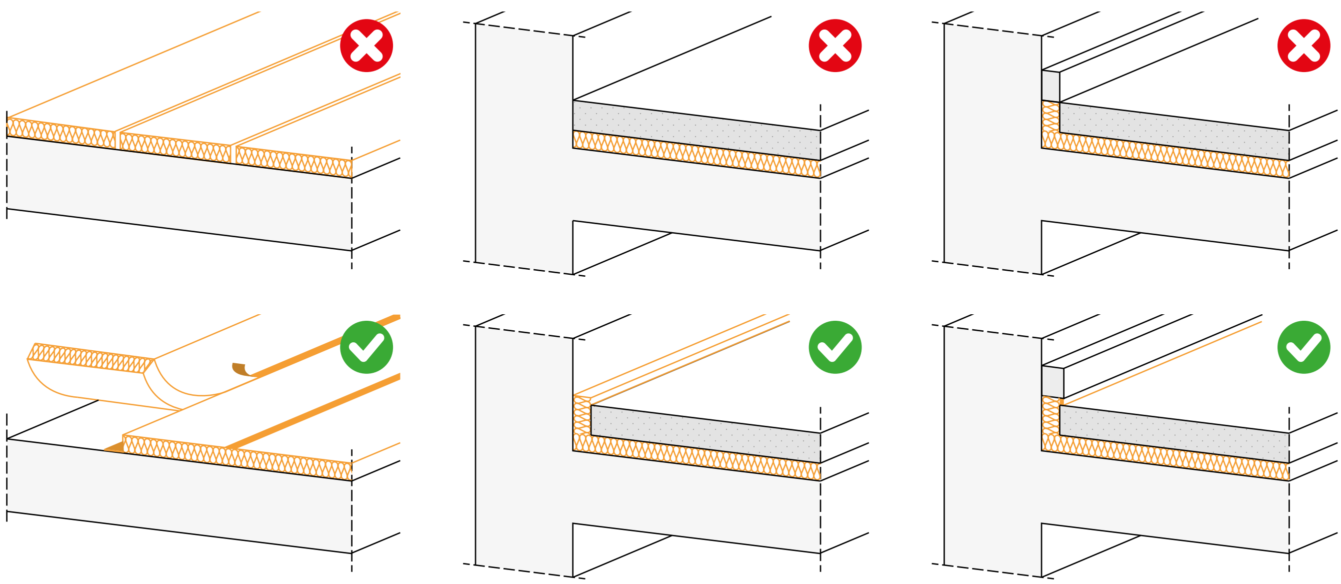


COMPRESSIBILITY - **c**

The compressibility class expresses the behaviour of a material while subjected to screed loading. During measurement, the product is subjected to different loads and its thickness is measured. The compressibility measurement is carried out to understand what loads the underscreed product can withstand, in order to avoid cracking and splitting of screeds.

CORRECT INSTALLATION

The technological solution of the floating screed is one of the most widely used and one of the most effective, but in order to achieve satisfactory results it is important that the system is designed and implemented correctly.



The resilient layer must be continuous because any gap would represent an acoustic bridge. When installing underscreed mats, care must be taken not to create discontinuities.

It is important to use the SILENT EDGE perimeter strip to ensure that the resilient layer is continuous around the entire perimeter of the room. The SILENT EDGE should only be trimmed after the floor has been installed and grouted.

The skirting board must be installed after the SILENT EDGE has been cut, ensuring that it is always suitably raised from the floor.

IIC vs L_W

IIC stands for **Impact Insulation Class** and is the value obtained by subtracting the noise level measured in the receiving room from the noise level measured in the source room. Impact Insulation Class, sometimes referred to as Impact Isolation Class, measures the resistance of the floor construction assembly against the propagation of impact-generated noise.

SILENT FLOOR PUR

RESILIENT HIGH PERFORMANCE UNDERSCREED MEMBRANE MADE OF RECYCLED POLYMERS

CERTIFIED
The effectiveness of the underscreed membrane has been certified in the labs of the Centre for Industrial Research of the University of Bologna.

SUSTAINABILITY
Recycled and recyclable. The product intelligently reuses polyurethane from production waste that would otherwise have to be disposed of.

HIGH PERFORMANCE
The special composition offers excellent elasticity, reaching attenuation values over 30 dB.

COMPOSITION

polyethylene vapour barrier

polyurethane agglomerate made from pre-consumer industrial waste

CODES AND DIMENSIONS

CODE	H(1) [m]	L [m]	thickness [mm]	A_f(2) [m^2]	
SILFLOORPUR10	1,6	10	10	15	6
SILFLOORPUR15	1,6	8	15	12	6
SILFLOORPUR20	1,6	6	20	9	6

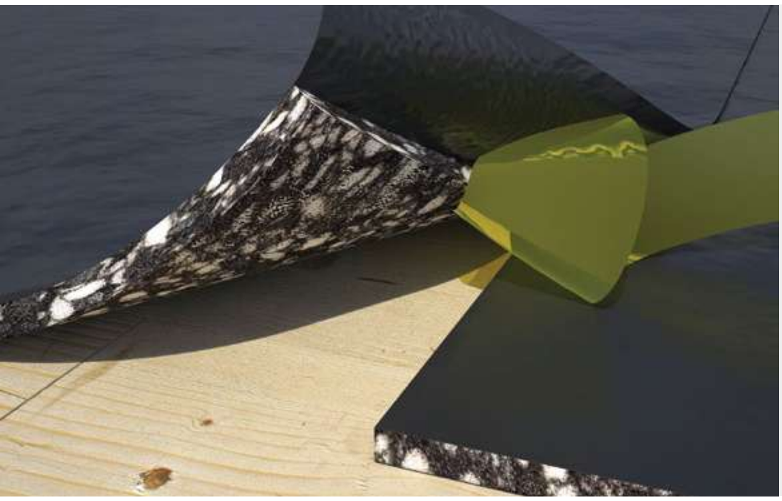
(1) 1.5 m of polyurethane agglomerate and vapour barrier + 0.1 m of vapour barrier for overlap with integrated adhesive strip.
(2) Without considering the overlap area.

SAFE
Polyurethane is a noble polymer that maintains elasticity over time, without subsidence or changes in performance.

VOC REQUIREMENTS
The membrane composition safeguards health and meets the recommended VOC limits.

PRODUCT STRATIGRAPHY COMPARISON

integrated adhesive strip	thickness	dynamic stiffness	load	estimate ΔL_w according to formula C.4 of EN ISO 12354-2
✔	10 mm	12,5 MN/m^3	125 kg/m^2	32,5 dB
			200 kg/m^2	35,1 dB
			250 kg/m^2	36,4 dB
✔	15 mm	8,8 MN/m^3	125 kg/m^2	34,6 dB
			200 kg/m^2	37,3 dB
			250 kg/m^2	38,6 dB
✔	20 mm	7,4 MN/m^3	125 kg/m^2	35,7 dB
			200 kg/m^2	38,4 dB
			250 kg/m^2	39,6 dB



SILFLOORPUR10

TECHNICAL DATA

Properties	standard	value
Surface mass m	-	0,9 kg/m²
Density ρ	-	80 kg/m³
Apparent dynamic stiffness s'_t	EN 29052-1	12,5 MN/m³
Dynamic stiffness s'	EN 29052-1	12,5 MN/m³
Theoretical estimate of impact sound pressure level attenuation ΔL_w (1)	ISO 12354-2	32,5 dB
System resonance frequency f_0 (2)	ISO 12354-2	50,6 Hz
Impact sound pressure level attenuation ΔL_w (3)	ISO 10140-3	21 dB
Thermal resistance R_t	-	0,46 m²K/W
Resistance to airflow r	ISO 9053	< 10,0 kPa·s·m⁻²
Compressibility class	EN 12431	CP2
CREEP Viscous sliding under compression X_{ct} (1,5 kPa)	EN 1606	7,50 %
Compression deformation stress	ISO 3386-1	17 kPa
Thermal conductivity λ	-	0,035 W/m·K
Specific heat c	-	1800 J/kg·K
Water vapour transmission Sd	-	> 100 m
Reaction to fire	EN 13501-1	class F
VOC emission classification	French decree no. 2011-321	A+

(1) ΔL_w= (13 lg(m'))-(14,2 lg(s'))+20,8 [dB] con m'= 125 kg/m².
(2) f_0= 160 √(s'/m') con m'= 125 kg/m².
(3) Measured in the laboratory on 200 mm CLT floor. See the manual for more information on configuration.

EN ISO 12354-2 ANNEX C | ESTIMATE ΔL_W (FORMULA C.4) E ΔL (FORMULA C.1)

The following tables show how the attenuation in dB (ΔL_W e ΔL) of SILFLOORPUR10 varies as the load m' (i.e., the surface mass of the layers with which SILFLOORPUR10 is loaded) changes.

SILFLOORPUR10

	s't or s'	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	[MN/m³]
	load m'	50	75	100	125	150	175	200	225	250	275	300	[kg/m²]
	ΔL_w	27,3	29,6	31,2	32,5	33,5	34,4	35,1	35,8	36,4	36,9	37,4	[dB]
	f_0	80,0	65,3	56,6	50,6	46,2	42,8	40,0	37,7	35,8	34,1	32,7	[Hz]
		ΔL in frequency											
[Hz]	**100**	2,9	5,5	7,4	8,9	10,1	11,1	11,9	12,7	13,4	14,0	14,6	[dB]
[Hz]	**125**	5,8	8,5	10,3	11,8	13,0	14,0	14,8	15,6	16,3	16,9	17,5	[dB]
[Hz]	**160**	9,0	11,7	13,5	15,0	16,2	17,2	18,1	18,8	19,5	20,1	20,7	[dB]
[Hz]	**200**	11,9	14,6	16,5	17,9	19,1	20,1	21,0	21,7	22,4	23,0	23,6	[dB]
[Hz]	**250**	14,8	17,5	19,4	20,8	22,0	23,0	23,9	24,6	25,3	26,0	26,5	[dB]
[Hz]	**315**	17,9	20,5	22,4	23,8	25,0	26,0	26,9	27,7	28,3	29,0	29,5	[dB]
[Hz]	**400**	21,0	23,6	25,5	26,9	28,1	29,1	30,0	30,8	31,5	32,1	32,6	[dB]
[Hz]	**500**	23,9	26,5	28,4	29,8	31,0	32,0	32,9	33,7	34,4	35,0	35,5	[dB]
[Hz]	**630**	26,9	29,5	31,4	32,9	34,0	35,0	35,9	36,7	37,4	38,0	38,6	[dB]
[Hz]	**800**	30,0	32,6	34,5	36,0	37,2	38,2	39,0	39,8	40,5	41,1	41,7	[dB]
[Hz]	**1000**	32,9	35,5	37,4	38,9	40,1	41,1	41,9	42,7	43,4	44,0	44,6	[dB]
[Hz]	**1250**	35,8	38,5	40,3	41,8	43,0	44,0	44,8	45,6	46,3	46,9	47,5	[dB]
[Hz]	**1600**	39,0	41,7	43,5	45,0	46,2	47,2	48,1	48,8	49,5	50,1	50,7	[dB]
[Hz]	**2000**	41,9	44,6	46,5	47,9	49,1	50,1	51,0	51,7	52,4	53,0	53,6	[dB]
[Hz]	**2500**	44,8	47,5	49,4	50,8	52,0	53,0	53,9	54,6	55,3	56,0	56,5	[dB]
[Hz]	**3150**	47,9	50,5	52,4	53,8	55,0	56,0	56,9	57.7	58,3	59,0	59,5	[dB]

EN ISO 12354-2 Annex C - formula C.4

$$\Delta L_W = \left(13 \lg\left(m'\right)\right) - \left(14{,}2 \lg\left(s'\right)\right) + 20{,}8 \text{ dB}$$

EN ISO 12354-2 Annex C - formula C.1

$$\Delta L = \left(30 \lg \frac{f}{f_0}\right) \text{dB}$$

EN ISO 12354-2 Annex C - formula C.2

$$f_0 = 160 \sqrt{\frac{s'}{m'}}$$

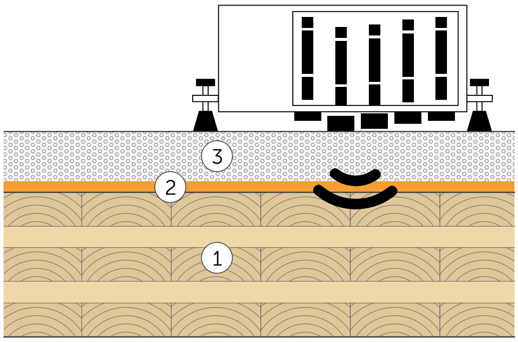
IMPACT NOISE INSULATION ACCORDING TO SCREED THICKNESS

A predictive study of the sound insulation of airborne and impact noise in buildings cannot be determined by calculations alone, but must be supported by experimental data and measurements in the laboratory and on site.

The acoustics laboratory at the University of Northern British Columbia is designed optimized for testing the sound insulation performance of floors in timber buildings. In fact, the receiving room is built of frame walls made of mullions and interposed rock wool insulation and OSB sheathing and two layers of gypsum board.

Impact noise assessment is measured according to ASTM E1007-15 using the impact sound machine and a sound pressure meter according to ISO. The tests involve evaluating the acoustic behavior of the floor slab according to the thickness of the screed (38 mm, 50 mm, 100 mm).

MATERIALS



① **X-LAM FLOOR SLABS:** The tested floor slab consists of three of 139 mm thick CLT 139V panels. Each CLT panel is 4.0 m long and 1.8 m wide. All joints are sealed with acoustic sealant and tapes. The edges between floors and walls are also sealed with acoustic sealant. The AIIC of the bare CLT floor slab is 21 (L'n,w = 89dB)

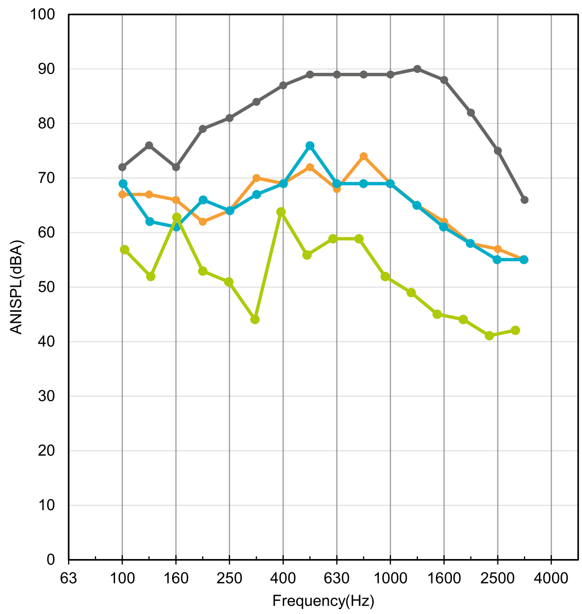
② **SILENT FLOOR PUR:** high-performance resilient agglomerate underscreed membrane made from pre-consumer industrial waste and PE vapour barrier.

