



# PIANO

TECHNICAL MANUAL

  
**rothoblaas**

Solutions for Building Technology



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## RESILIENT SOUNDPROOFING PROFILE

### CODES AND DIMENSIONS

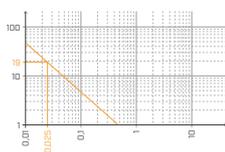
CODE	B [mm]	L [m]	s [mm]	pcs
PIANO4040	80	10	6	1
PIANO5050	100	10	6	1
PIANO6060	120	10	6	1
PIANO140	140	10	6	1
PIANOB4040	80	10	6	1
PIANOB5050	100	10	6	1
PIANOB6060	120	10	6	1
PIANOB140	140	10	6	1
PIANOC080	80	10	6	1
PIANOC100	100	10	6	1
PIANOC120	120	10	6	1
PIANOC140	140	10	6	1
PIANOD080	80	10	6	1
PIANOD100	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)

page 12

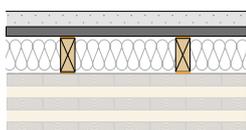


### $K_{ij}$ values entered in **ETA**

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

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

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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 $\Delta_{t,ij}^{(1)}$	elastic modulus in compression $E_c$
PIANO A 	6 mm	> 4 dB	0,23 N/mm <sup>2</sup>
PIANO B 	6 mm	> 4 dB	1,08 N/mm <sup>2</sup>
PIANO C 	6 mm	> 4 dB	7,92 N/mm <sup>2</sup>
PIANO D 	6 mm	> 4 dB	22,1 N/mm <sup>2</sup>
PIANO E 	6 mm	> 4 dB	24,76 N/mm <sup>2</sup>

### LEGEND:

-  load for acoustic optimisation
-  compression at 3 mm deformation (ultimate limit state)

dynamic elastic modulus $E'_{5\text{Hz}} - E'_{50\text{Hz}}$	damping factor $\tan\delta_{5\text{Hz}} - \tan\delta_{50\text{Hz}}$	acoustic load / maximum applied load <sup>(2)</sup>									
		0	5	10	15	20	25	30	35		
<b>0,5 N/mm<sup>2</sup> - 0,5 N/mm<sup>2</sup></b>	<b>0,186 - 0,238</b>	acoustic load [N/mm <sup>2</sup> ] <b>0,008   0,052</b>									
		maximum applied load [N/mm <sup>2</sup> ] <b>0,008   0,15</b>									
<b>1,75 N/mm<sup>2</sup> - 2,07 N/mm<sup>2</sup></b>	<b>0,308 - 0,372</b>	acoustic load [N/mm <sup>2</sup> ] <b>0,04   0,286</b>									
		maximum applied load [N/mm <sup>2</sup> ] <b>0,04   0,85</b>									
<b>9,35 N/mm<sup>2</sup> - 11,61 N/mm<sup>2</sup></b>	<b>0,272 - 0,306</b>	acoustic load [N/mm <sup>2</sup> ] <b>0,26   1,4</b>									
		maximum applied load [N/mm <sup>2</sup> ] <b>0,26   12,07</b>									
<b>20,3 N/mm<sup>2</sup> - 25,81 N/mm<sup>2</sup></b>	<b>0,297 - 0,349</b>	acoustic load [N/mm <sup>2</sup> ] <b>1,2   2,28</b>									
		maximum applied load [N/mm <sup>2</sup> ] <b>1,2   16,9</b>									
<b>54,8 N/mm<sup>2</sup> - 67,08 N/mm<sup>2</sup></b>	<b>0,243 - 0,253</b>	acoustic load [N/mm <sup>2</sup> ] <b>1,8   3,2</b>									
		maximum applied load [N/mm <sup>2</sup> ] <b>1,8   17,07</b>									

<sup>(1)</sup>  $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$

<sup>(2)</sup> 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.

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

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<sup>(1)</sup>

CODE	B [mm]	load for acoustic optimisation <sup>(2)</sup> [kN/m] [lb/ft]				compression for acoustic optimisation <sup>(2)</sup> [N/mm <sup>2</sup> ] [psi]		reduction [mm] [in.]		compressive stress at 3 mm (ultimate limit state) [N/mm <sup>2</sup> ] [psi]
		min	max	min	max	min	max			
PIANO4040	80	0,64	472	4,16	3068					
	40 (divided)	0,32	236	2,08	1534					
PIANO5050	100	0,8	590	5,2	3835	0,008 1,2	0,052 7,5	0,2 8	1,35 53	
	50 (divided)	0,4	295	2,6	1918					
PIANO6060	120	0,96	708	6,24	4602					
	60 (divided)	0,48	354	3,12	2301					
PIANO140	140	1,12	826	7,28	5369					

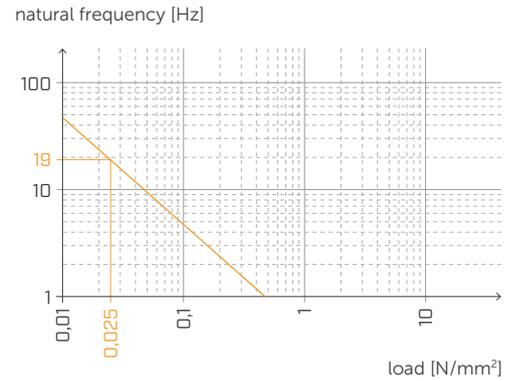
**Note:** The static behaviour of the material in compression is evaluated, considering that the deformations due to the loads are static. This is because a building is not affected by significant movement phenomena, nor dynamic deformation.

Rothblaas 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.

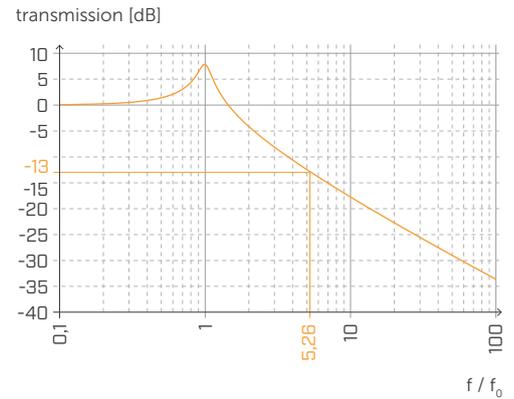
Suppose there is a load of 0,025 N/mm<sup>2</sup> acting on the profile. In this case, we used the PIANO A product, because the load is not particularly high. Reading the graph, it can be seen that the profile has a resonance frequency of around 19 Hz.



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.

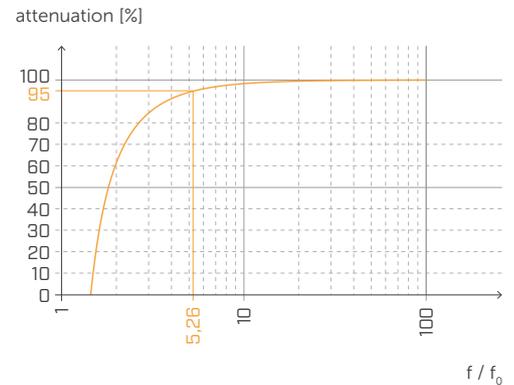


**TRANSMISSION IS POSITIVE WHEN THE MATERIAL TRANSMITS AND IS NEGATIVE WHEN THE PROFILE BEGINS TO INSULATE.** This means this figure shows that the product, loaded in this way, insulates 13 dB at a reference frequency of 100 Hz.

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

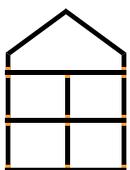
### STATIC AND DYNAMIC MODULUS OF ELASTICITY

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.



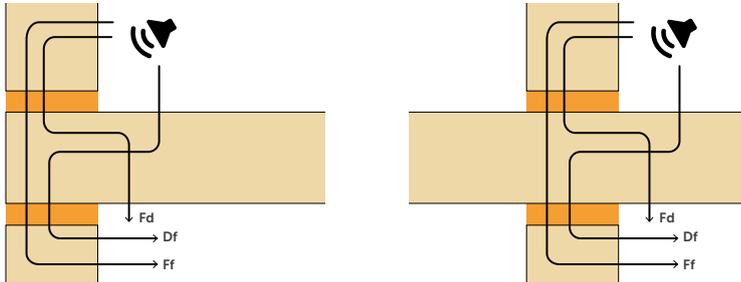
In buildings, **PIANO** is subject to static and quasi-static loading, so the dynamic elastic modulus is not as representative of the product's actual behaviour.

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 - $K_{ij}$

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.



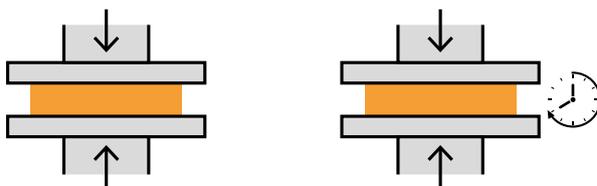
In the European Technical Assessment, the results are expressed clearly to avoid ambiguity in the configuration.



## 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<sup>(1)</sup>

CODE	B [mm]	load for acoustic optimisation <sup>(2)</sup> [kN/m]		compression for acoustic optimisation <sup>(2)</sup> [N/mm <sup>2</sup> ]		deformation [mm]		compressive stress at 3 mm (ultimate limit state) [N/mm <sup>2</sup> ]
		from	a	from	a	from	a	
PIANO4040	80	0,64	4,16	0,008	0,052	0,2	1,35	0,15
	40 (divided)	0,32	2,08					
PIANO5050	100	0,8	5,2					
	50 (divided)	0,4	2,6					
PIANO6060	120	0,96	6,24					
	60 (divided)	0,48	3,12					
PIANO140	140	1,12	7,28					

<sup>(1)</sup>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.

<sup>(2)</sup>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 $\Delta_{l,ij}$ <sup>(3)</sup>	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 $\tan \delta_{1Hz}$	ISO 4664-1	0,177
Damping factor $\tan \delta_{5Hz}$	ISO 4664-1	0,186
Damping factor $\tan \delta_{10Hz}$	ISO 4664-1	0,192
Damping factor $\tan \delta_{50Hz}$	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 $\sigma_{1mm}$	ISO 844	0,04 N/mm <sup>2</sup>
Compressive stress at 2 mm strain $\sigma_{2mm}$	ISO 844	0,08 N/mm <sup>2</sup>
Compressive stress at 3 mm strain $\sigma_{3mm}$	ISO 844	0,15 N/mm <sup>2</sup>
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	4,25%

<sup>(3)</sup>  $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$



## PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$ <sup>(3)</sup> : > 4 dB

Maximum applied load  
(3 mm deformation):

**0,15 N/mm<sup>2</sup>**

Acoustic service load:

from **0,008** to **0,052 N/mm<sup>2</sup>**

# STATIC LOAD

[buildings]



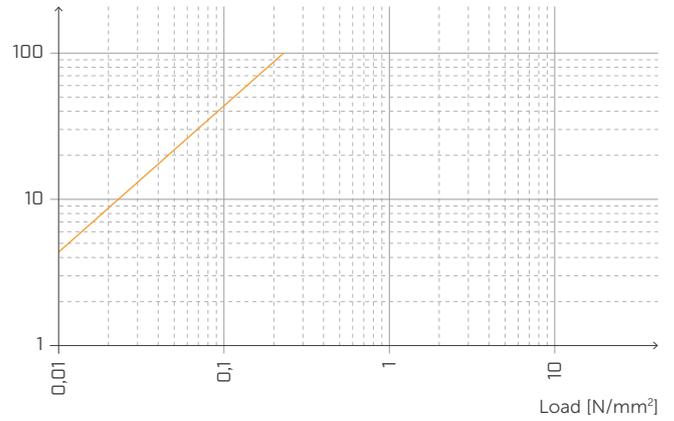
## NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



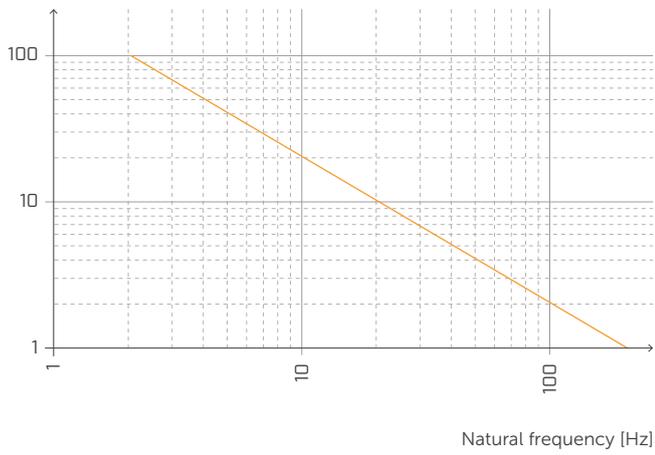
## DEFORMATION AND LOAD

Deformation [%]



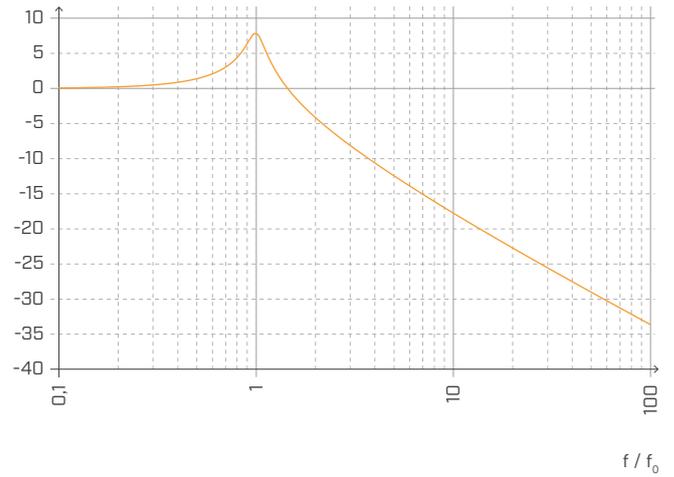
## DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



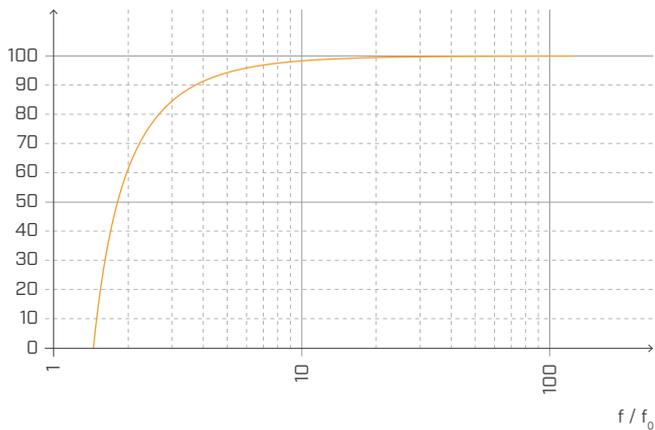
## TRANSMISSIBILITY

Transmission [dB]



## ATTENUATION

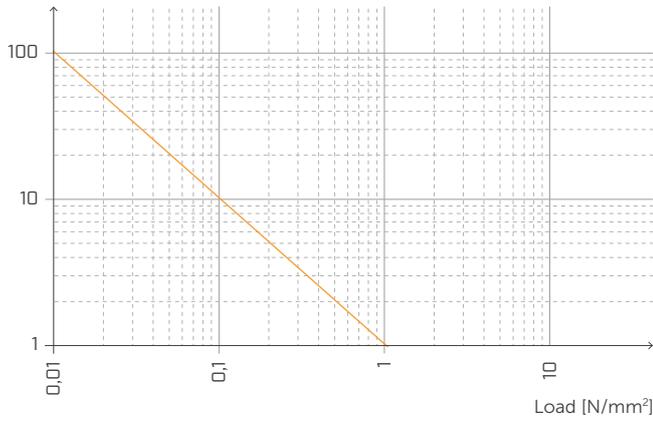
Attenuation [%]



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

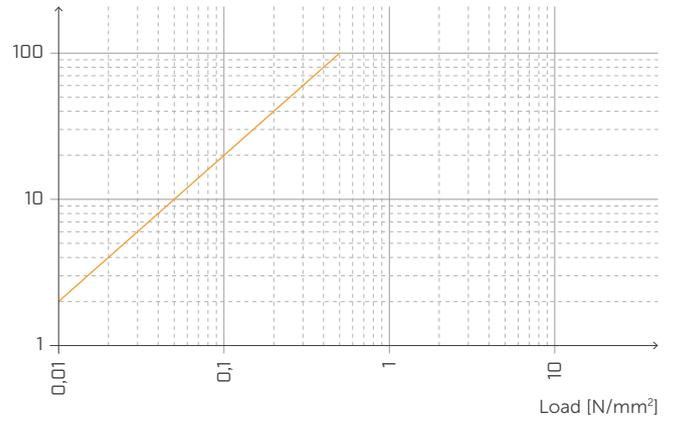
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



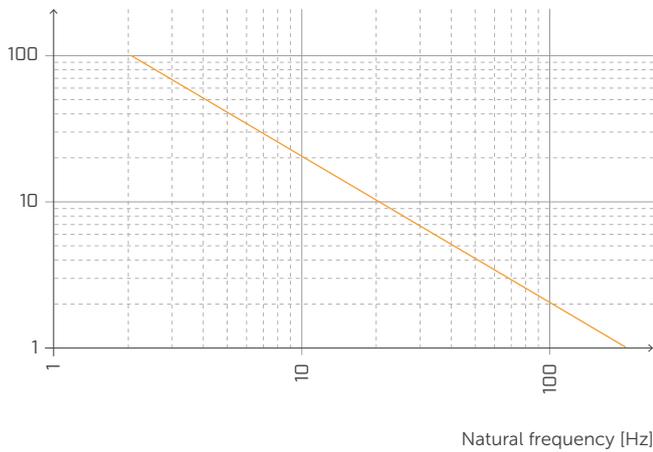
**DEFORMATION AND LOAD**

Deformation [%]