③ **Screed**: ordinary concrete
- thickness 38 mm, 91 kg/m^2
- thickness 50 mm, 120 kg/m^2
- thickness 100 mm, 240 kg/m^2

RESULTS

- CLT
- CLT + SILENT FLOOR PUR + 38 mm concrete
- CLT + SILENT FLOOR PUR + 50 mm concrete
- CLT + SILENT FLOOR PUR + 100 mm concrete

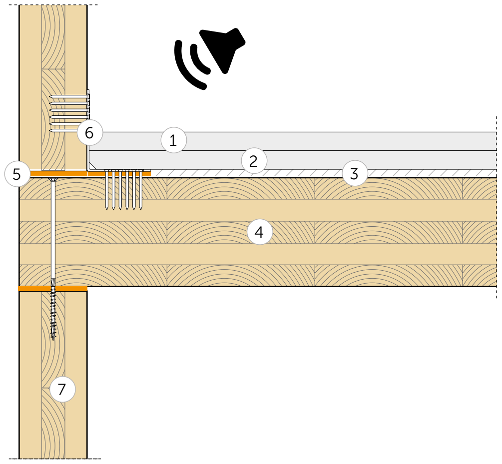
	AIIC (dBA)	$L'_{n,w}$ (dB)	Acoustic improvement (dB)
CLT	21	89	
CLT + SILENT FLOOR PUR + 38 mm concrete	41	69	**20**
CLT + SILENT FLOOR PUR + 50 mm concrete	42	68	**21**
CLT + SILENT FLOOR PUR + 100 mm concrete	48	62	**27**



Testing laboratory: University of Northernn British Columbia
Test protocol: 20200720

LABORATORY MEASUREMENT | CLT FLOOR 1

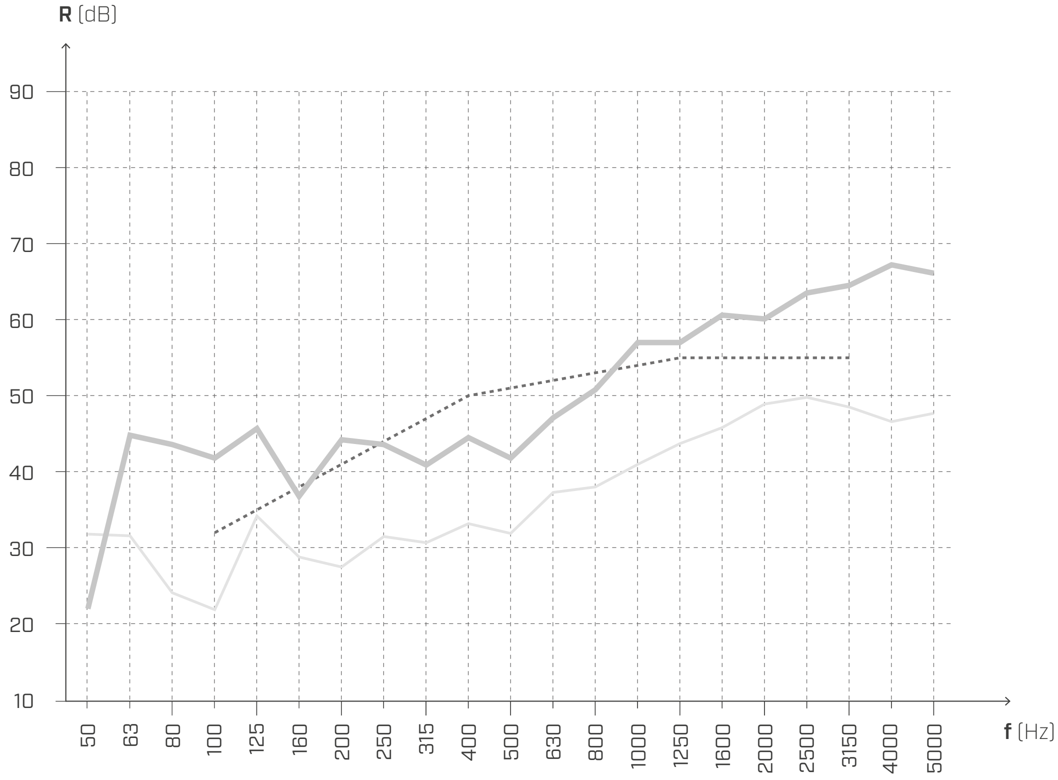
AIRBORNE SOUND INSULATION ACCORDING TO ISO 16283-1



FLOOR SLAB
Surface = 21,64 m^2
Mass = 167 kg/m^2
Receiving room volume = 75,52 m^3

1. Reinforced gypsum-fibre board (44 kg/m^2) (thickness: 32 mm)
2. High density cardboard and sand panels (34,6 kg/m^2) (thickness: 30 mm)
3. **SILENT FLOOR PUR - SILFLOORPUR10** (thickness: 10 mm)
4. CLT (thickness: 160 mm)
5. **XYLOFON 35 - XYL35100**
6. TITAN SILENT
7. CLT (thickness: 120 mm)

AIRBORNE SOUND INSULATION



f [Hz]	R [dB]
50	22,0
63	44,8
80	43,6
100	41,8
125	45,7
160	36,8
200	44,2
250	43,6
315	40,9
400	44,5
500	41,8
630	47,1
800	50,8
1000	57,0
1250	57,0
1600	60,6
2000	60,1
2500	63,5
3150	64,5
4000	67,2
5000	66,1

$R'_w(C;C_{tr})$ = **51 (0;-6) dB**

STC = **51**

$\Delta R'_w$ = +12 dB[(1)]

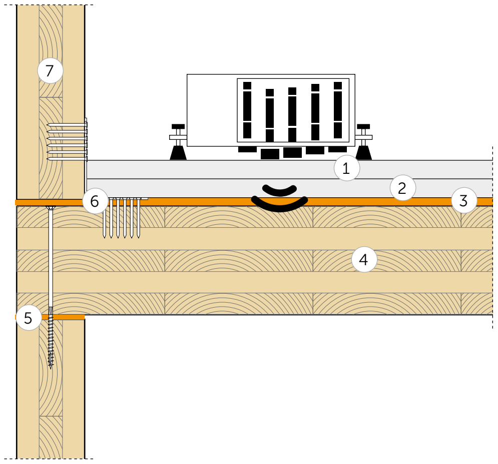
ΔSTC = +12 [(1)]

Testing laboratory: Universität Innsbruck Arbeitsbereich für Holzbau Technikerstraße 13A - 6020 Innsbruck.
Test protocol: M07B_L211217_m-Bodenaufbau

NOTES:
[(1)] Increase due to the addition of layers no. 1, 2 and 3.

LABORATORY MEASUREMENT | CLT FLOOR 1

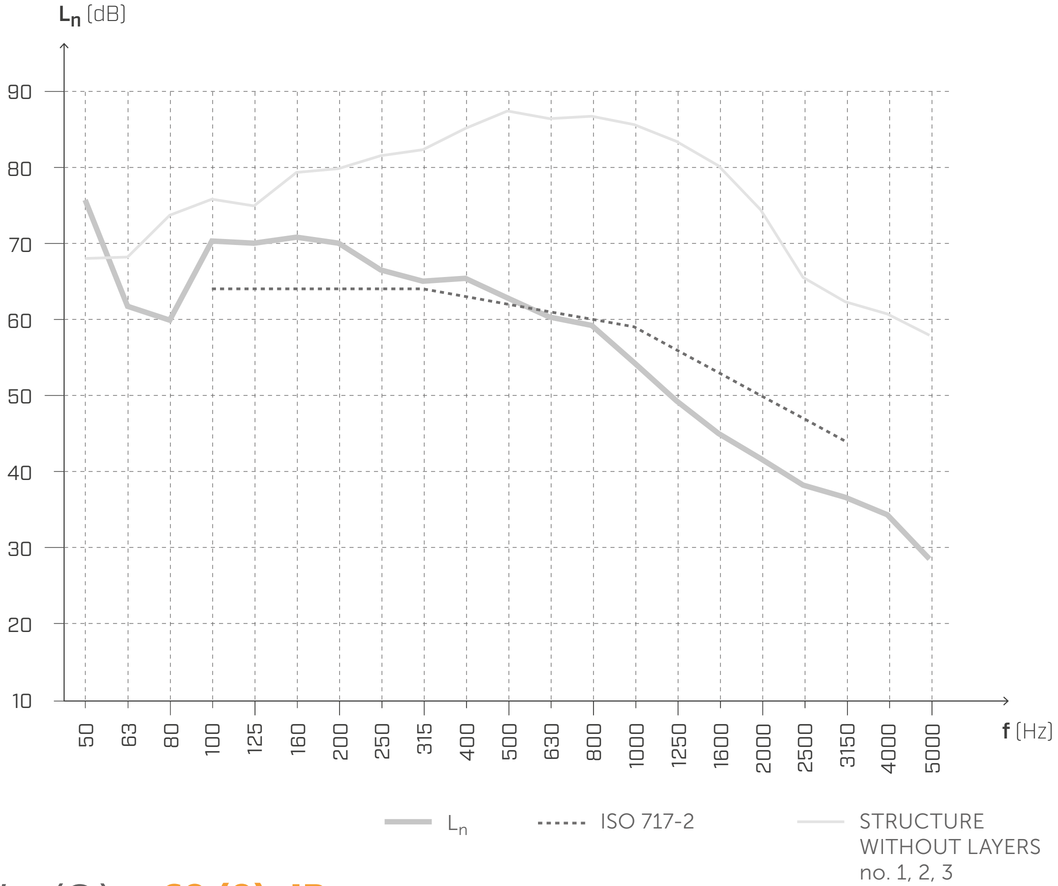
IMPACT SOUND INSULATION ACCORDING TO ISO 16283-1



Surface = 21,64 m^2
Mass = 167 kg/m^2
Receiving room volume = 75,52 m^3

1. Reinforced gypsum-fibre board (44 kg/m^2) (thickness: 32 mm)
2. high density cardboard and sand panels (34,6 kg/m^2), (thickness: 30 mm)
3. **SILENT FLOOR PUR- SILFLOORPUR10** (s: 10 mm)
4. CLT (thickness: 160 mm)
5. **XYLOFON 35 - XYL35100**
6. TITAN SILENT
7. CLT (thickness: 120 mm)

Impact sound NOISE INSULATION



f [Hz]	L_n [dB]
50	75,7
63	61,7
80	59,9
100	70,3
125	70
160	70,8
200	70
250	66,5
315	65
400	65,4
500	62,8
630	60,3
800	59,2
1000	54,3
1250	49,3
1600	45
2000	41,7
2500	38,2
3150	36,6
4000	34,3
5000	28,5

$L'_{n,w}(C_I)$ = **62 (0) dB**

$\Delta L_{n,w}(C_I)$ = -22 dB[(1)]

IIC = **48**

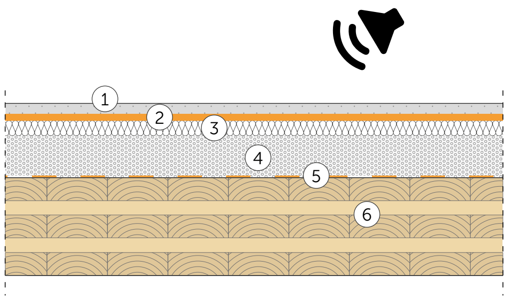
ΔIIC = +22[(2)]

Testing laboratory: Universität Innsbruck Arbeitsbereich für Holzbau Technikerstraße 13A - 6020 Innsbruck.
Test protocol: M07B_T211217_m-Bodenaufbau

NOTES:
(1) Decrease due to the addition of layers no. 1 and no. 2.
(2) Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 2

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD ISO 10140-2



FLOOR SLAB

Surface = 12 m^2
Mass = 230 kg/m^2
Receiving room volume = 54,7 m^3

1. Concrete screed (2000 kg/m^3) (thickness: 50 mm)
2. **SILENT FLOOR PUR** (thickness: 10 mm)
3. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3) (thickness 40 mm)
4. Light screed with EPS (500 kg/m^3) (thickness: 120 mm)
5. **BARRIER SD150**
6. CLT 5 layers (thickness: 150 mm)

AIRBORNE SOUND INSULATION

f [Hz]	R [dB]
50	-
63	-
80	-
100	30,7
125	37,1
160	40,8
200	46,3
250	46,1
315	49,5
400	51,6
500	54,4
630	55,7
800	59,6
1000	64,5
1250	67,6
1600	69,8
2000	72,1
2500	71,8
3150	74,1
4000	74,5
5000	71,1

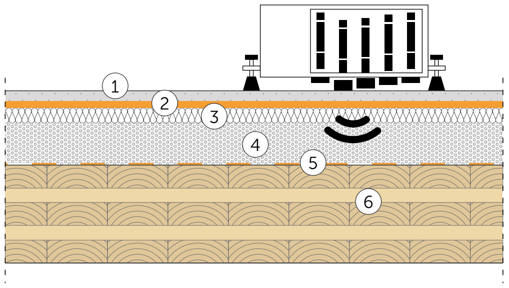
R_w = **57 (-2;-9) dB**

STC = **57**

Testing laboratory: Alma Mater Studiorum Università di Bologna
Test protocol: 01L/RothoB

LABORATORY MEASUREMENT | CLT FLOOR 2

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD: ISO 10140-3 AND EN ISO 717-2

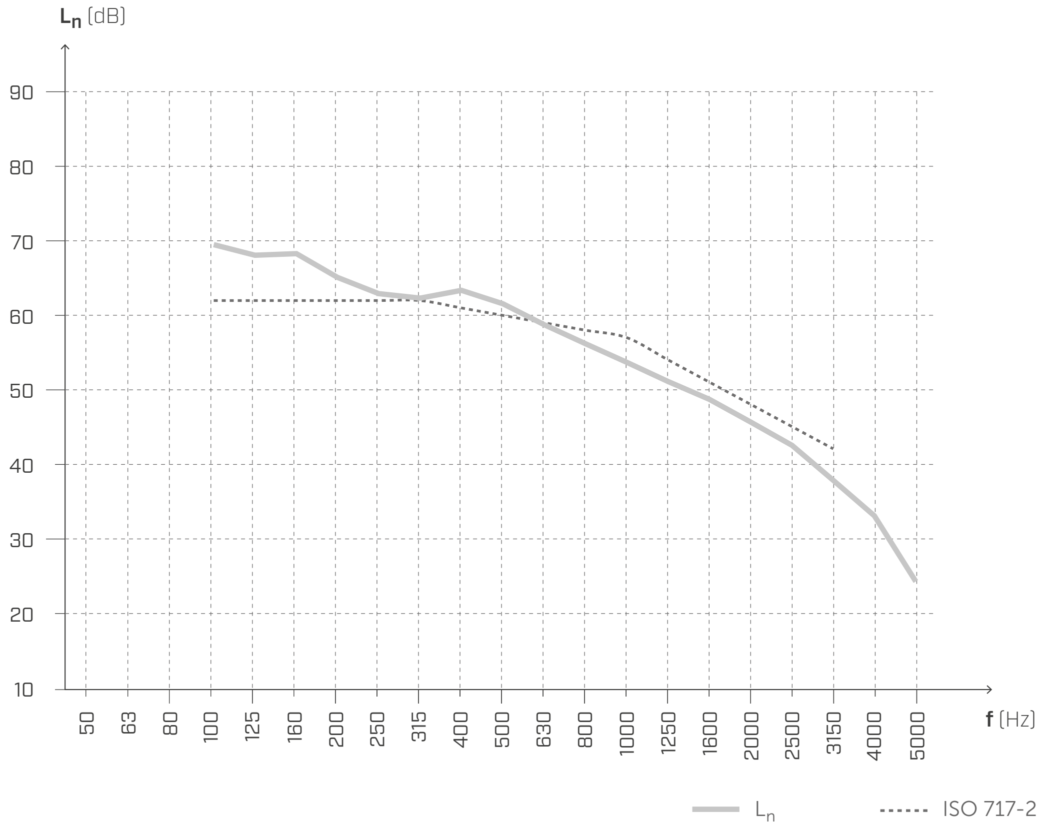


FLOOR SLAB

Surface = 12 m^2
Mass = 230 kg/m^2
Receiving room volume = 54,7 m^3

1. Concrete screed (2000 kg/m^3), (thickness: 50 mm)
2. **SILENT FLOOR PUR** (thickness: 10 mm)
3. Mineral wool insulation s' ≤ 10 MN/m^3 (110 kg/m^3), (thickness: 40 mm)
4. Light screed with EPS (500 kg/m^3) (thickness: 120 mm)
5. **BARRIER SD150**
6. CLT 5 layers (thickness: 150 mm)