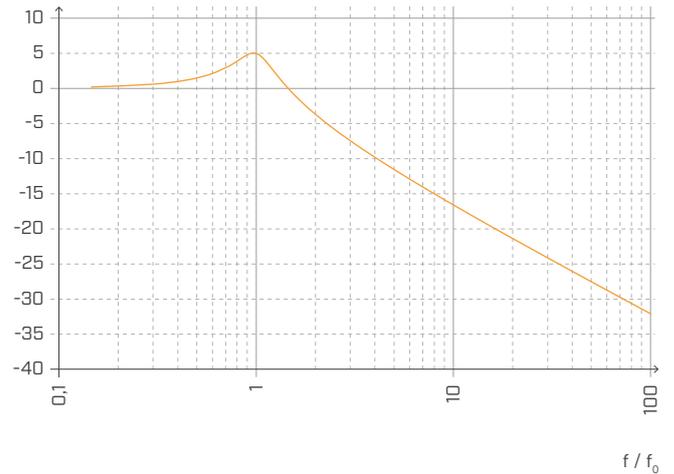
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



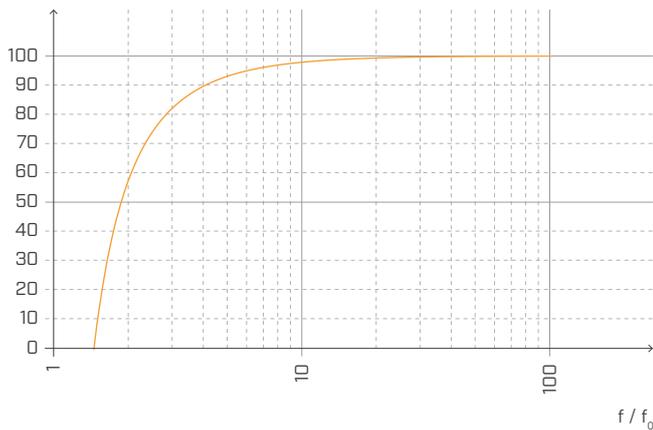
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

Attenuation [%]



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

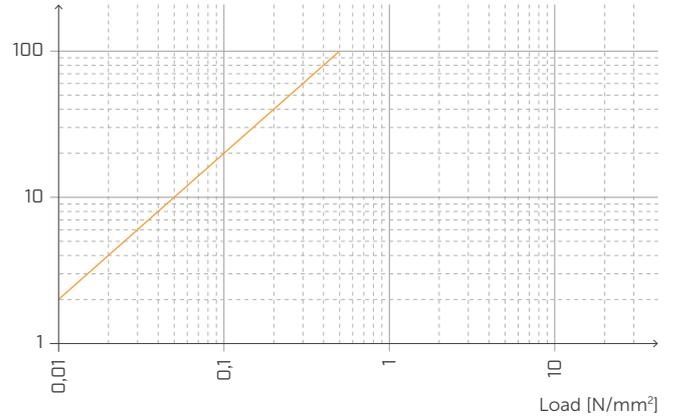
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



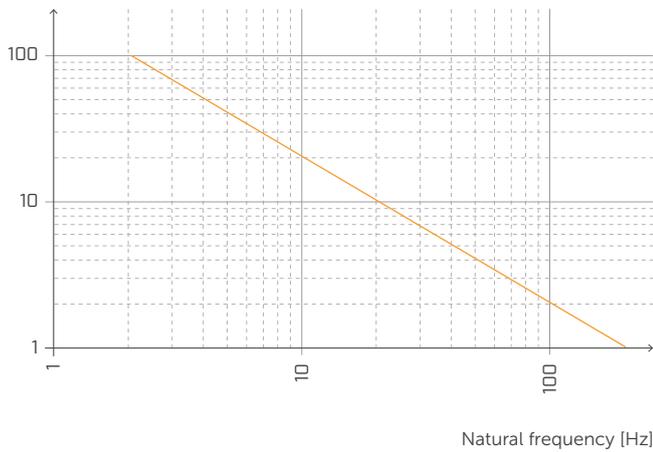
**DEFORMATION AND LOAD**

Deformation [%]



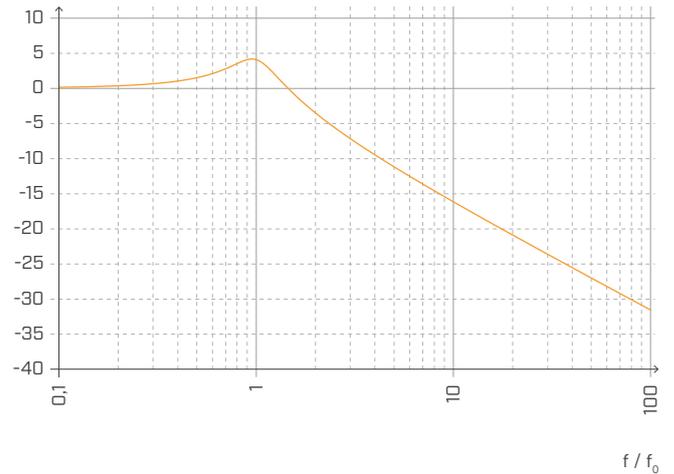
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



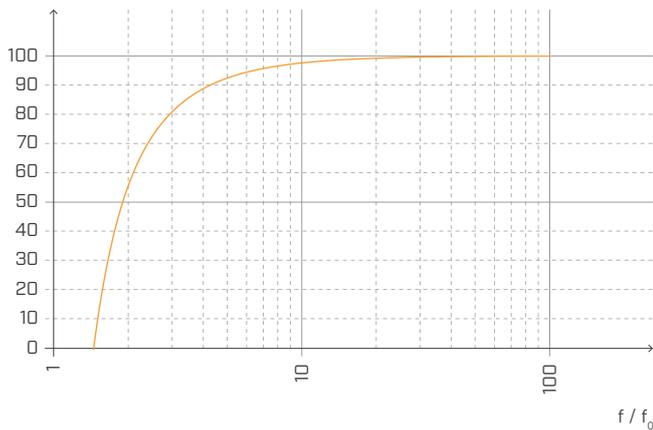
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

Attenuation [%]



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

# PIANO B

TABLE OF USE<sup>(1)</sup>

CODE	B [mm]	load for acoustic optimisation <sup>(2)</sup> [kN/m]		compression for acoustic optimisation <sup>(2)</sup> [N/mm <sup>2</sup> ]		deformation [mm]		compressive stress at 3 mm (ultimate limit state) [N/mm <sup>2</sup> ]
		from	a	from	a	from	a	
PIANO B4040	80	3,2	21,6	0,04	0,27	0,2	1,49	0,85
	40 (divided)	1,6	10,8					
PIANO B5050	100	4	27					
	50 (divided)	2	13,5					
PIANO B6060	120	4,8	32,4					
	60 (divided)	2,4	16,2					
PIANO A140	140	5,6	37,8					

<sup>(1)</sup>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.

<sup>(2)</sup>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 $\Delta_{l,ij}$ <sup>(3)</sup>	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 $\tan \delta_{1Hz}$	ISO 4664-1	0,270
Damping factor $\tan \delta_{5Hz}$	ISO 4664-1	0,308
Damping factor $\tan \delta_{10Hz}$	ISO 4664-1	0,314
Damping factor $\tan \delta_{50Hz}$	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 $\sigma_{1mm}$	ISO 844	0,14 N/mm <sup>2</sup>
Compressive stress at 2 mm strain $\sigma_{2mm}$	ISO 844	0,31 N/mm <sup>2</sup>
Compressive stress at 3 mm strain $\sigma_{3mm}$	ISO 844	0,85 N/mm <sup>2</sup>
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	1,50%

<sup>(3)</sup>  $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$



## PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$ <sup>(3)</sup> : > 4 dB

Maximum applied load  
(3 mm deformation):

**0,85 N/mm<sup>2</sup>**

Acoustic service load:

from **0,04** to **0,27 N/mm<sup>2</sup>**

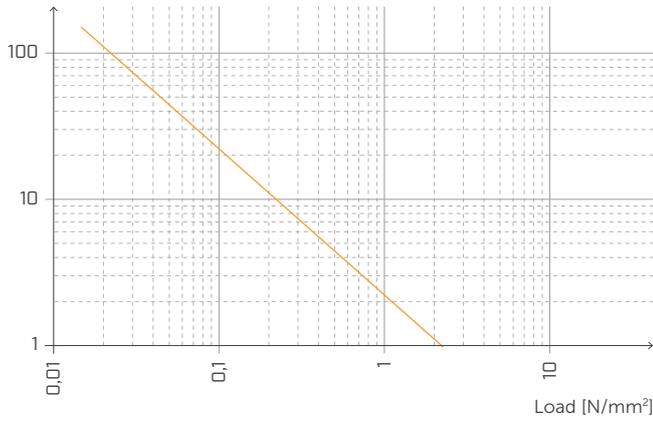
# STATIC LOAD

[buildings]



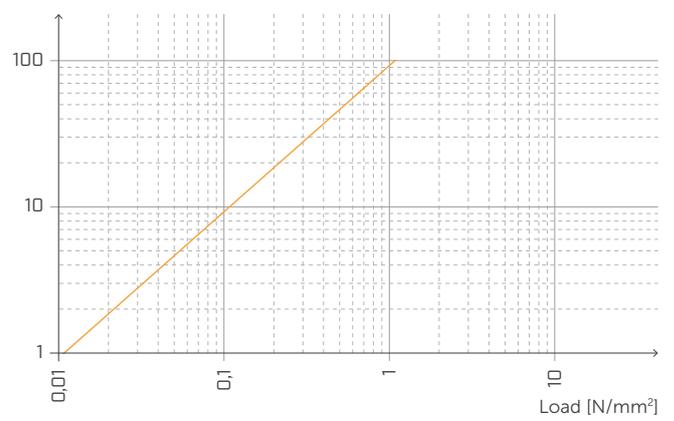
## NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



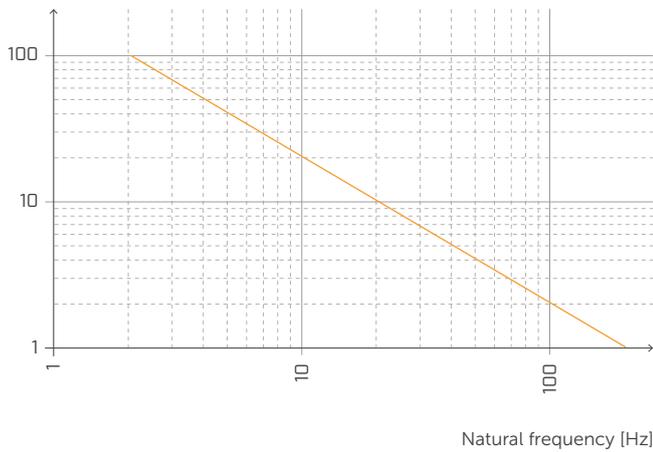
## DEFORMATION AND LOAD

Deformation [%]



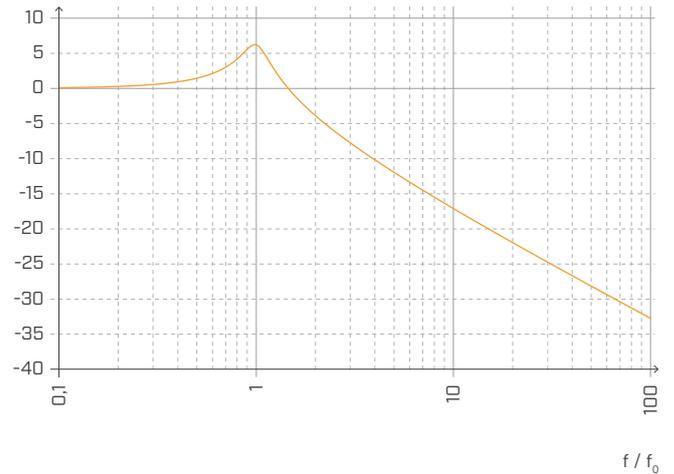
## DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



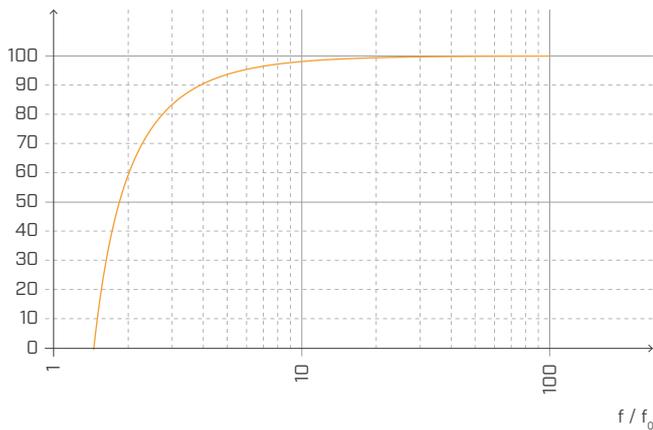
## TRANSMISSIBILITY

Transmission [dB]



## ATTENUATION

Attenuation [%]



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

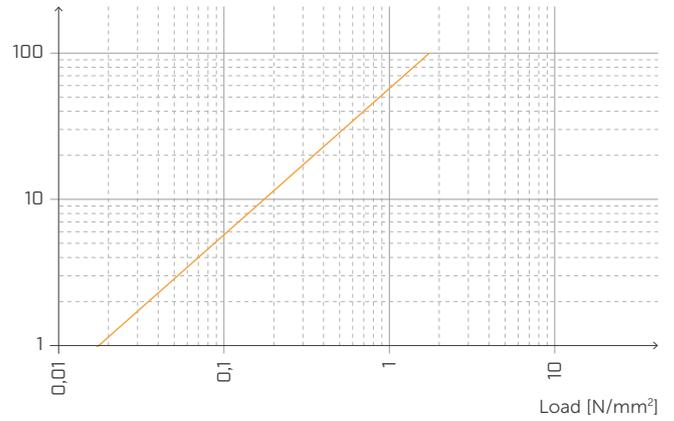
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



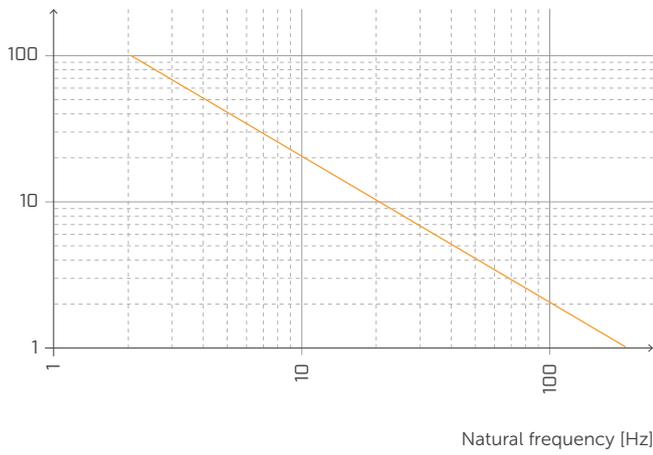
**DEFORMATION AND LOAD**

Deformation [%]



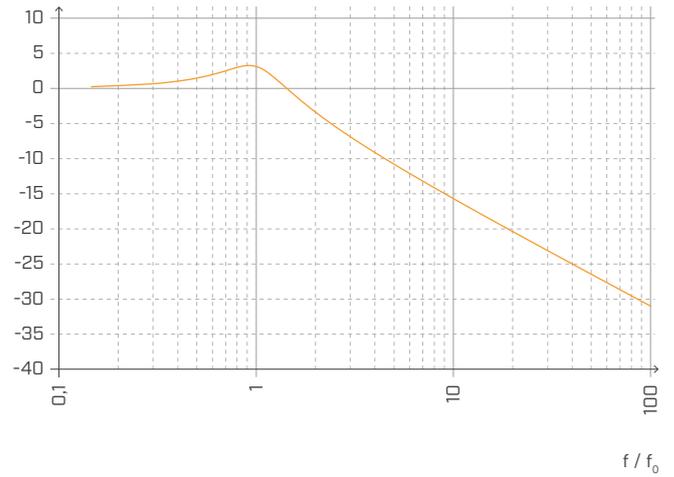
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



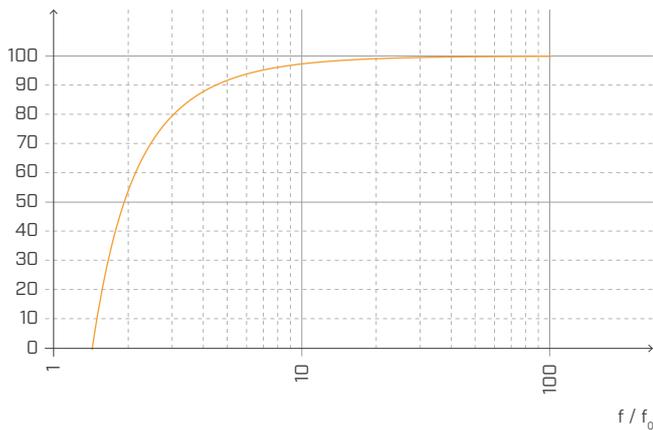
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

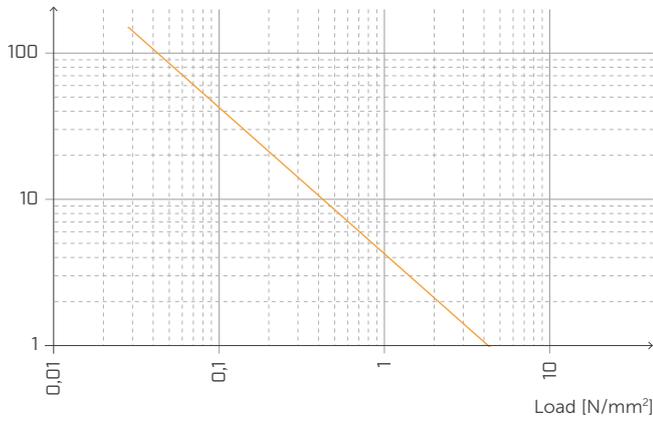
Attenuation [%]