IMPACT SOUND INSULATION



f [Hz]	L_n [dB]
50	-
63	-
80	-
100	69,5
125	68,1
160	68,3
200	65,1
250	62,9
315	62,3
400	63,4
500	61,6
630	58,7
800	56,2
1000	53,7
1250	51,1
1600	48,7
2000	45,6
2500	42,5
3150	37,8
4000	33,0
5000	24,1

$L_{n,w}$ (C_I) = **60 (0) dB**

$\Delta L_{n,w}(C_I)$ = -27 dB[(1)]

IIC = **50**

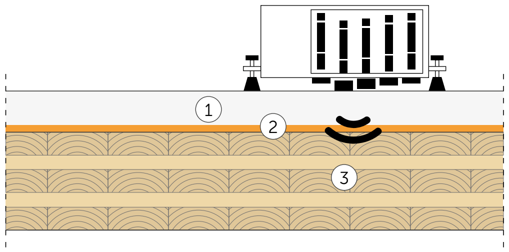
ΔIIC = +27[(2)]

Testing laboratory: Alma Mater Studiorum Università di Bologna
Test protocol: 01R/RothoB

NOTES:
[(1)] Decrease due to the addition of layers no. 1 and no. 2.
[(2)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 3

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD: ISO 10140-3 AND EN ISO 717-2



FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 215,1 kg/m^2
Receiving room volume = 60,1 m^3

(1) Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
(2) **SILENT FLOOR PUR - SILFLOORPUR10** (thickness: 10 mm)
(3) CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION

f [Hz]	L_n [dB]
50	61,6
63	61,0
80	60,7
100	71,5
125	69,9
160	70,4
200	70,6
250	67,8
315	67,0
400	64,9
500	61,5
630	60,1
800	58,8
1000	56,9
1250	56,1
1600	54,8
2000	55,5
2500	55,5
3150	55,6
4000	51,8
5000	44,5

$L_{n,w}(C_I)$ = **65 (-2) dB**

$\Delta L_{n,w}(C_I) = -21$ dB(1)

IIC = **44**

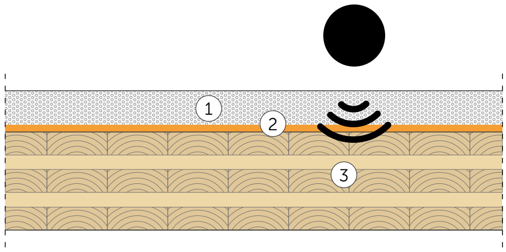
$\Delta IIC = +20$(2)

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L2.

NOTES:
(1) Decrease due to the addition of layers no. 1 and no. 2.
(2) Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 3

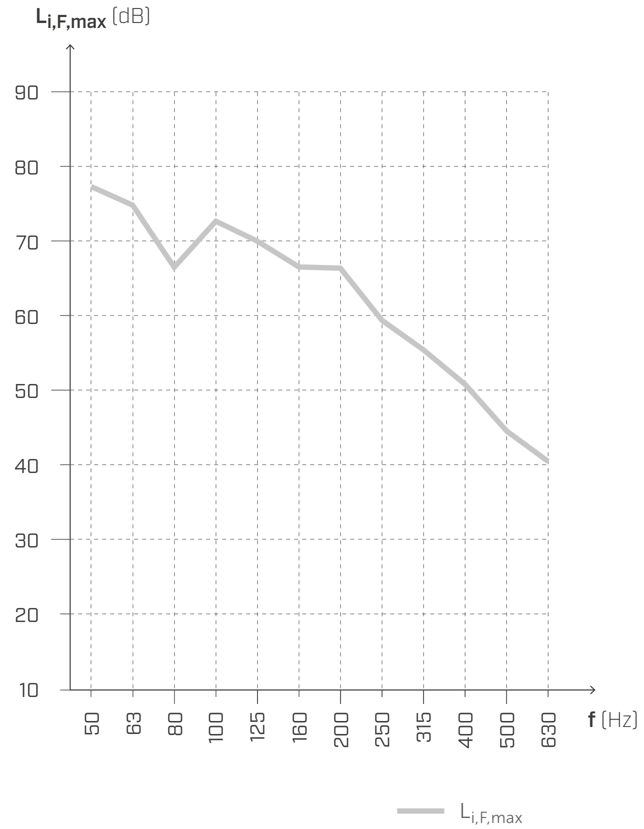
MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
RUBBER BALL METHOD | REFERENCE STANDARD: ISO 10140-3 AND EN ISO 717-2



FLOOR SLAB
Surface = 13,71 m^2
Surface mass = 215,1 kg/m^2
Receiving room volume = 60,1 m^3

1. Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
2. **SILENT FLOOR PUR - SILFLOORPUR10** (thickness: 10 mm)
3. CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION

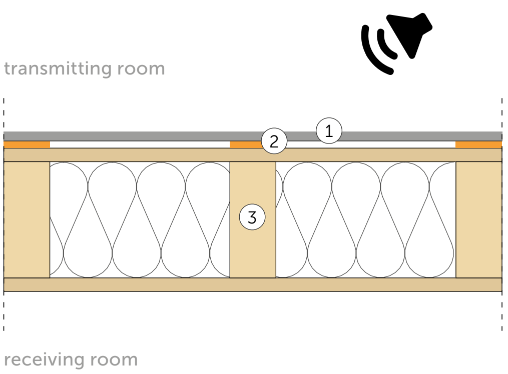


f [Hz]	$L_{i,F,max}$ [dB]
50	77,3
63	74,8
80	66,5
100	72,7
125	70,0
160	66,5
200	66,3
250	59,4
315	55,4
400	50,8
500	44,5
630	40,4

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L2.

LABORATORY MEASUREMENT | FRAME WALL 4A

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 10140-2 AND EN ISO 717-1



WALL

Surface = 10,16 m^2
Surface mass = 33,6 kg/m^2
Receiving room volume = 60,6 m^3

(1) Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)
(2) **SILENT FLOOR PUR - SILFLOORPUR10** strips (thickness: 10 mm)
(3) Timber frame (thickness: 170 mm)
timber struts 60 x 140 mm - spacing 600 mm
2x rock wool (thickness: 60mm), (70 kg/m^3)
OSB (thickness: 15 mm), (550 kg/m^3)

AIRBORNE SOUND INSULATION

f [Hz]	R [dB]
50	25,7
63	20,1
80	23,2
100	24,0
125	25,0
160	27,4
200	35,7
250	39,7
315	40,3
400	44,4
500	43,8
630	50,5
800	54,8
1000	55,7
1250	56,7
1600	58,3
2000	58,3
2500	55,9
3150	54,2
4000	58,9
5000	61,1

$R_w(C;C_{tr})$ = **47 (-2;-8) dB** STC = **48**

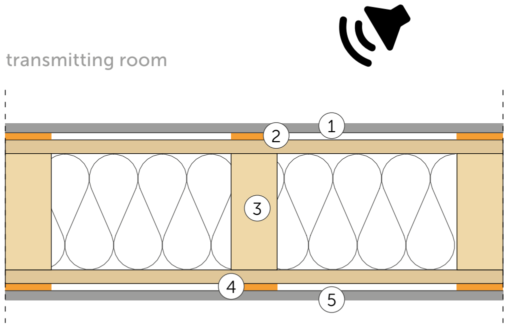
ΔR_w = +6 dB[(1)] *ΔSTC = +7*[(1)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R6a.

NOTES:
[(1)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 4B

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 10140-2 AND EN ISO 717-1



WALL

Surface = 10,16 m^2
Surface mass = 42,9 kg/m^2
Receiving room volume = 60,6 m^3

1. Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)
2. **SILENT FLOOR PUR - SILFLOORPUR10** strips (thickness: 10 mm)
3. Timber frame (thickness: 170 mm)
   timber struts 60 x 140 mm - spacing 600 mm
   2x rock wool (thickness: 60mm), (70 kg/m^3)
   OSB (thickness: 15 mm), (550 kg/m^3)
4. **SILENT FLOOR PUR - SILFLOORPUR10 strips** (thickness: 10 mm)
5. Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)

AIRBORNE SOUND INSULATION

f [Hz]	R [dB]
50	24,9
63	21,6
80	21,0
100	24,8
125	27,6
160	30,4
200	39,8
250	41,9
315	44,4
400	48,8
500	50,3
630	57,6
800	61,0
1000	63,6
1250	65,5
1600	66,8
2000	66,7
2500	64,4
3150	60,0
4000	63,1
5000	62,5

$R_w(C;C_{tr})$ = **51 (-3;-10) dB** STC = **51**

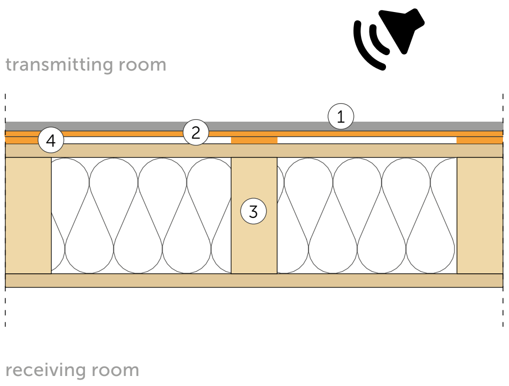
ΔR_w = +10 dB[(1)] *ΔSTC = +10*[(1)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R6b.

NOTES:
[(1)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | FRAME WALL 5A

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 10140-2 AND EN ISO 717-1

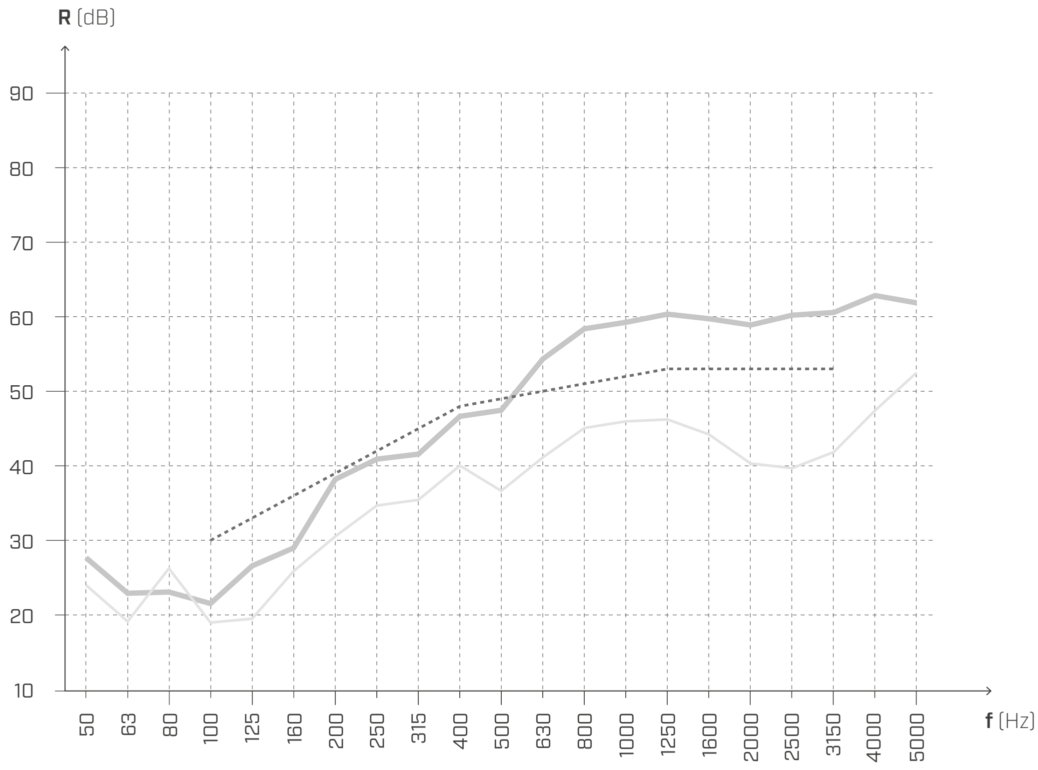


WALL

Surface = 10,16 m^2
Surface mass = 38,6 kg/m^2
Receiving room volume = 60,6 m^3

(1) Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)
(2) **SILENT WALL BYTUM SA** (thickness: 4 mm), (1250 kg/m^3), 5 kg/m^2)
(3) **SILENT FLOOR PUR - SILFLOORPUR10** strips (thickness: 10 mm)
(4) Timber frame (thickness: 170 mm)
timber struts 60 x 140 mm - spacing 600 mm
2x rock wool (thickness: 60mm), (70 kg/m^3)
OSB (thickness: 15 mm), (550 kg/m^3)

AIRBORNE SOUND INSULATION



f [Hz]	R [dB]
50	27,7
63	22,9
80	23,1
100	21,6
125	26,6
160	29,0
200	38,2
250	40,9
315	41,6
400	46,7
500	47,5
630	54,3
800	58,4
1000	59,2
1250	60,3
1600	59,7
2000	58,9
2500	60,2
3150	60,6
4000	62,8
5000	61,8

$R_w(C;C_{tr})$ = **49 (-3;-10) dB** STC = **50**

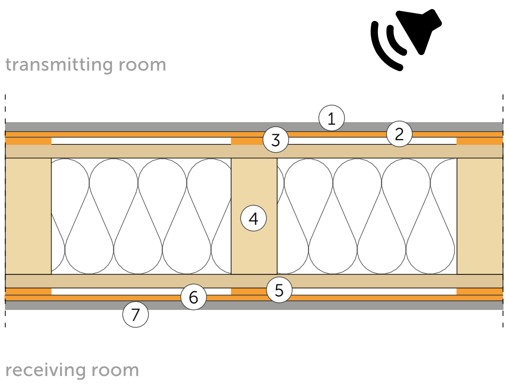
ΔR_W = +8 dB[(1)] *ΔSTC = +9*[(1)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R5a.