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

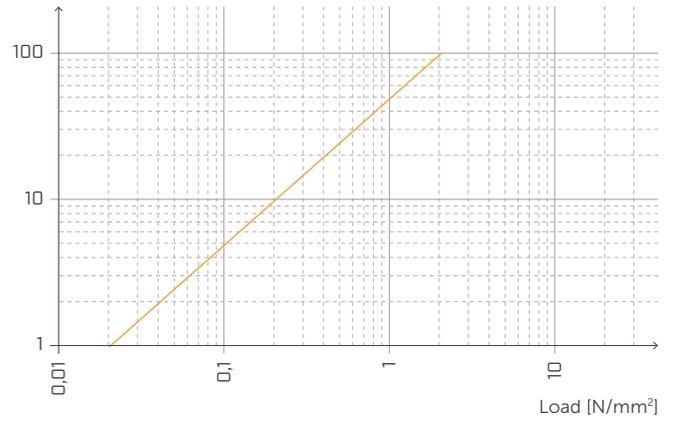
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



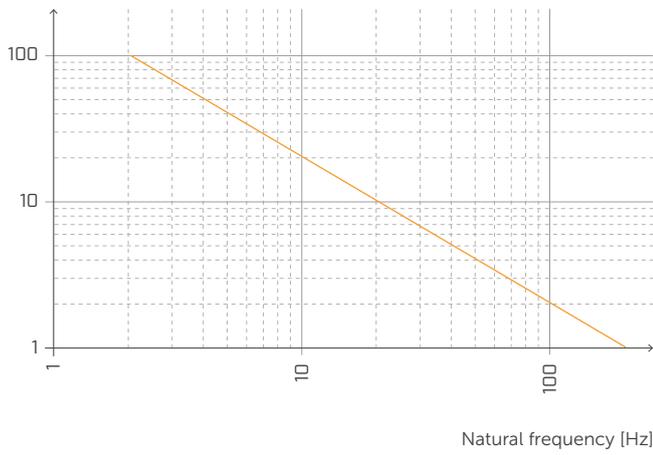
**DEFORMATION AND LOAD**

Deformation [%]



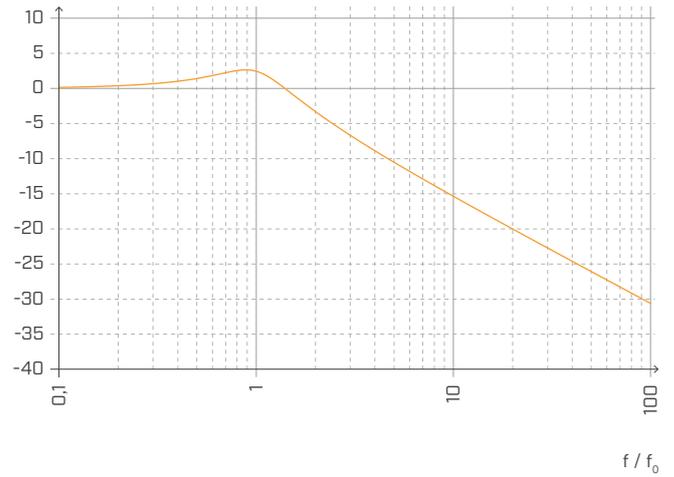
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



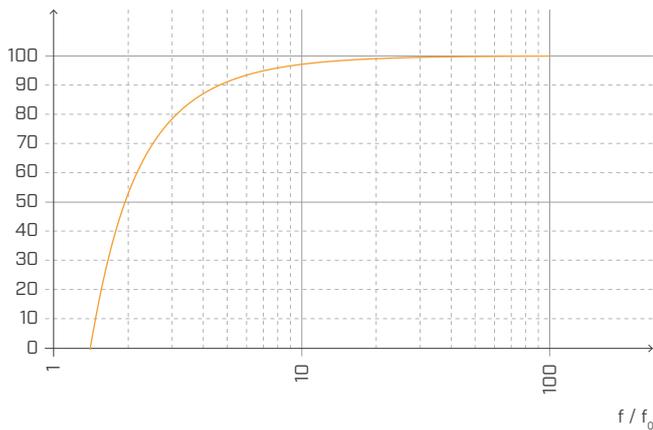
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

Attenuation [%]



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

# PIANO C

TABLE OF USE<sup>(1)</sup>

CODE	B [mm]	load for acoustic optimisation <sup>(2)</sup> [kN/m]		compression for acoustic optimisation <sup>(2)</sup> [N/mm <sup>2</sup> ]		deformation [mm]		compressive stress at 3 mm (ultimate limit state) [N/mm <sup>2</sup> ]
		from	a	from	a	from	a	
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					

<sup>(1)</sup>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.

<sup>(2)</sup>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 $\Delta_{l,ij}$ <sup>(3)</sup>	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 $\tan \delta_{1Hz}$	ISO 4664-1	0,258
Damping factor $\tan \delta_{5Hz}$	ISO 4664-1	0,272
Damping factor $\tan \delta_{10Hz}$	ISO 4664-1	0,283
Damping factor $\tan \delta_{50Hz}$	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 $\sigma_{1mm}$	ISO 844	1,50 N/mm <sup>2</sup>
Compressive stress at 2 mm strain $\sigma_{2mm}$	ISO 844	3,55 N/mm <sup>2</sup>
Compressive stress at 3 mm strain $\sigma_{3mm}$	ISO 844	9,23 N/mm <sup>2</sup>
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	< 1%

<sup>(3)</sup>  $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$



## PERFORMANCE

Acoustic improvement tested:

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

Maximum applied load  
(3 mm deformation):

**12,07 N/mm<sup>2</sup>**

Acoustic service load:

from **0,12 to 1,4 N/mm<sup>2</sup>**

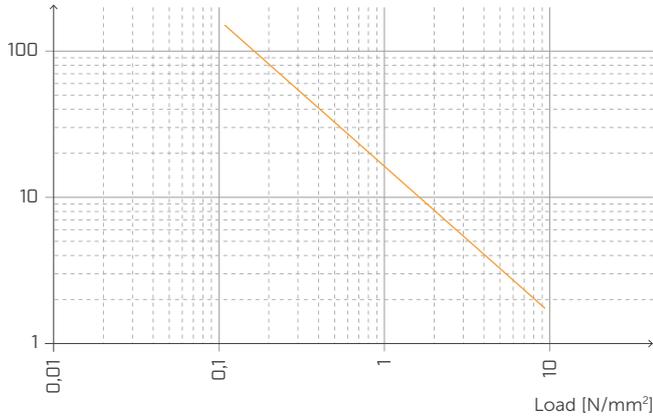
# STATIC LOAD

(buildings)



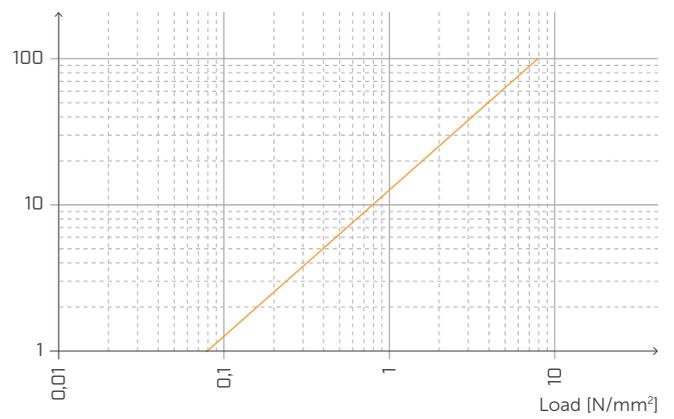
## NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



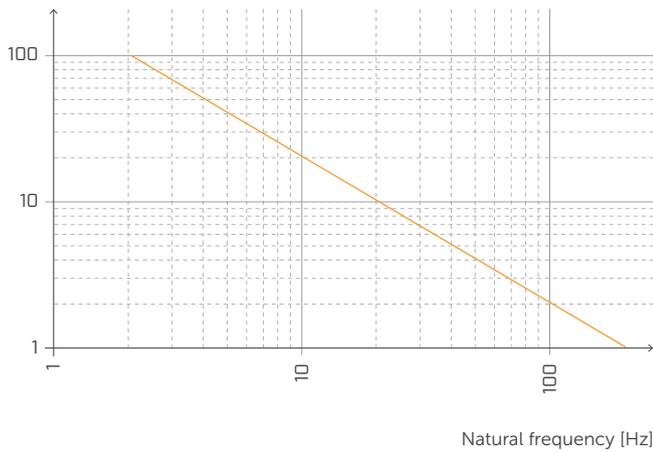
## DEFORMATION AND LOAD

Deformation [%]