NOTES:
[(1)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | FRAME WALL 5B

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 10140-2 AND EN ISO 717-1

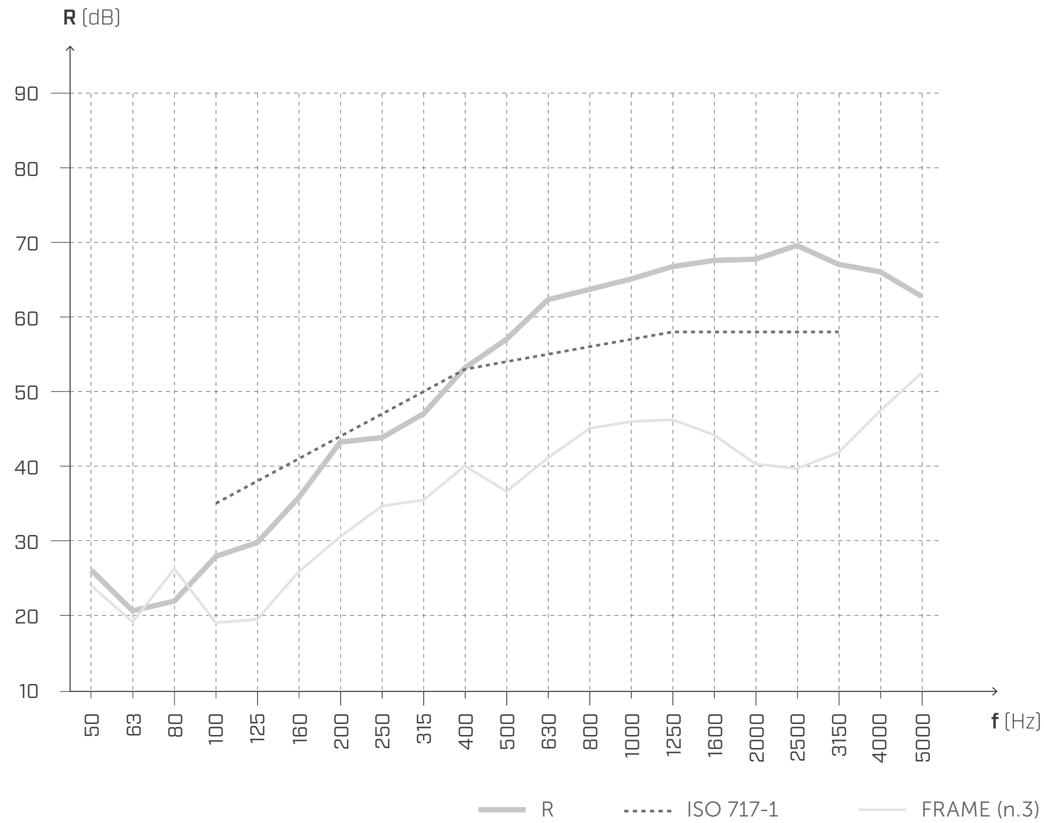


WALL

Surface = 10,16 m^2
Surface mass = 52,9 kg/m^2
Receiving room volume = 60,6 m^3

1. Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)
2. **SILENT WALL BYTUM SA** (thickness: 4 mm), (1250 kg/m^3), 5 kg/m^2)
3. **SILENT FLOOR PUR - SILFLOORPUR10** strips (thickness: 10 mm)
4. Timber frame (thickness: 170 mm)
   timber struts 60 x 140 mm - spacing 600 mm
   2x rock wool (thickness: 60mm), (70 kg/m^3)
   OSB (thickness: 15 mm), (550 kg/m^3)
5. **SILENT FLOOR PUR - SILFLOORPUR10 strips** (thickness: 10 mm)
6. **SILENT WALL BYTUM SA** (thickness: 4 mm), (1250 kg/m^3), 5 kg/m^2)
7. Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)

AIRBORNE SOUND INSULATION



f [Hz]	R [dB]
50	26,1
63	20,6
80	21,9
100	27,9
125	29,8
160	35,8
200	43,2
250	43,8
315	47,0
400	53,2
500	57,0
630	62,3
800	63,7
1000	65,1
1250	66,8
1600	67,6
2000	67,7
2500	69,6
3150	67,0
4000	66,0
5000	62,8

$R_w(C;C_{tr})$ = **54 (-3;-9) dB**

$\Delta R_w = +13$ dB[(1)]

STC = **54**

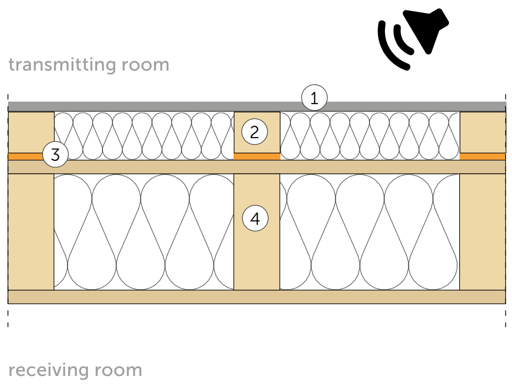
$\Delta STC = +13$[(1)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R5b.

NOTES:
[(1)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | FRAME WALL 6A

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 10140-2 AND EN ISO 717-1



WALL

Surface = 10,16 m^2
Surface mass = 37,2 kg/m^2
Receiving room volume = 60,6 m^3

(1) Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)
(2) Counter wall (thickness: 40 mm
timber battens 40 x 60 mm - spacing 600 mm
rock wool (thickness: 40mm), (38 kg/m^3)
(3) SILENT FLOOR PUR - SILFLOORPUR10 strips (thickness: 10 mm)
(4) Timber frame (thickness: 170 mm)
timber struts 60 x 140 mm - spacing 600 mm
2x rock wool (thickness: 60mm), (70 kg/m^3)
OSB (thickness: 15 mm), (550 kg/m^3)

AIRBORNE SOUND INSULATION

f [Hz]	R [dB]
50	22,9
63	18,0
80	22,1
100	23,4
125	24,2
160	32,4
200	37,5
250	42,5
315	45,8
400	48,1
500	48,9
630	54,5
800	56,1
1000	57,5
1250	58,9
1600	60,8
2000	59,9
2500	59,0
3150	58,2
4000	65,7
5000	72,2

$R_w(C;C_{tr})$ = **50 (-4;-10) dB** STC = **48**

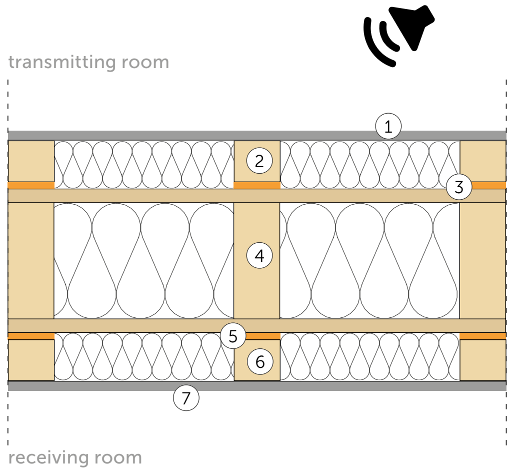
ΔR_w = +9 dB(1) *ΔSTC = +7(1)*

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R12a.

NOTES:
(1) Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | FRAME WALL 6B

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD ISO 10140-2

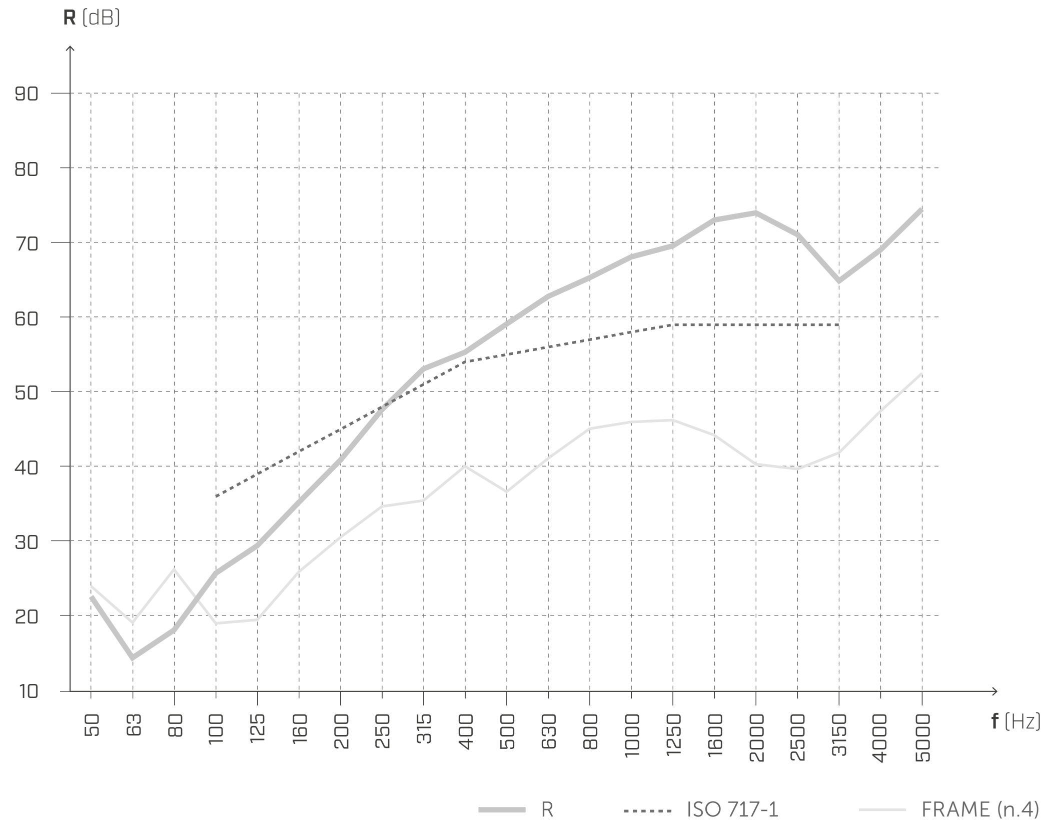


WALL

Surface = 10,16 m^2
Surface mass = 52,2 kg/m^2
Receiving room volume = 60,6 m^3

(1) Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)
(2) Counter wall (thickness: 40 mm)
timber battens 40 x 60 mm - spacing 600 mm;
rock wool (thickness: 40 mm), (38 kg/m^3)
(3) **SILENT FLOOR PUR - SILFLOORPUR10 strips** (thickness: 10 mm)
(4) Timber frame (thickness: 170 mm)
timber struts 60 x 140 mm - spacing 600 mm;
2x rock wool (thickness: 60mm), (70 kg/m^3)
OSB (thickness: 15 mm), (550 kg/m^3)
(5) **SILENT FLOOR PUR - SILFLOORPUR10 strips** (thickness: 10 mm), (110 kg/m^3), (1,1 kg/m^2)
(6) Counter wall (thickness: 40 mm)
timber battens 40 x 60 mm - spacing 600 mm;
rock wool (thickness: 40 mm), (38 kg/m^3)
(7) Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)

AIRBORNE SOUND INSULATION



f [Hz]	R [dB]
50	22,6
63	14,4
80	18,1
100	25,7
125	29,4
160	35,2
200	40,9
250	47,6
315	53,1
400	55,3
500	59,1
630	62,8
800	65,3
1000	68,1
1250	69,6
1600	73,0
2000	74,0
2500	71,0
3150	64,9
4000	69,0
5000	74,5

$R_w(C;C_{tr})$ = **55 (-5;-12) dB** STC = **53**

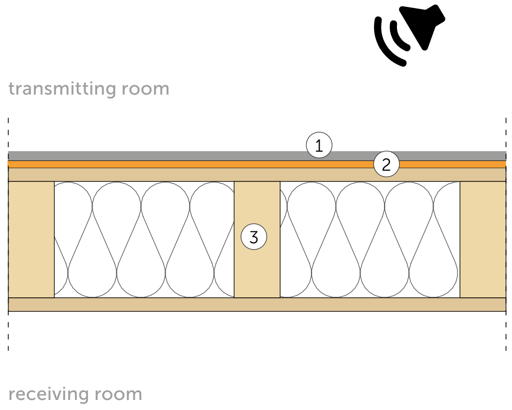
ΔR_w = +14 dB[(1)] *ΔSTC = +12*[(1)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R12b.

NOTES:
[(1)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | FRAME WALL 7A

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 10140-2 AND EN ISO 717-1



WALL

Surface = 10,16 m^2
Surface mass = 34,4 kg/m^2
Receiving room volume = 60,6 m^3

(1) Plasterboard (thickness: 12,5 mm); (720 kg/m^3); (9 kg/m^2)
(2) **SILENT FLOOR PUR - SILFLOORPUR10** (thickness: 10 mm)
(3) Timber frame (thickness: 170 mm)
timber struts 60 x 140 mm - spacing 600 mm
2x rock wool (thickness: 60mm), (70 kg/m^3)
OSB (thickness: 15 mm), (550 kg/m^3)

AIRBORNE SOUND INSULATION

f [Hz]	R [dB]
50	23,6
63	19,9
80	24,2
100	23,3
125	24,2
160	26,4
200	34,0
250	38,7
315	40,6
400	44,8
500	46,8
630	53,6
800	59,2
1000	61,0
1250	62,3
1600	61,8
2000	59,1
2500	57,3
3150	56,2
4000	62,4
5000	68,7

$R_w(C;C_{tr})$ = **47 (-3;-9) dB**   STC = **47**

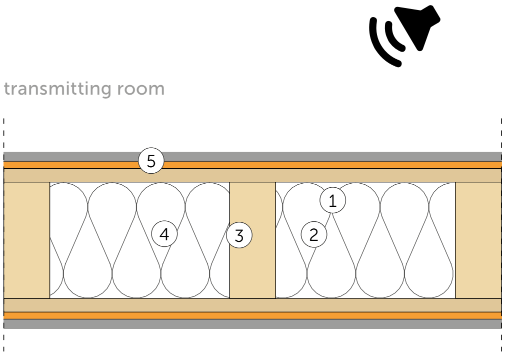
ΔR_w = +6 dB[(1)]   *ΔSTC = +6*[(1)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R13a.

NOTES:
[(1)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | FRAME WALL 7B

MEASUREMENT OF AIRBORNE SOUND INSULATION EVALUATION INDEX
REFERENCE STANDARD: ISO 10140-2 AND EN ISO 717-1



WALL

Surface = 10,16 m^2
Surface mass = 44,5 kg/m^2
Receiving room volume = 60,6 m^3

1. Plasterboard (thickness: 12,5 mm); (720 kg/m^3) (9 kg/m^2)
2. **SILENT FLOOR PUR - SILFLOORPUR10** (thickness: 10 mm)
3. Timber frame (thickness: 170 mm)
   timber struts 60 x 140 mm - spacing 600 mm;
   2x rock wool (thickness: 60mm), (70 kg/m^3)
   OSB (thickness: 15 mm), (550 kg/m^3)
4. **SILENT FLOOR PUR - SILFLOORPUR10** (thickness: 10 mm)
5. Plasterboard (thickness: 12,5 mm); (720 kg/m^3) (9 kg/m^2)

AIRBORNE SOUND INSULATION

f [Hz]	R [dB]
50	23,2
63	19,3
80	20,9
100	25,9
125	27,4
160	30,5
200	36,0
250	41,3
315	45,4
400	51,4
500	57,6
630	63,2
800	68,6
1000	71,3
1250	73,0
1600	75,0
2000	73,6
2500	70,2
3150	64,5
4000	69,1
5000	73,9

$R_w(C;C_{tr})$ = **51 (-3;-9) dB**

ΔR_w = +10 dB[(1)]

STC = **51**

ΔSTC = +10[(1)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-R13b.

NOTES:
[(1)] Increase due to the addition of layers no. 1 and no. 2.

ON SITE MEASUREMENTS

COMMERCIAL BUILDING

Atlanta (USA)

The newly constructed building boasts office space, restaurants, shops, a hotel and art studios. It is a very innovative project that also uses TIMBER as a structural material. To improve the acoustic performance of the floors, SILENT FLOOR PUR was used and ALADIN was used to reduce lateral transmission.

description	commercial building covering more than 300000 sq ft
type of structure	mixed
location	Atlanta (Georgia, USA)
products	SILENT FLOOR PUR, ALADIN

SILFLOORPUR15

TECHNICAL DATA

Properties	standard	value
Surface mass m	-	1,4 kg/m^2
Density ρ	-	90 kg/m^3
Apparent dynamic stiffness s'_t	EN 29052-1	8,8 MN/m^3
Dynamic stiffness s'	EN 29052-1	8,8 MN/m^3
Theoretical estimate of impact sound pressure level attenuation ΔL_w(1)	ISO 12354-2	34,6 dB
System resonance frequency f_0 (2)	ISO 12354-2	42,5 Hz
Impact sound pressure level attenuation ΔL_w(3)	ISO 10140-3	23 dB
Thermal resistance R_t	-	0,52 m^{2}K/W
Resistance to airflow r	ISO 9053	< 10,0 kPa·s·m^{-2}
Compressibility class	EN 12431	CP2
CREEP Viscous sliding under compression X_{ct} (1,5 kPa)	EN 1606	7,50 %
Compression deformation stress	ISO 3386-1	17 kPa
Thermal conductivity λ	-	0,035 W/m·K
Specific heat c	-	1800 J/kg·K
Water vapour transmission Sd	-	> 100 m
Reaction to fire	EN 13501-1	class F
VOC emission classification	French decree no. 2011-321	A+

(1) ΔL_w= (13 lg(m'))-(14,2 lg(s'))+20,8 [dB] con m'= 125 kg/m^2.
(2) f_0= 160 √(s'/m') con m'= 125 kg/m^2.
(3) Measured in the laboratory on 200 mm CLT floor. See the manual for more information on configuration.

EN ISO 12354-2 ANNEX C | ESTIMATE ΔL_W (FORMULA C.4) E ΔL (FORMULA C.1)

The following tables show how the attenuation in dB (ΔL_W e ΔL) of SILFLOORPUR15 varies as the load m' (i.e., the surface mass of the layers with which SILFLOORPUR15 is loaded) changes.