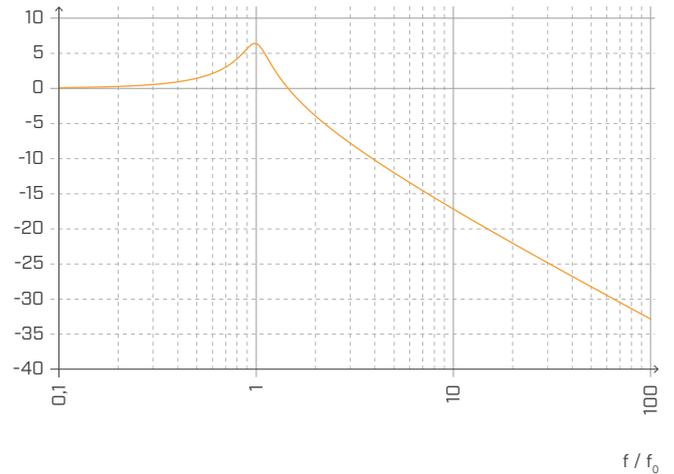
## DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



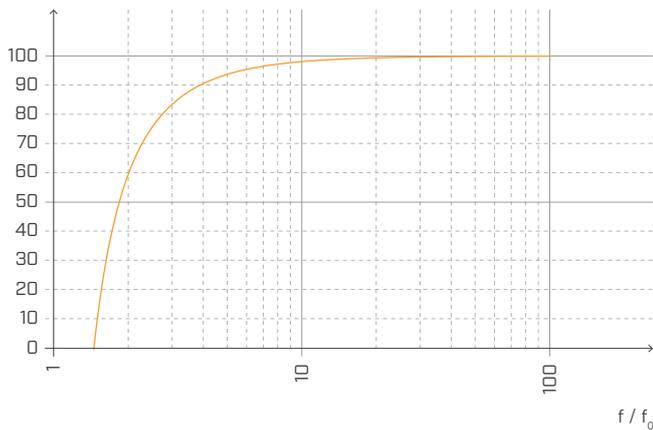
## TRANSMISSIBILITY

Transmission [dB]



## ATTENUATION

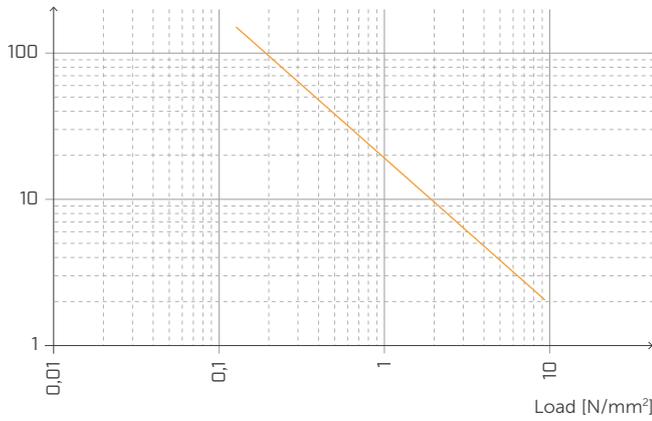
Attenuation [%]



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

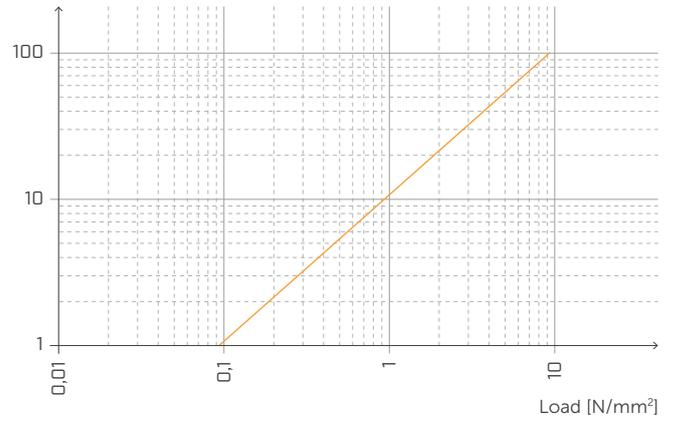
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



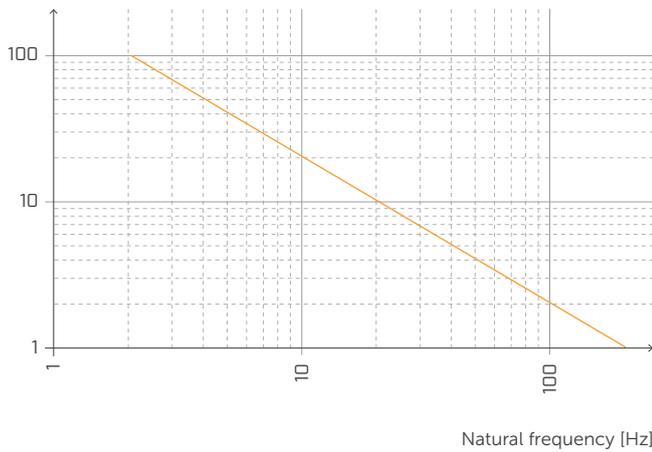
**DEFORMATION AND LOAD**

Deformation [%]



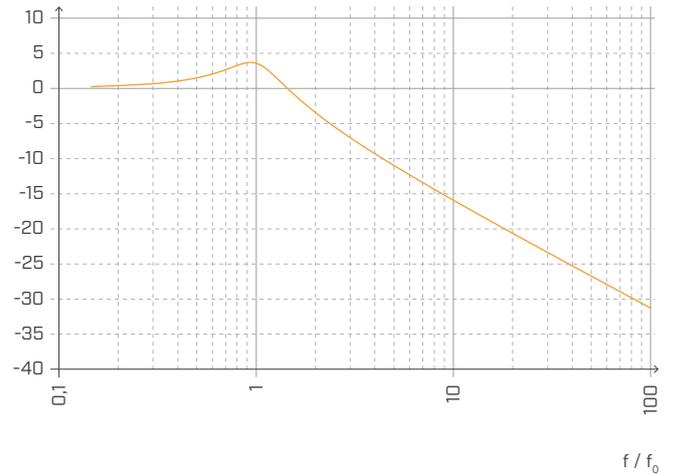
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



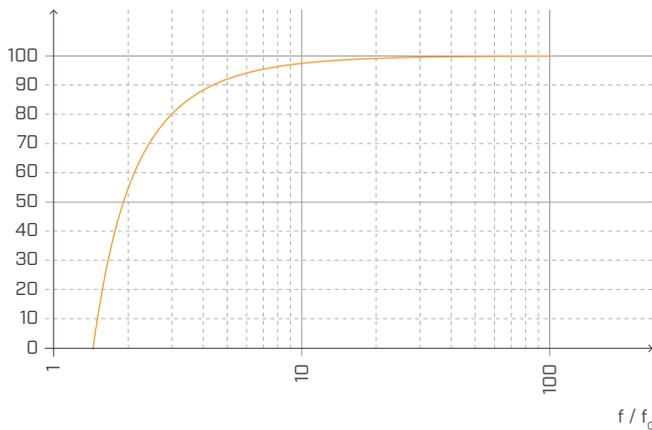
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

Attenuation [%]



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

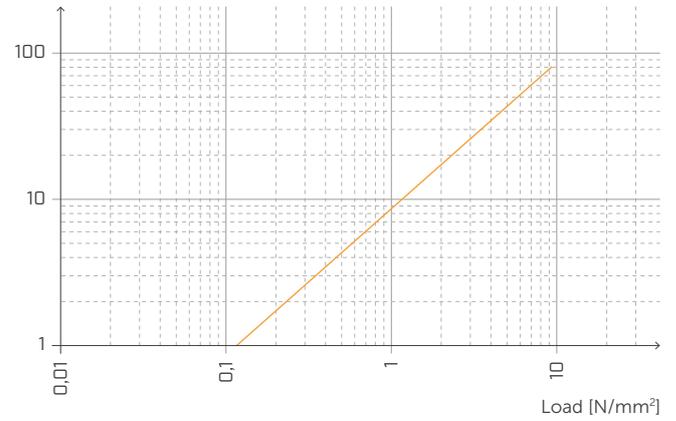
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



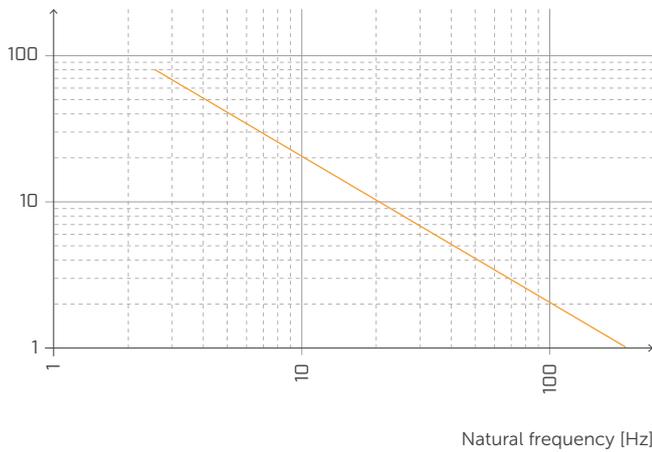
**DEFORMATION AND LOAD**

Deformation [%]



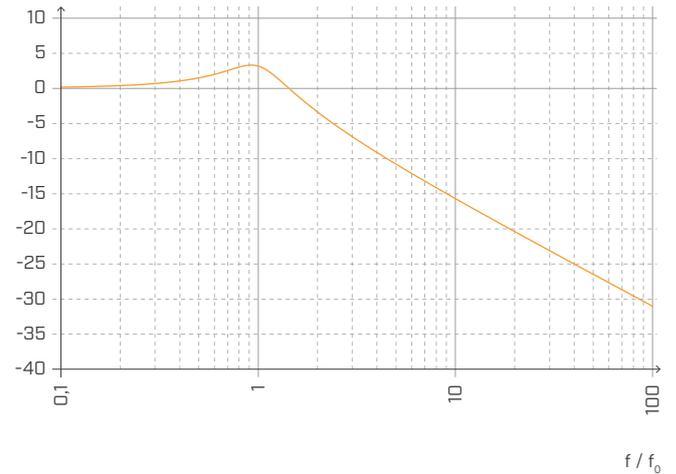
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



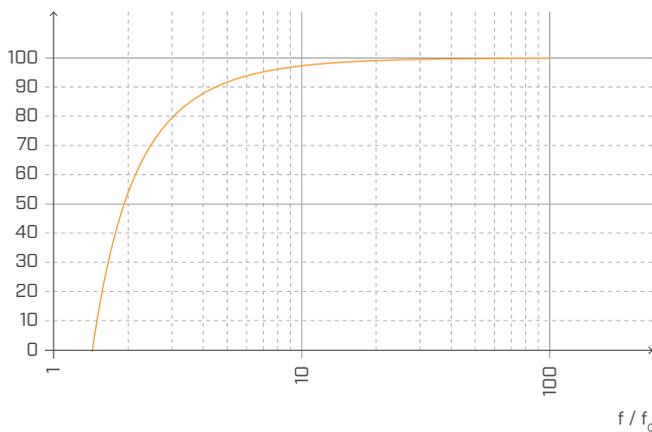
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

Attenuation [%]



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

# PIANO D

TABLE OF USE<sup>(1)</sup>

CODE	B [mm]	load for acoustic optimisation <sup>(2)</sup> [kN/m]		compression for acoustic optimisation <sup>(2)</sup> [N/mm <sup>2</sup> ]		deformation [mm]		compressive stress at 3 mm (ultimate limit state) [N/mm <sup>2</sup> ]
		from	a	from	a	from	a	
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					

<sup>(1)</sup>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.

<sup>(2)</sup>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 $\Delta_{l,ij}$ <sup>(3)</sup>	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 $\tan \delta_{1Hz}$	ISO 4664-1	0,273
Damping factor $\tan \delta_{5Hz}$	ISO 4664-1	0,297
Damping factor $\tan \delta_{10Hz}$	ISO 4664-1	0,31
Damping factor $\tan \delta_{50Hz}$	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 $\sigma_{1mm}$	ISO 844	4,40 N/mm <sup>2</sup>
Compressive stress at 2 mm strain $\sigma_{2mm}$	ISO 844	10,49 N/mm <sup>2</sup>
Compressive stress at 3 mm strain $\sigma_{3mm}$	ISO 844	16,9 N/mm <sup>2</sup>
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	< 1%

<sup>(3)</sup>  $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$



## PERFORMANCE

Acoustic improvement tested:

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

Maximum applied load  
(3 mm deformation):

**16,9 N/mm<sup>2</sup>**

Acoustic service load:

from **1,2** to **2,28 N/mm<sup>2</sup>**

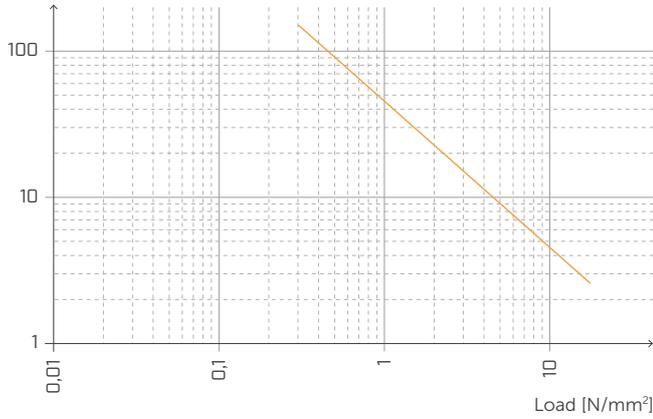
# STATIC LOAD

[buildings]



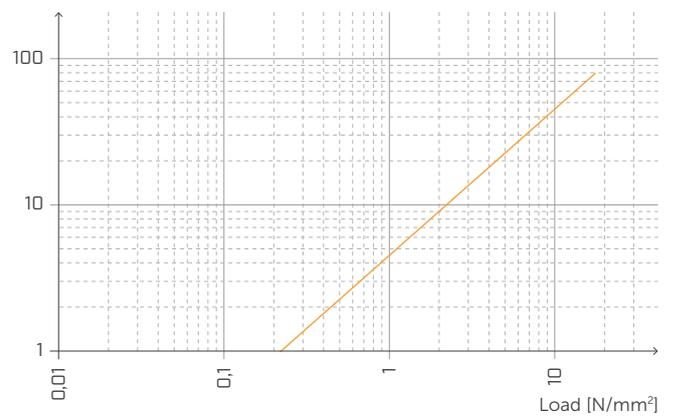
## NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



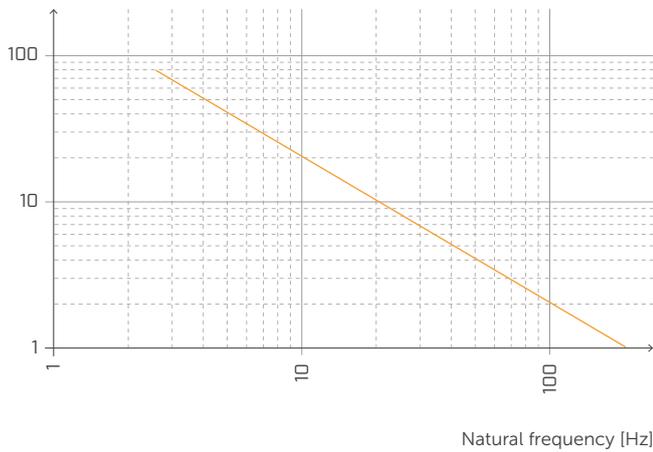
## DEFORMATION AND LOAD

Deformation [%]



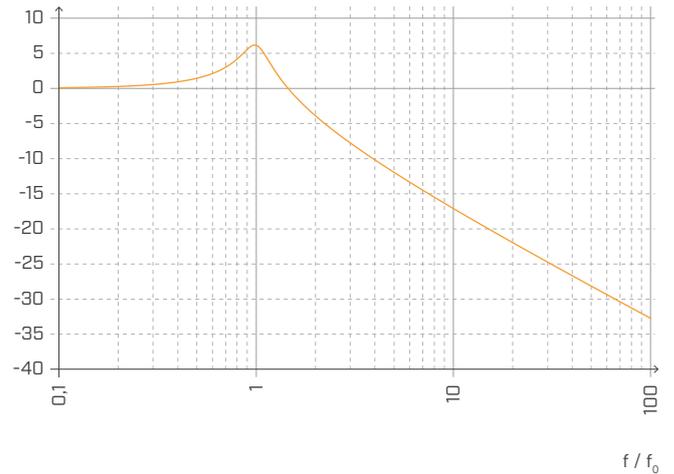
## DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



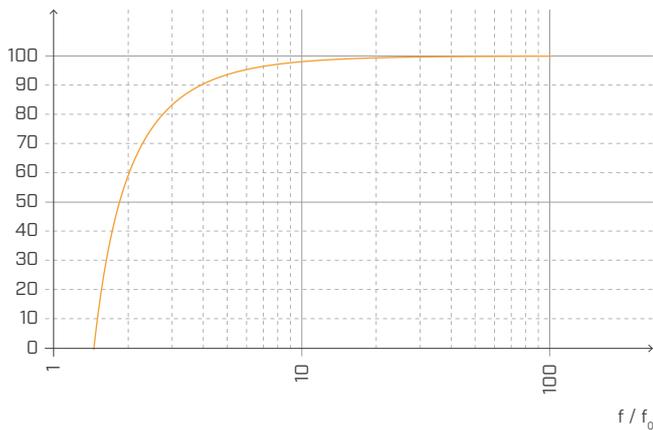
## TRANSMISSIBILITY

Transmission [dB]



## ATTENUATION

Attenuation [%]



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

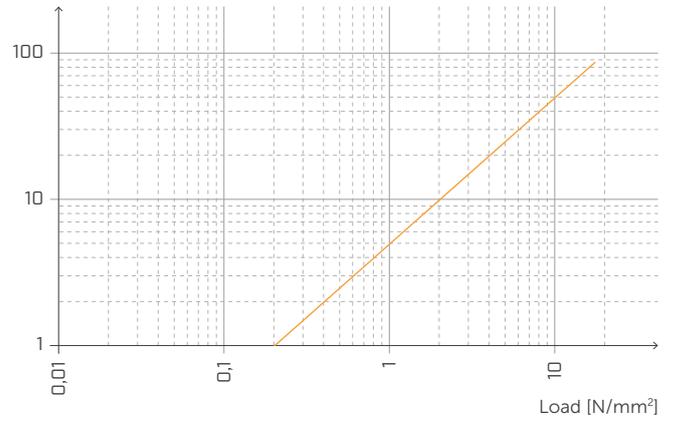
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