SILFLOORPUR15

		s't or s'	8,8	8,8	8,8	8,8	8,8	8,8	8,8	8,8	8,8	8,8	8,8	[MN/m^3]
		load m'	50	75	100	125	150	175	200	225	250	275	300	[kg/m^2]
		ΔL_w	29,5	31,8	33,4	34,6	35,7	36,5	37,3	38,0	38,6	39,1	39,6	[dB]
		f_0	67,1	54,8	47,5	42,5	38,8	35,9	33,6	31,6	30,0	28,6	27,4	[Hz]
								ΔL in frequency						
[Hz]	**100**		5,2	7,8	9,7	11,2	12,4	13,4	14,2	15,0	15,7	16,3	16,9	[dB]
[Hz]	**125**		8,1	10,7	12,6	14,1	15,3	16,3	17,1	17,9	18,6	19,2	19,8	[dB]
[Hz]	**160**		11,3	14,0	15,8	17,3	18,5	19,5	20,3	21,1	21,8	22,4	23,0	[dB]
[Hz]	**200**		14,2	16,9	18,7	20,2	21,4	22,4	23,3	24,0	24,7	25,3	25,9	[dB]
[Hz]	**250**		17,1	19,8	21,6	23,1	24,3	25,3	26,2	26,9	27,6	28,2	28,8	[dB]
[Hz]	**315**		20,1	22,8	24,7	26,1	27,3	28,3	29,2	29,9	30,6	31,2	31,8	[dB]
[Hz]	**400**		23,3	25,9	27,8	29,2	30,4	31,4	32,3	33,1	33,7	34,4	34,9	[dB]
[Hz]	**500**		26,2	28,8	30,7	32,1	33,3	34,3	35,2	36,0	36,6	37,3	37,8	[dB]
[Hz]	**630**		29,2	31,8	33,7	35,1	36,3	37,3	38,2	39,0	39,7	40,3	40,8	[dB]
[Hz]	**800**		32,3	34,9	36,8	38,3	39,4	40,4	41,3	42,1	42,8	43,4	44,0	[dB]
[Hz]	**1000**		35,2	37,8	39,7	41,2	42,4	43,4	44,2	45,0	45,7	46,3	46,9	[dB]
[Hz]	**1250**		38,1	40,7	42,6	44,1	45,3	46,3	47,1	47,9	48,6	49,2	49,8	[dB]
[Hz]	**1600**		41,3	44,0	45,8	47,3	48,5	49,5	50,3	51,1	51,8	52,4	53,0	[dB]
[Hz]	**2000**		44,2	46,9	48,7	50,2	51,4	52,4	53,3	54,0	54,7	55,3	55,9	[dB]
[Hz]	**2500**		47,1	49,8	51,6	53,1	54,3	55,3	56,2	56,9	57,6	58,2	58,8	[dB]
[Hz]	**3150**		50,1	52,8	54,7	56,1	57,3	58,3	59,2	59,9	60,6	61,2	61,8	[dB]

EN ISO 12354-2 Annex C - formula C.4

$$\Delta L_W = \left(13 \lg\left(m'\right)\right) - \left(14{,}2 \lg\left(s'\right)\right) + 20{,}8 \text{ dB}$$

EN ISO 12354-2 Annex C - formula C.1

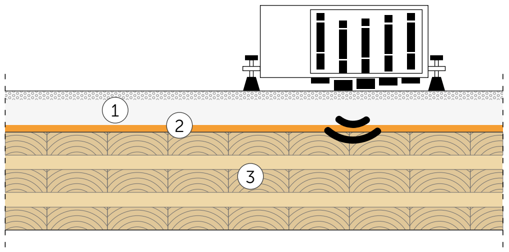
$$\Delta L = \left(30 \lg \frac{f}{f_0}\right) \text{dB}$$

EN ISO 12354-2 Annex C - formula C.2

$$f_0 = 160 \sqrt{\frac{s'}{m'}}$$

LABORATORY MEASUREMENT | CLT FLOOR 1

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD: ISO 10140-3 AND EN ISO 717-2



FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 215,7 kg/m^2
Receiving room volume = 60,1 m^3

(1) Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
(2) **SILENT FLOOR PUR - SILFLOORPUR15** (thickness: 15 mm)
(3) CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION

f [Hz]	L_n [dB]
50	62,7
63	63,1
80	64,0
100	70,6
125	67,3
160	64,6
200	66,9
250	63,9
315	62,4
400	60,5
500	58,3
630	56,9
800	56,2
1000	54,0
1250	53,2
1600	53,5
2000	56,4
2500	54,3
3150	50,0
4000	46,0
5000	40,7

$L_{n,w}(C_I)$ = **63 (-3) dB**

$\Delta L_{n,w}$ = -23 dB[(1)]

IIC = **47**

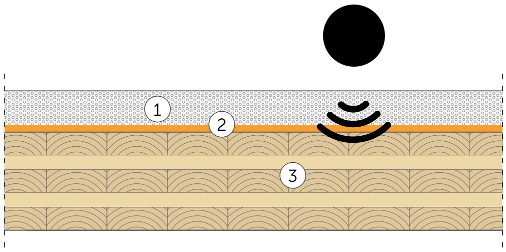
ΔIIC = +23[(2)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L6.

NOTES:
(1) Decrease due to the addition of layers no. 1 and no. 2.
(2) Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 1

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
RUBBER BALL METHOD | REFERENCE STANDARD: ISO 16283-2

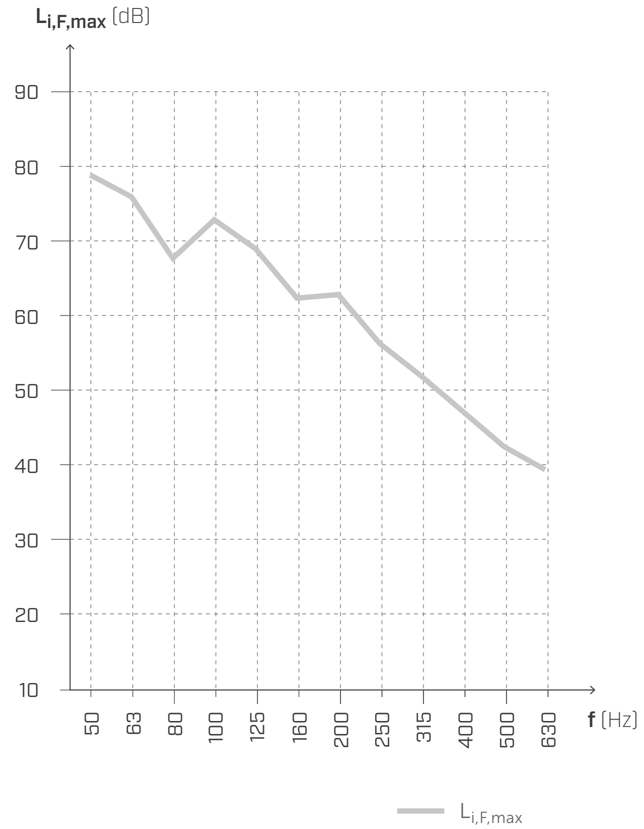


FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 215,7 kg/m^2
Receiving room volume = 60,1 m^3

1. Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
2. **SILENT FLOOR PUR - SILFLOORPUR15** (thickness: 15 mm)
3. CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION

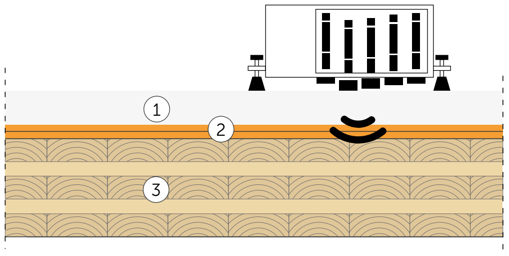


f [Hz]	$L_{i,F,max}$ [dB]
50	78,8
63	75,9
80	67,7
100	72,8
125	68,9
160	62,3
200	62,8
250	56,3
315	51,9
400	47,2
500	42,5
630	39,4

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L6.

LABORATORY MEASUREMENT | CLT FLOOR 2

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD: ISO 10140-3 AND EN ISO 717-2

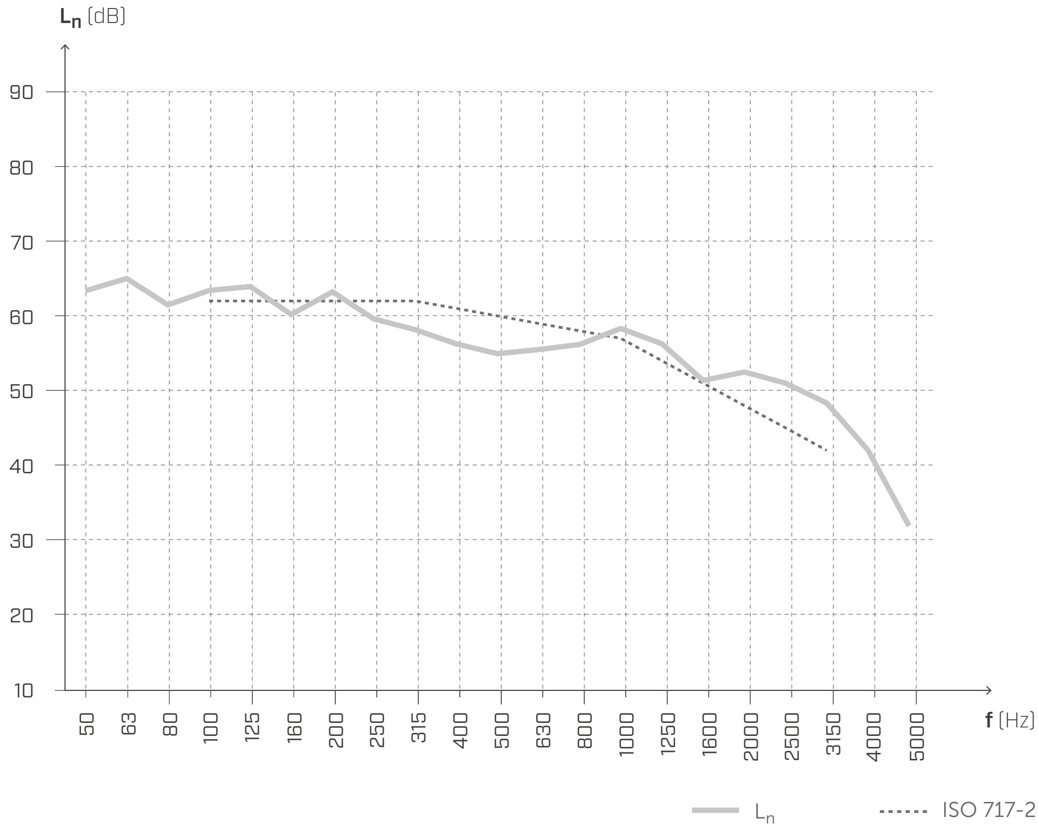


FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 217,3 kg/m^2
Receiving room volume = 60,1 m^3

1. Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
2. **2x SILENT FLOOR PUR - SILFLOORPUR15** (thickness: 15 mm)
3. CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION



f [Hz]	L_n [dB]
50	63,4
63	65,0
80	61,5
100	63,4
125	63,9
160	60,2
200	63,2
250	59,6
315	58,2
400	56,3
500	55,0
630	55,5
800	56,2
1000	58,3
1250	56,3
1600	51,3
2000	52,5
2500	51,0
3150	48,4
4000	42,1
5000	31,9

$L_{n,w}(C_l)$ = **60 (-4) dB**

$\Delta L_{n,w}$ = -26 dB(1)

IIC = **50**

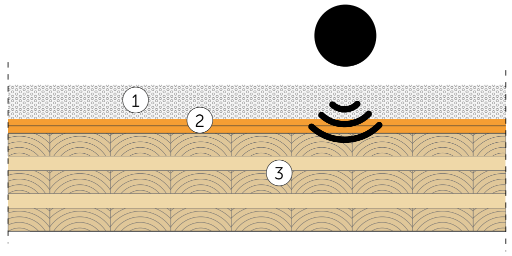
ΔIIC = +26(2)

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L6.

NOTES:
(1) Decrease due to the addition of layers no. 1 and no. 2.
(2) Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 2

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
RUBBER BALL METHOD | REFERENCE STANDARD: ISO 16283-2

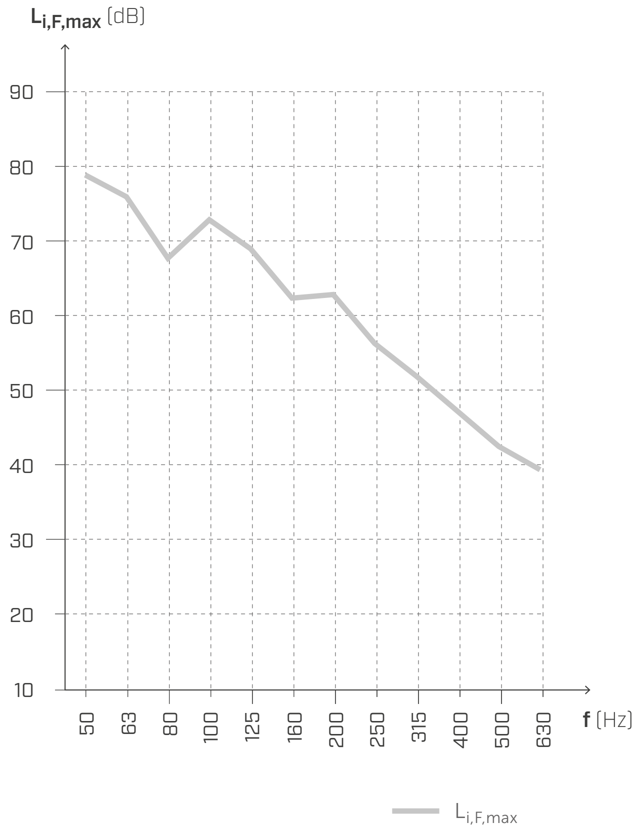


FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 217,3 kg/m^2
Receiving room volume = 60,1 m^3

(1) Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
(2) **2x SILENT FLOOR PUR - SILFLOORPUR15** (thickness: 15 mm
(3) CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

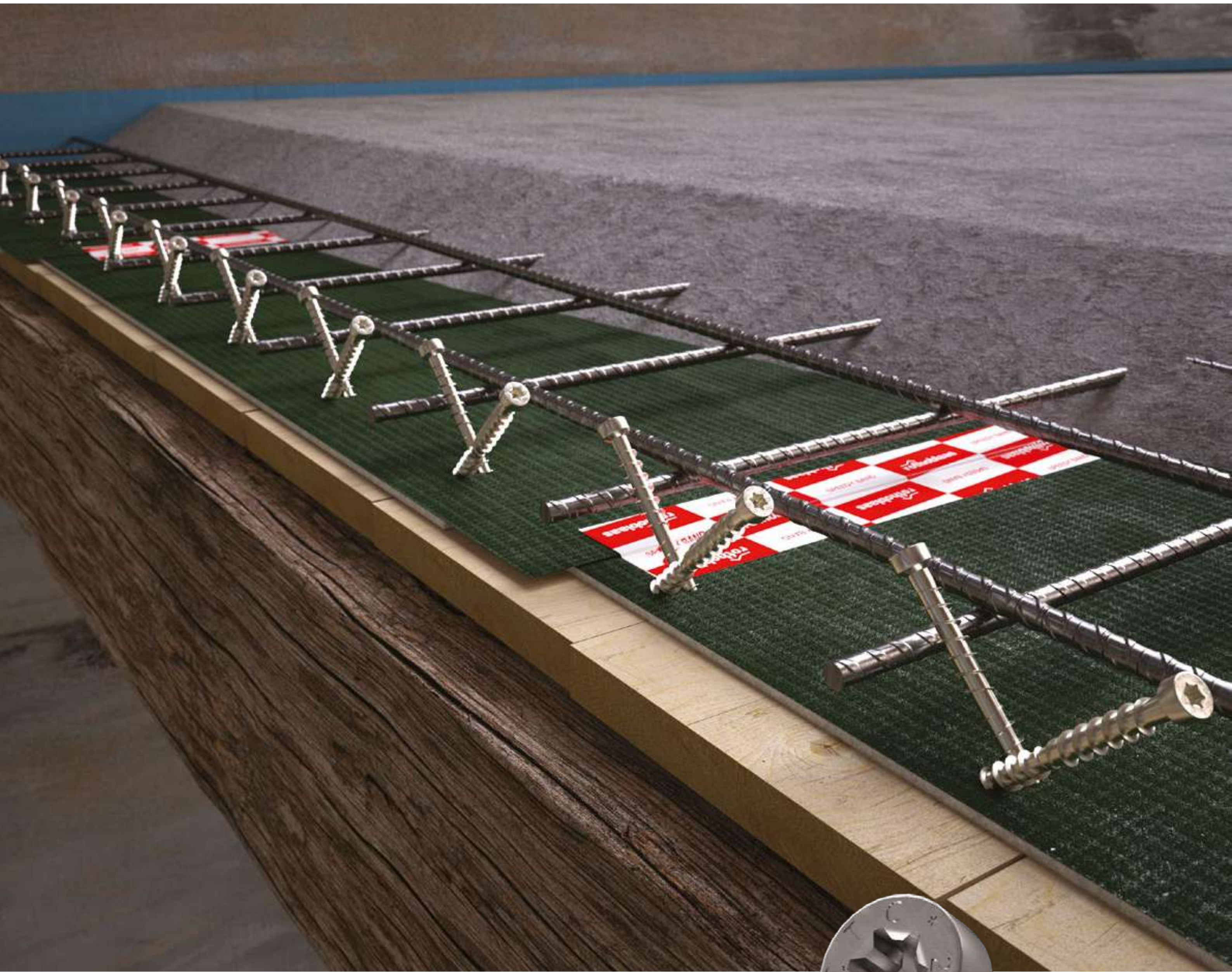
IMPACT SOUND INSULATION



f [Hz]	$L_{i,F,max}$ [dB]
50	81,5
63	79,0
80	68,2
100	65,2
125	63,5
160	57,8
200	59,6
250	52,9
315	48,5
400	44,3
500	40,7
630	38,0

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L6.

CERTAIN COLLABORATIONS ARE BORN TO LAST



CTC is the connector for timber-to-concrete floors.
CE certified, it allows to connect a 5 or 6 cm reinforced concrete slab to the timber beams of the underneath floor, obtaining a new timber-concrete structure with extraordinary strength and excellent static and acoustic performance. It is an approved self-drilling, reversible, fast and minimally invasive system.

Scan the QR code and discover the technical features of CTC connector

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Solutions for Building Technology

SILFLOORPUR20

TECHNICAL DATA

Properties	standard	value
Surface mass m	-	1,8 kg/m²
Density ρ	-	90 kg/m³
Apparent dynamic stiffness s'_t	EN 29052-1	7,4 MN/m³
Dynamic stiffness s'	EN 29052-1	7,4 MN/m³
Theoretical estimate of impact sound pressure level attenuation ΔL_w (1)	ISO 12354-2	35,7 dB
System resonance frequency f_0 (2)	ISO 12354-2	38,9 Hz
Impact sound pressure level attenuation ΔL_w (3)	ISO 10140-3	25 dB
Thermal resistance R_t	-	0,92 m²K/W
Resistance to airflow r	ISO 9053	< 10,0 kPa·s·m⁻²
Compressibility class	EN 12431	CP2
CREEP Viscous sliding under compression X_{ct} (1,5 kPa)	EN 1606	7,50 %
Compression deformation stress	ISO 3386-1	17 kPa
Thermal conductivity λ	-	0,035 W/m·K
Specific heat c	-	1800 J/kg·K
Water vapour transmission Sd	-	> 100 m
Reaction to fire	EN 13501-1	class F
VOC emission classification	French decree no. 2011-321	A+

(1) ΔL_w= (13 lg(m'))-(14,2 lg(s'))+20,8 [dB] con m'= 125 kg/m².
(2) f_0= 160 √(s'/m') con m'= 125 kg/m².
(3) Measured in the laboratory on 200 mm CLT floor. See the manual for more information on configuration.

EN ISO 12354-2 ANNEX C | ESTIMATE ΔL_W (FORMULA C.4) E ΔL (FORMULA C.1)

The following tables show how the attenuation in dB (ΔL_W e ΔL) of SILFLOORPUR20 varies as the load m' (i.e., the surface mass of the layers with which SILFLOORPUR20 is loaded) changes.

SILFLOORPUR20

	s't or s'	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5	[MN/m³]
	load m'	50	75	100	125	150	175	200	225	250	275	300	[kg/m²]
	ΔL_w	27,3	29,6	31,2	32,5	33,5	34,4	35,1	35,8	36,4	36,9	37,4	[dB]
	f_0	80,0	65,3	56,6	50,6	46,2	42,8	40,0	37,7	35,8	34,1	32,7	[Hz]
							ΔL in frequency						
[Hz]	**100**	2,9	5,5	7,4	8,9	10,1	11,1	11,9	12,7	13,4	14,0	14,6	[dB]
[Hz]	**125**	5,8	8,5	10,3	11,8	13,0	14,0	14,8	15,6	16,3	16,9	17,5	[dB]
[Hz]	**160**	9,0	11,7	13,5	15,0	16,2	17,2	18,1	18,8	19,5	20,1	20,7	[dB]
[Hz]	**200**	11,9	14,6	16,5	17,9	19,1	20,1	21,0	21,7	22,4	23,0	23,6	[dB]
[Hz]	**250**	14,8	17,5	19,4	20,8	22,0	23,0	23,9	24,6	25,3	26,0	26,5	[dB]
[Hz]	**315**	17,9	20,5	22,4	23,8	25,0	26,0	26,9	27,7	28,3	29,0	29,5	[dB]
[Hz]	**400**	21,0	23,6	25,5	26,9	28,1	29,1	30,0	30,8	31,5	32,1	32,6	[dB]
[Hz]	**500**	23,9	26,5	28,4	29,8	31,0	32,0	32,9	33,7	34,4	35,0	35,5	[dB]
[Hz]	**630**	26,9	29,5	31,4	32,9	34,0	35,0	35,9	36,7	37,4	38,0	38,6	[dB]
[Hz]	**800**	30,0	32,6	34,5	36,0	37,2	38,2	39,0	39,8	40,5	41,1	41,7	[dB]
[Hz]	**1000**	32,9	35,5	37,4	38,9	40,1	41,1	41,9	42,7	43,4	44,0	44,6	[dB]
[Hz]	**1250**	35,8	38,5	40,3	41,8	43,0	44,0	44,8	45,6	46,3	46,9	47,5	[dB]
[Hz]	**1600**	39,0	41,7	43,5	45,0	46,2	47,2	48,1	48,8	49,5	50,1	50,7	[dB]
[Hz]	**2000**	41,9	44,6	46,5	47,9	49,1	50,1	51,0	51,7	52,4	53,0	53,6	[dB]
[Hz]	**2500**	44,8	47,5	49,4	50,8	52,0	53,0	53,9	54,6	55,3	56,0	56,5	[dB]
[Hz]	**3150**	47,9	50,5	52,4	53,8	55,0	56,0	56,9	57.7	58,3	59,0	59,5	[dB]

EN ISO 12354-2 Annex C - formula C.4

$$\Delta L_W = \left(13 \lg\left(m'\right)\right) - \left(14{,}2 \lg\left(s'\right)\right) + 20{,}8 \text{ dB}$$

EN ISO 12354-2 Annex C - formula C.1

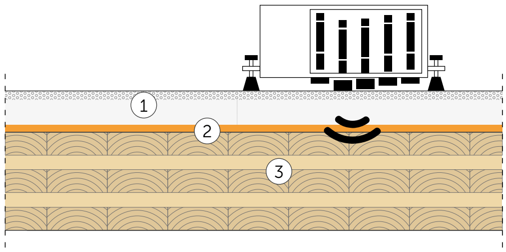
$$\Delta L = \left(30 \lg \frac{f}{f_0}\right) \text{dB}$$

EN ISO 12354-2 Annex C - formula C.2

$$f_0 = 160 \sqrt{\frac{s'}{m'}}$$

LABORATORY MEASUREMENT | CLT FLOOR 1

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD: ISO 10140-3 AND EN ISO 717-2

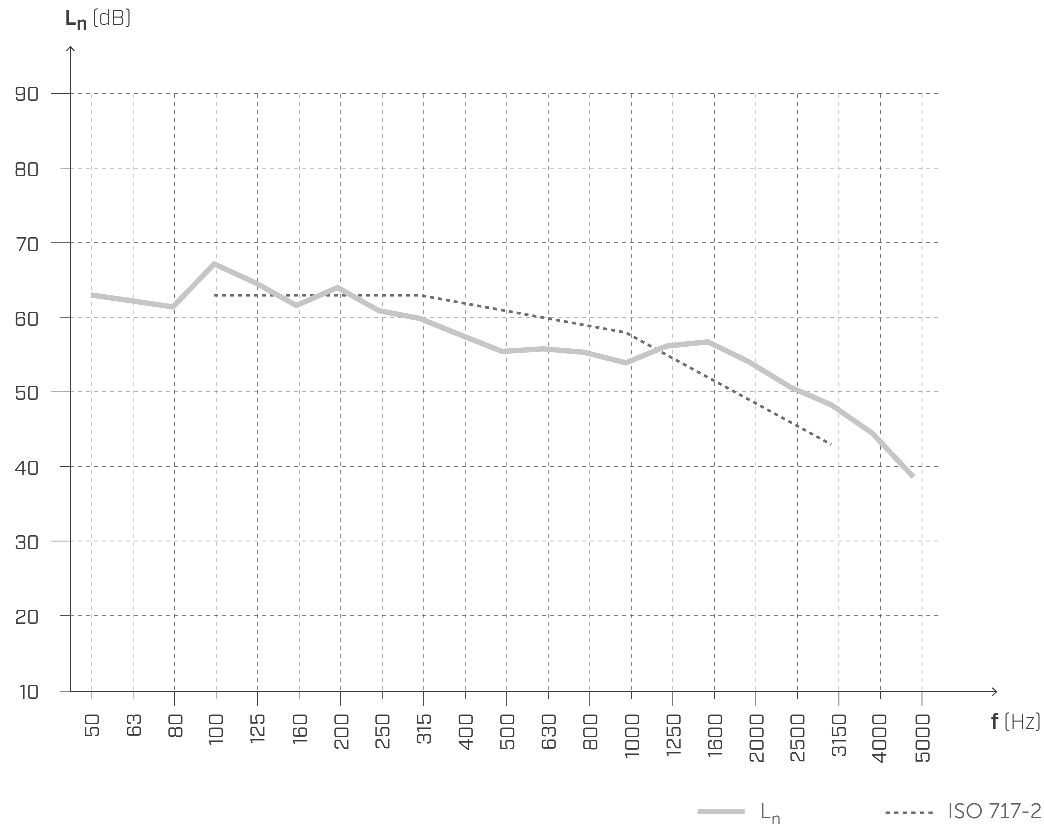


FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 216,2 kg/m^2
Receiving room volume = 60,1 m^3

(1) Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
(2) SILENT FLOOR PUR - SILFLOORPUR20 (thickness: 20 mm)
(3) CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION



f [Hz]	L_n [dB]
50	63,0
63	62,3
80	61,4
100	67,2
125	64,7
160	61,6
200	64,0
250	60,9
315	59,9
400	57,6
500	55,5
630	55,8
800	55,3
1000	53,9
1250	56,2
1600	56,7
2000	54,1
2500	50,7
3150	48,3
4000	44,5
5000	38,6

$L_{n,w}(C_I)$ = **61 (-4) dB**

$\Delta L_{n,w}$ = -25 dB[(1)]

IIC = **49**

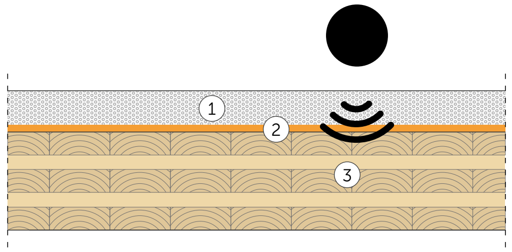
ΔIIC = +25[(2)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L1.

NOTES:
(1) Decrease due to the addition of layers no. 1 and no. 2.
(2) Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 1

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
RUBBER BALL METHOD | REFERENCE STANDARD: ISO 16283-2

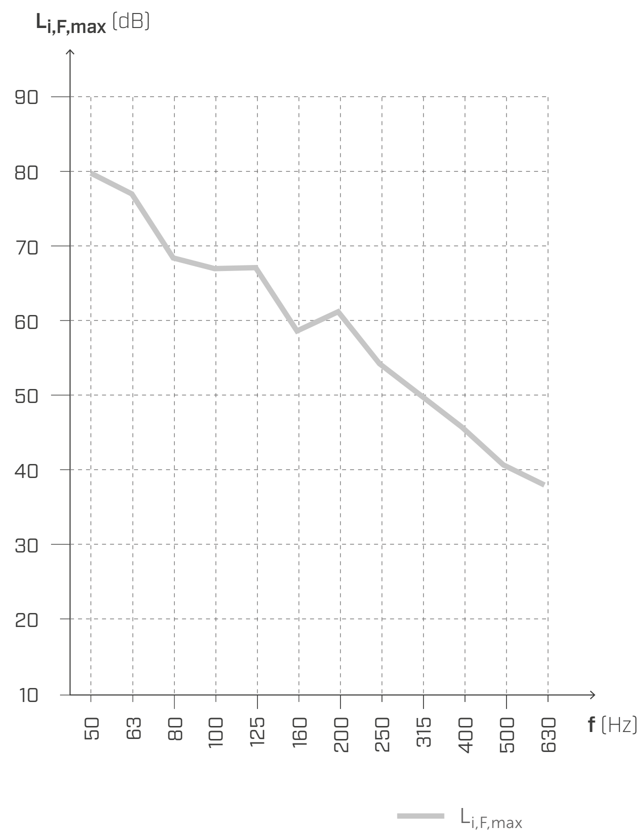


FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 216,2 kg/m^2
Receiving room volume = 60,1 m^3

① Concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
② **SILENT FLOOR PUR - SILFLOORPUR20** (thickness: 20 mm)
③ CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION

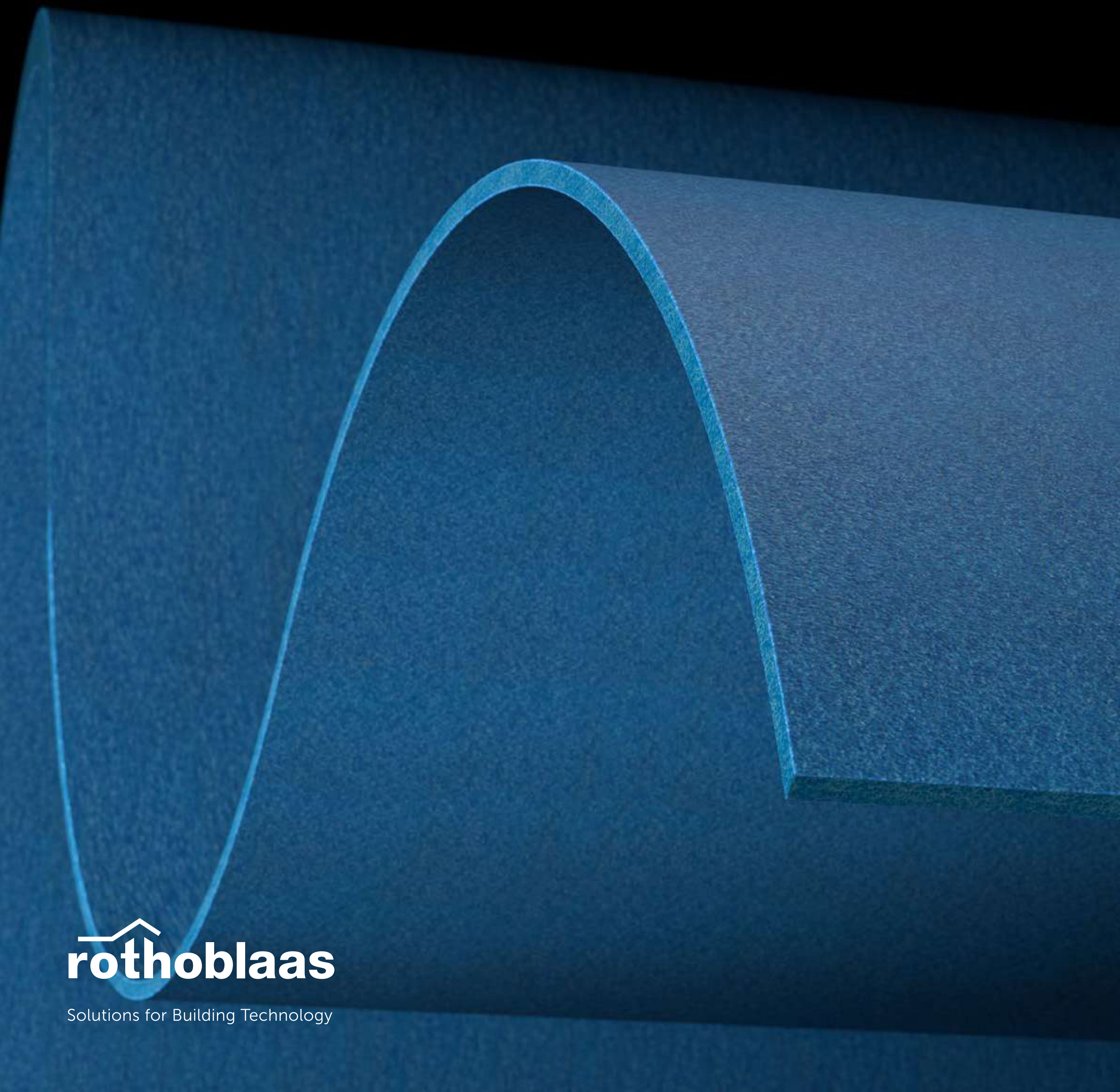


f [Hz]	$L_{i,F,max}$ [dB]
50	79,8
63	77,0
80	68,4
100	67,0
125	67,1
160	58,6
200	61,2
250	54,2
315	50,0
400	45,7
500	40,7
630	38,0

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L1.

SILENT FLOOR PE

TECHNICAL MANUAL



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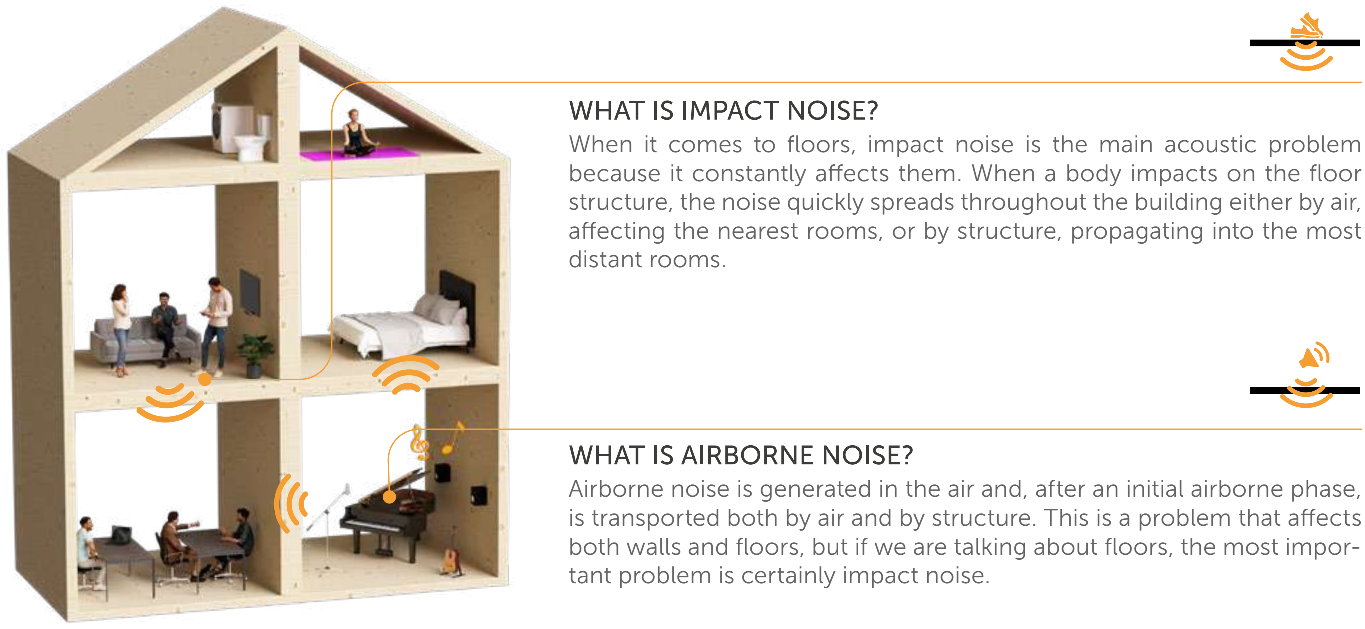
CONTENTS

ACOUSTIC PROBLEMS OF FLOORS



WHAT IS IMPACT NOISE?

When it comes to floors, impact noise is the main acoustic problem because it constantly affects them. When a body impacts on the floor structure, the noise quickly spreads throughout the building either by air, affecting the nearest rooms, or by structure, propagating into the most distant rooms.

WHAT IS AIRBORNE NOISE?

Airborne noise is generated in the air and, after an initial airborne phase, is transported both by air and by structure. This is a problem that affects both walls and floors, but if we are talking about floors, the most important problem is certainly impact noise.

HERE IS THE SOLUTION

In order to be able to minimise the discomfort caused by impact noise, a stratigraphic package should be designed consisting of layers of different materials that are disconnected from each other and are able to dissipate the energy transmitted by the impact.

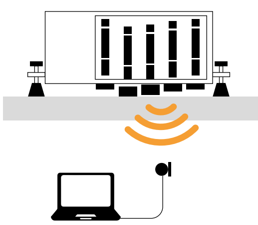
MASS-SPRING-MASS SYSTEM

A floating screed system such as the one shown in the images below can be schematised with a mass-spring-mass system, in which the structural floor represents the mass, the impact-absorbing product is equivalent to the spring, and the upper screed with the floor constitutes the second mass of the system. In this context, "resilient layer" is defined as the element with the spring function characterised by its own *dynamic stiffness s'*.

HOW IS THE IMPACT NOISE LEVEL MEASURED?

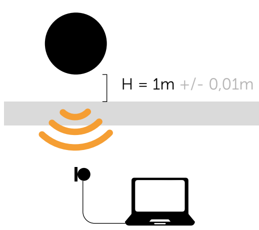
The impact noise level is a measure of the disturbance perceived in a room when an impact noise source is activated in the upper room. It can be measured both on site and in the laboratory. Clearly, ideal conditions exist in the laboratory for the effects of lateral transmission to be neglected, as the laboratory itself is constructed so that the walls are decoupled from the ceiling.

TAPPING MACHINE method



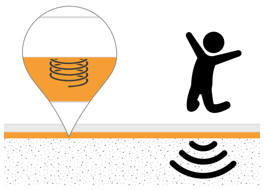
The TAPPING MACHINE is used to simulate "light" and "hard" impacts, such as walking with heeled shoes or the impact caused by falling objects.

RUBBER BALL method



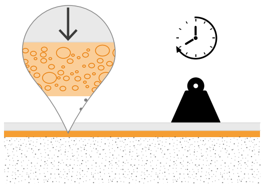
The RUBBER BALL is used to simulate "soft" and "heavy" impacts, such as a barefoot walk or a child jumping.

HOW TO CHOOSE THE BEST PRODUCT



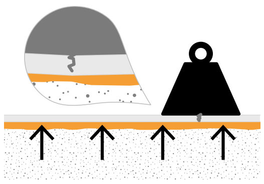
DYNAMIC STIFFNESS – **s'**

Expressed in MN/m³, it is measured according to EN 29052-1 and expresses the deformation capacity of a material that is subjected to a dynamic stress. Consequently, it indicates the ability to dampen the vibrations generated by an impact noise.
The measurement method involves, first, measuring the *apparent dynamic stiffness* s'_t of the material and then correcting it, if necessary, to obtain the *real dynamic stiffness s'*. Dynamic stiffness depends in fact on the *flow resistivity r*, which is measured in the lateral direction of the sample. If the material has specific flow resistivity values, the apparent dynamic stiffness must be corrected by adding the contribution of the gas contained within the material: air.



VISCOUS SLIDING UNDER COMPRESSION – **CREEP**

Expressed as a percentage, it is measured according to EN 1606 and represents the long-term deformation of a material under constant load to be simulated. The measurement in the laboratory must be carried out over a period of at least 90 days.

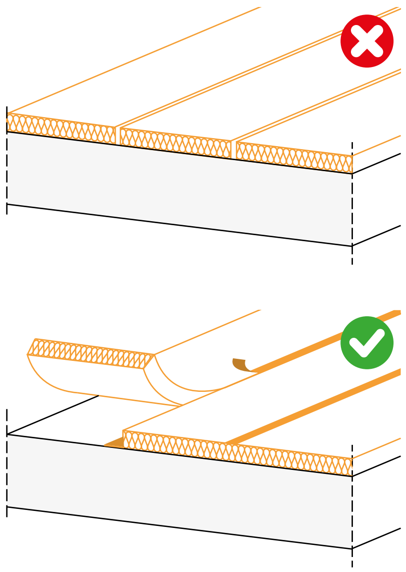


COMPRESSIBILITY - **c**

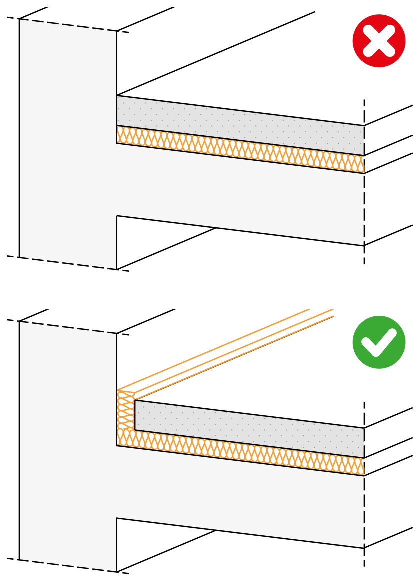
The compressibility class expresses the behaviour of a material while subjected to screed loading. During measurement, the product is subjected to different loads and its thickness is measured. The compressibility measurement is carried out to understand what loads the underscreed product can withstand, in order to avoid cracking and splitting of screeds.

CORRECT INSTALLATION

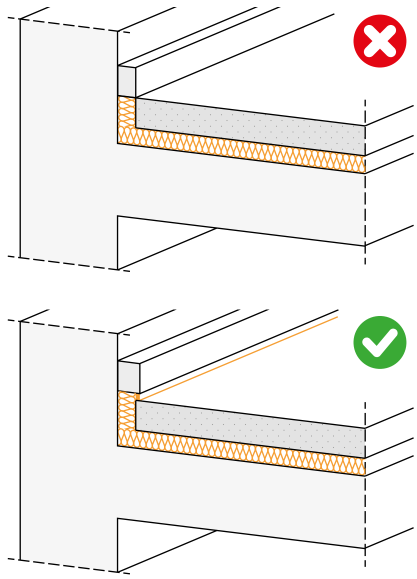
The technological solution of the floating screed is one of the most widely used and one of the most effective, but in order to achieve satisfactory results it is important that the system is designed and implemented correctly.



The resilient layer must be continuous because any gap would represent an acoustic bridge. When installing underscreed mats, care must be taken not to create discontinuities.



It is important to use the SILENT EDGE perimeter strip to ensure that the resilient layer is continuous around the entire perimeter of the room. The SILENT EDGE should only be trimmed after the floor has been installed and grouted.



The skirting board must be installed after the SILENT EDGE has been cut, ensuring that it is always suitably raised from the floor.

IIC vs L_W

IIC stands for **Impact Insulation Class** and is the value obtained by subtracting the noise level measured in the receiving room from the noise level measured in the source room. Impact Insulation Class, sometimes referred to as Impact Isolation Class, measures the resistance of the floor construction assembly against the propagation of impact-generated noise.

SILENT FLOOR PE

RESILIENT UNDERSCREED MEMBRANE MADE OF CLOSED CELL PE

CLOSED CELL
Thanks to the grid of closed cell polyethylene, the foil will not permanently deform and remains effective over time.

COST-PERFORMANCE
Composition of the mixture optimised to provide both good performance and low cost.

VERSATILE
This product is a versatile solution in any application where a light and flexible resilient product is required.

COMPOSITION

closed cell expanded polyethylene

CODES AND DIMENSIONS

CODE	H [m]	L [m]	thickness [mm]	A [m^2]	
SILFLOORPE6	1,55	50	5	77,5	4
SILFLOORPE10	1,30	50	10	65	2

SEVERAL USES
The format and composition offer various uses in the construction field, also as under floor.

STABLE
The grid of polyethylene foam is durable and does not suffer from issues associated with chemical actions or incompatibility of materials.

PRODUCT STRATIGRAPHY COMPARISON

thickness	dynamic stiffness	load	estimate ΔL_w according to formula C.4 of EN ISO 12354-2
5 mm	43 MN/m³	125 kg/m²	24,9 dB
		200 kg/m²	27,5 dB
		250 kg/m²	28,8 dB
10 mm	41 MN/m³	125 kg/m²	25,2 dB
		200 kg/m²	27,8 dB
		250 kg/m²	29,1 dB

SILFLOORPE6

TECHNICAL DATA

Properties	standard	value
Thickness	-	5 mm
Surface mass m	-	0,15 kg/m²
Apparent dynamic stiffness s'_t	EN 29052-1	43 MN/m³
Dynamic stiffness s'	EN 29052-1	43 MN/m³
Theoretical estimate of impact sound pressure level attenuation ΔL_w (1)	ISO 12354-2	24,9 dB
System resonance frequency f_0 (2)	ISO 12354-2	93,8 Hz
Impact sound pressure level attenuation ΔL_w (3)	ISO 10140-3	19 dB
Thermal resistance R_t	-	0,13 m²K/W
Water vapour transmission Sd	-	24,1 m
Water vapour resistance factor μ	EN 12086	5000
Density ρ	-	30 kg/m³
Resistance to airflow r	ISO 9053	> 100.0 kPa·s·m⁻²
Thermal conductivity λ	-	0,038 W/m·K
VOC emission classification	French decree no. 2011-321	A+

(1) ΔL_w= (13 lg(m'))-(14,2 lg(s'))+20,8 [dB] with m'= 125 kg/m².
(2) f_0= 160 √(s'/m') with m'= 125 kg/m².
(3) Measured in the laboratory on 200 mm CLT floor. See the manual for more information on configuration.

EN ISO 12354-2 ANNEX C | ESTIMATE ΔL_W (formula C.4) E ΔL (formula C.1)

The following tables show how the attenuation in dB (ΔL_W e ΔL) of SILFLOORPE6 varies as the load m' (i.e., the surface mass of the layers with which SILFLOORPE6 is loaded) changes.

SILFLOORPE6

	s't or s'	43	43	43	43	43	43	43	43	43	43	43	[MN/m³]
	load m'	50	75	100	125	150	175	200	225	250	275	300	[kg/m²]
	ΔL_w	19,7	22,0	23,6	24,9	25,9	26,8	27,5	28,2	28,8	29,3	29,8	[dB]
	f_0	148,4	121,2	104,9	93,8	85,7	79,3	74,2	69,9	66,4	63,3	60,6	[Hz]
							ΔL in frequency						
[Hz]	**100**	-5,1	-2,5	-0,6	0,8	2,0	3,0	3,9	4,7	5,3	6.0	6,5	[dB]
[Hz]	**125**	-2,2	0,4	2,3	3,7	4,9	5,9	6,8	7,6	8,3	8,9	9,4	[dB]
[Hz]	**160**	1,0	3,6	5,5	7,0	8,1	9,1	10,0	10,8	11,5	12,1	12,7	[dB]
[Hz]	**200**	3,9	6,5	8,4	9,9	11,0	12,1	12,9	13,7	14,4	15,0	15,6	[dB]
[Hz]	**250**	6,8	9,4	11,3	12,8	14,0	15,0	15,8	16,6	17,3	17,9	18,5	[dB]
[Hz]	**315**	9,8	12,4	14,3	15,8	17,0	18,0	18,8	19,6	20,3	20,9	21,5	[dB]
[Hz]	**400**	12,9	15,6	17,4	18,9	20,1	21,1	22,0	22,7	23,4	24,0	24,6	[dB]
[Hz]	**500**	15,8	18,5	20,3	21,8	23,0	24,0	24,9	25,6	26,3	26,9	27,5	[dB]
[Hz]	**630**	18,8	21,5	23,4	24,8	26,0	27,0	27,9	28,6	29,3	29,9	30,5	[dB]
[Hz]	**800**	22,0	24,6	26,5	27,9	29,1	30,1	31,0	31,7	32,4	33,1	33,6	[dB]
[Hz]	**1000**	24,9	27,5	29,4	30,8	32,0	33,0	33,9	34,7	35,3	36,0	36,5	[dB]
[Hz]	**1250**	27,8	30,4	32,3	33,7	34,9	35,9	36,8	37,6	38,3	38,9	39,4	[dB]
[Hz]	**1600**	31,0	33,6	35,5	37,0	38,1	39,1	40,0	40,8	41,5	42,1	42,7	[dB]
[Hz]	**2000**	33,9	36,5	38,4	39,9	41,0	42,1	42,9	43,7	44,4	45,0	45,6	[dB]
[Hz]	**2500**	36,8	39,4	41,3	42,8	44,0	45,0	45,8	46,6	47,3	47,9	48,5	[dB]
[Hz]	**3150**	39,8	42,4	44,3	45,8	47,0	48,0	48,8	49,6	50,3	50,9	51,5	[dB]

EN ISO 12354-2 Allegato C - formula C.4

$$\Delta L_W = \left(13 \lg\left(m'\right)\right) - \left(14{,}2 \lg\left(s'\right)\right) + 20{,}8 \text{ dB}$$

EN ISO 12354-2 Allegato C - formula C.1

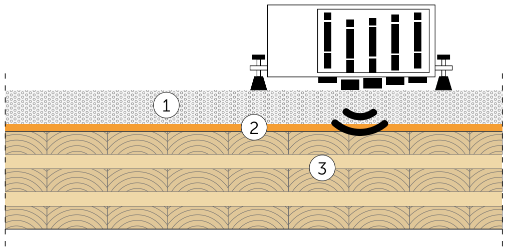
$$\Delta L = \left(30 \lg \frac{f}{f_0}\right) \text{dB}$$

EN ISO 12354-2 Allegato C - formula C.2

$$f_0 = 160 \sqrt{\frac{s'}{m'}}$$

LABORATORY MEASUREMENT | CLT FLOOR 1

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
REFERENCE STANDARD: ISO 10140-3 AND EN ISO 717-2

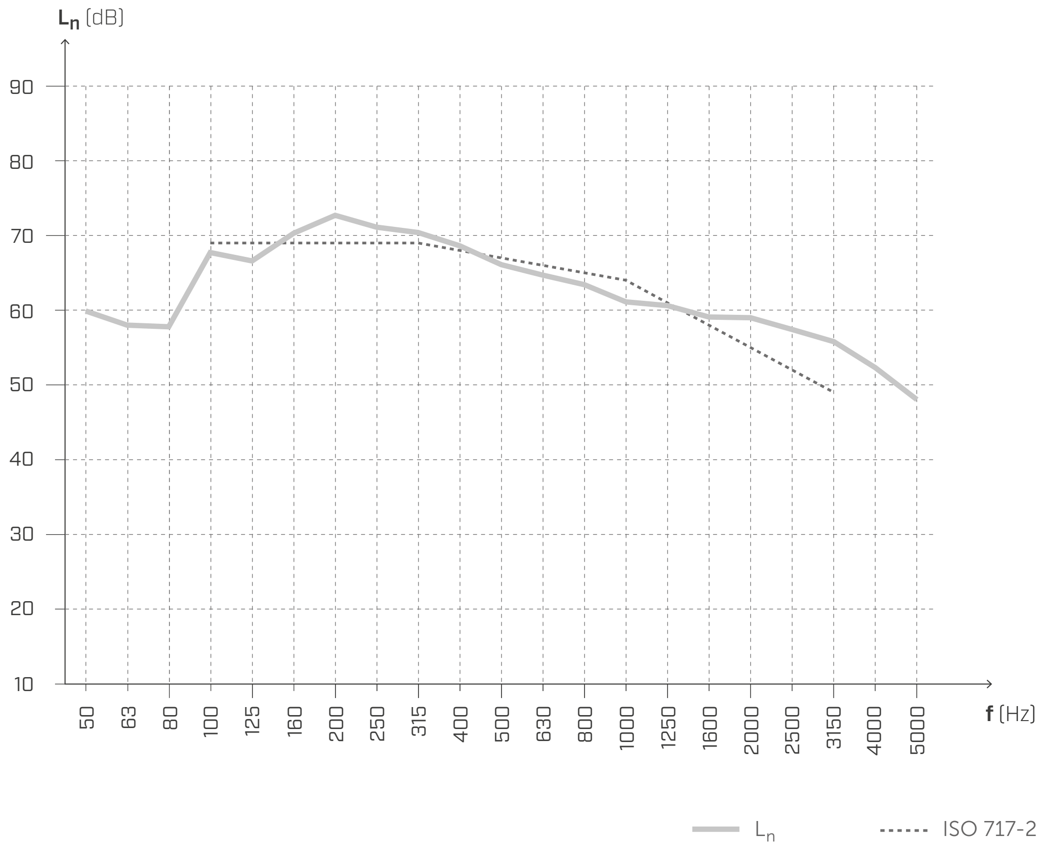


FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 214,2 kg/m^2
Receiving room volume = 60,1 m^3

(1) concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
(2) SILENT FLOOR PE - SILFLOORPE5 (thickness: 5 mm); (30 kg/m^3); (0,15 kg/m^2)
(3) CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION



f [Hz]	L_n [dB]
50	59,9
63	58,0
80	57,8
100	67,7
125	66,6
160	70,3
200	72,7
250	71,1
315	70,4
400	68,6
500	66,1
630	64,7
800	63,4
1000	61,1
1250	60,6
1600	59,1
2000	59
2500	57,4
3150	55,8
4000	52,3
5000	48,0

$L_{n,w}$ (C_I) = **67 (-3) dB**

IIC = **43**

$\Delta L_{n,w}$ = -19 dB[(1)]

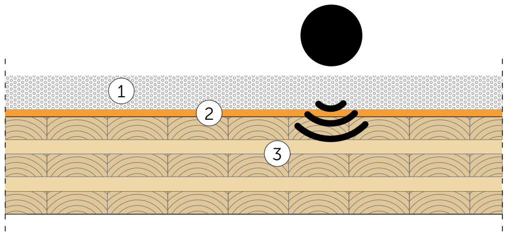
ΔIIC = +19[(2)]

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L7.

NOTES:
[(1)] Decrease due to the addition of layers no. 1 and no. 2.
[(2)] Increase due to the addition of layers no. 1 and no. 2.

LABORATORY MEASUREMENT | CLT FLOOR 1

MEASUREMENT OF THE EVALUATION INDEX OF THE REDUCTION OF THE IMPACT SOUND PRESSURE LEVEL
RUBBER BALL METHOD | REFERENCE STANDARD: ISO 16283-2

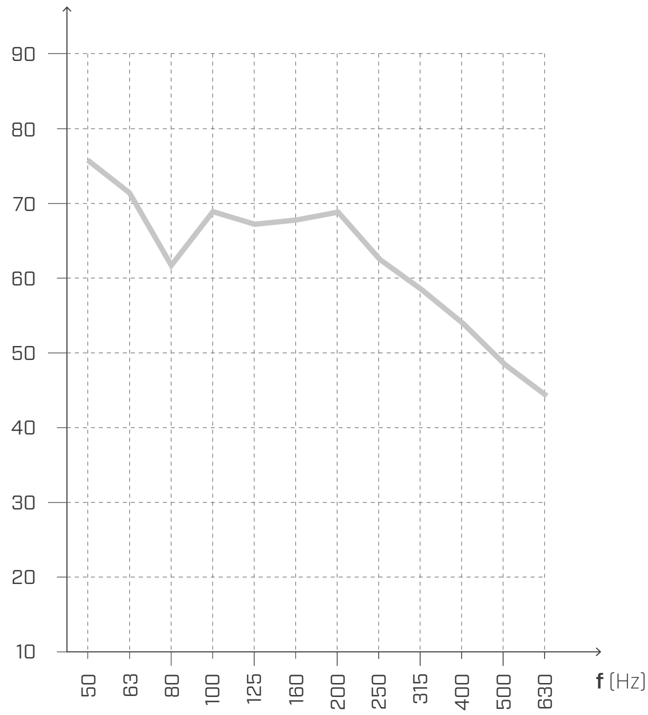


FLOOR SLAB

Surface = 13,71 m^2
Surface mass = 214,2 kg/m^2
Receiving room volume = 60,1 m^3

1. concrete screed (thickness: 50 mm); (2600 kg/m^3); (130 kg/m^2)
2. **SILENT FLOOR PE - SILFLOORPE5** (thickness: 5 mm); (30 kg/m^3); (0,15 kg/m^2)
3. CLT 5 layers (thickness: 200 mm); (420 kg/m^3); (84 kg/m^2)

IMPACT SOUND INSULATION



f [Hz]	$L_{i,F,max}$ [dB]
50	75,8
63	71,4
80	61,7
100	68,9
125	67,2
160	67,8
200	68,9
250	62,5
315	58,5
400	53,9
500	48,5
630	44,3

$L_{i,F,max}$

Testing laboratory: Building Physics Lab | Libera Università di Bolzano.
Test protocol: Pr. 2022-rothoLATE-L7.

SILFLOORPE10

TECHNICAL DATA

Properties	standard	value
Thickness	-	10 mm
Surface mass m	-	0,30 kg/m^2
Apparent dynamic stiffness s'_t	EN 29052-1	41 MN/m^3
Dynamic stiffness s'	EN 29052-1	41 MN/m^3
Theoretical estimate of impact sound pressure level attenuation ΔL_w(1)	ISO 12354-2	25,2 dB
System resonance frequency f_0(2)	ISO 12354-2	91,6 Hz
Impact sound pressure level attenuation ΔL_w(3)	ISO 10140-3	-
Thermal resistance R_t	-	0,26 m^{2}K/W
Water vapour transmission Sd	-	48,2 m
Water vapour resistance factor µ	EN 12086	5000
Density ρ	-	30 kg/m^3
Resistance to airflow r	ISO 9053	> 100.0 kPa·s·m^{-2}
Thermal conductivity λ	-	0,038 W/m·K
VOC emission classification	French decree no. 2011-321	A+

(1) ΔL_W= (13 lg(m'))-(14,2 lg(s'))+20,8 [dB] with m'= 125 kg/m^2.
(2) f_0= 160 √(s'/m') with m'= 125 kg/m^2.
(3) Measured in the laboratory on 200 mm CLT floor. See the manual for more information on configuration.

EN ISO 12354-2 ANNEX C | ESTIMATE ΔL_W (formula C.4) E ΔL (formula C.1)

The following tables show how the attenuation in dB (ΔL_W e ΔL) of SILFLOORPE10 varies as the load m' (i.e., the surface mass of the layers with which SILFLOORPE10 is loaded) changes.

SILFLOORPE10

	s't or s'	41	41	41	41	41	41	41	41	41	41	41	[MN/m^3]
	load m'	50	75	100	125	150	175	200	225	250	275	300	[kg/m^2]
	ΔL_W	20,0	22,3	23,9	25,2	26,2	27,1	27,8	28,5	29,1	29,6	30,1	[dB]
	f_0	144,9	118,3	102,4	91,6	83,7	77,4	72,4	68,3	64,8	61,8	59,1	[Hz]
		ΔL in frequency											
[Hz]	**100**	-4,8	-2,2	-0,3	1,1	2,3	3,3	4,2	5,0	5,7	6,3	6,8	[dB]
[Hz]	**125**	-1,9	0,7	2,6	4,0	5,2	6,2	7,1	7,9	8,6	9,2	9,7	[dB]
[Hz]	**160**	1,3	3,9	5,8	7,3	8,4	9,5	10,3	11,1	11,8	12,4	13,0	[dB]
[Hz]	**200**	4,2	6,8	8,7	10,2	11,4	12,4	13,2	14,0	14,7	15,3	15,9	[dB]
[Hz]	**250**	7,1	9,7	11,6	13,1	14,3	15,3	16,1	16,9	17,6	18,2	18,8	[dB]
[Hz]	**315**	10,1	12,8	14,6	16,1	17,3	18,3	19,1	19,9	20,6	21,2	21,8	[dB]
[Hz]	**400**	13,2	15,9	17,7	19,2	20,4	21,4	22,3	23,0	23,7	24,3	24,9	[dB]
[Hz]	**500**	16,1	18,8	20,7	22,1	23,3	24,3	25,2	25,9	26,6	27,2	27,8	[dB]
[Hz]	**630**	19,1	21,8	23,7	25,1	26,3	27,3	28,2	28,9	29,6	30,3	30,8	[dB]
[Hz]	**800**	22,3	24,9	26,8	28,2	29,4	30,4	31,3	32,1	32,7	33,4	33,9	[dB]
[Hz]	**1000**	25,2	27,8	29,7	31,1	32,3	33,3	34,2	35,0	35,7	36,3	36,8	[dB]
[Hz]	**1250**	28,1	30,7	32,6	34,0	35,2	36,2	37,1	37,9	38,6	39,2	39,7	[dB]
[Hz]	**1600**	31,3	33,9	35,8	37,3	38,4	39,5	40,3	41,1	41,8	42,4	43,0	[dB]
[Hz]	**2000**	34,2	36,8	38,7	40,2	41,4	42,4	43.2	44,0	44,7	45,3	45,9	[dB]
[Hz]	**2500**	37,1	39,7	41,6	43,1	44,3	45,3	46,1	46,9	47,6	48,2	48,8	[dB]
[Hz]	**3150**	40,1	42,8	44,6	46,1	47,3	48,3	49,1	49,9	50,6	51,2	51,8	[dB]

EN ISO 12354-2 Allegato C - formula C.4

$$\Delta L_W = \left(13 \lg\left(m'\right)\right) - \left(14{,}2 \lg\left(s'\right)\right) + 20{,}8 \text{ dB}$$

EN ISO 12354-2 Allegato C - formula C.1

$$\Delta L = \left(30 \lg \frac{f}{f_0}\right) \text{dB}$$

EN ISO 12354-2 Allegato C - formula C.2

$$f_0 = 160 \sqrt{\frac{s'}{m'}}$$

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