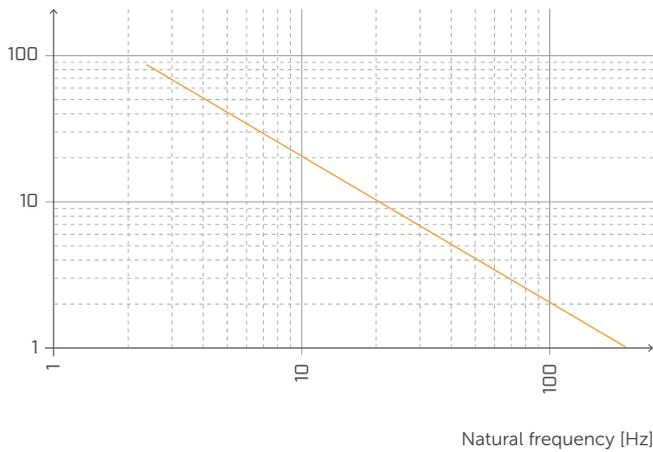
**DEFORMATION AND LOAD**

Deformation [%]



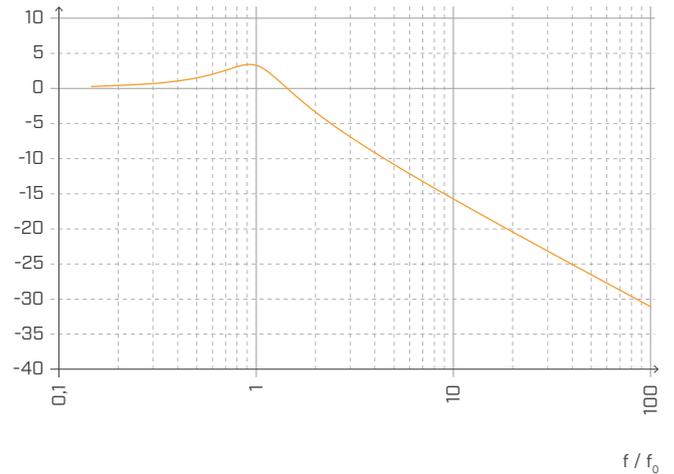
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



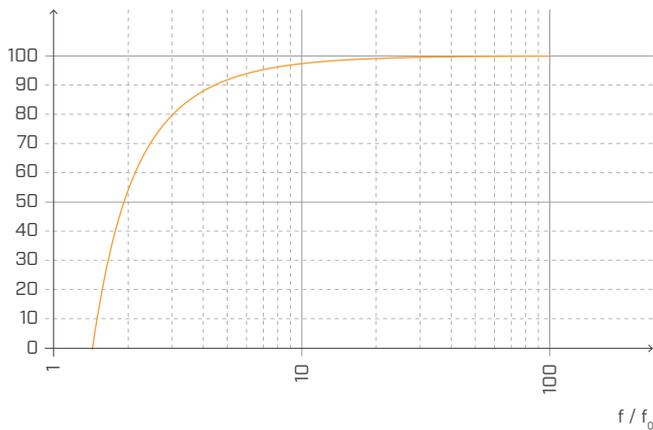
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

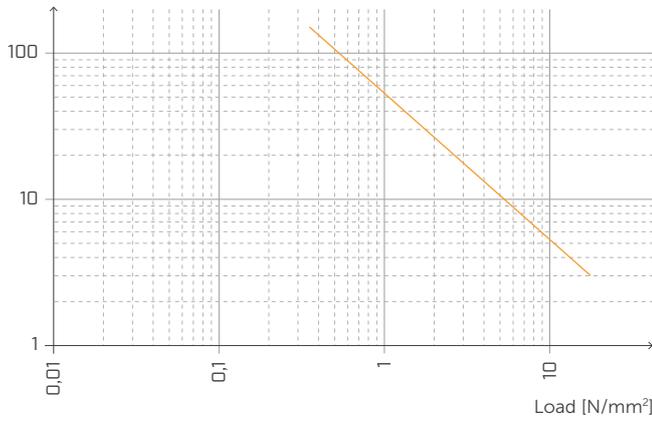
Attenuation [%]



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

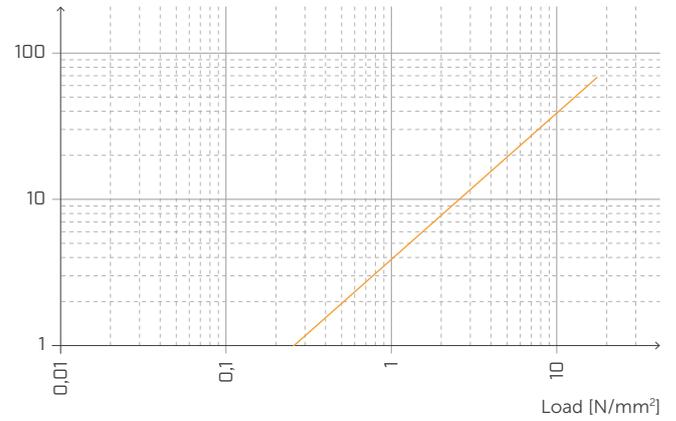
**NATURAL FREQUENCY AND LOAD**

Natural frequency [Hz]



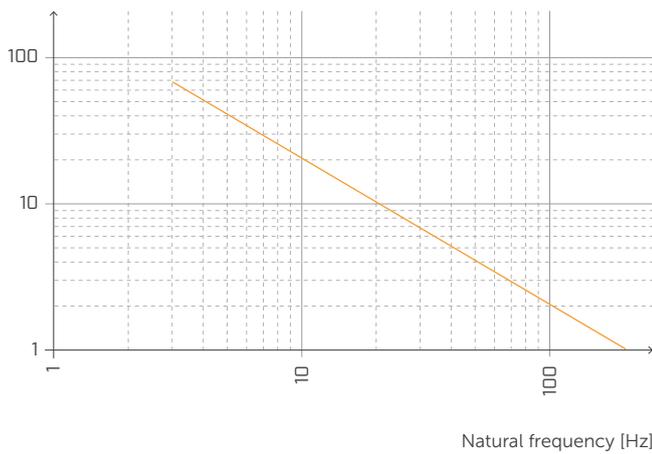
**DEFORMATION AND LOAD**

Deformation [%]



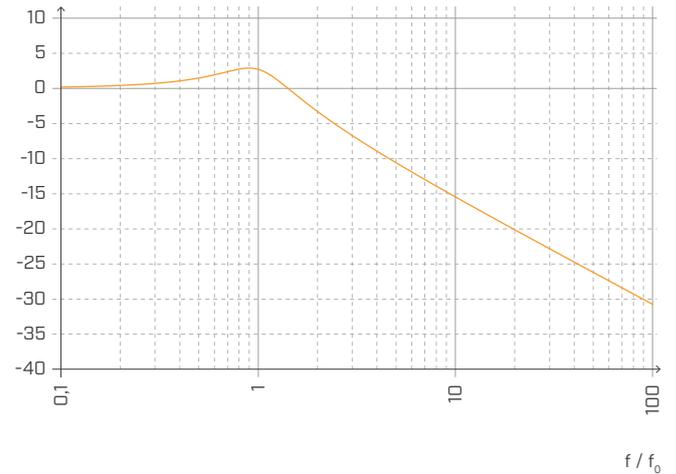
**DEFORMATION AND NATURAL FREQUENCY**

Deformation [%]



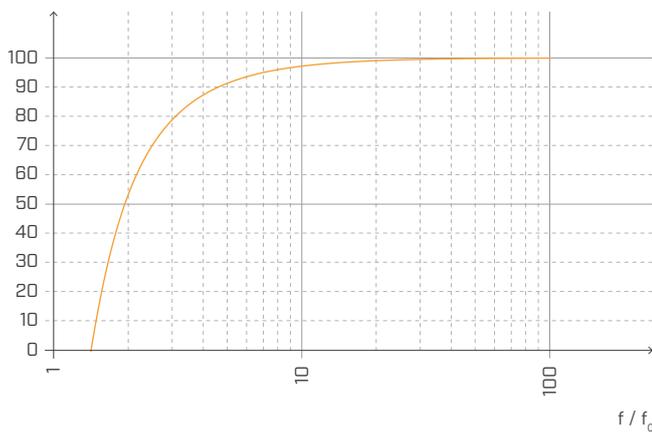
**TRANSMISSIBILITY**

Transmission [dB]



**ATTENUATION**

Attenuation [%]



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

# PIANO E

TABLE OF USE<sup>(1)</sup>

CODE	B [mm]	load for acoustic optimisation <sup>(2)</sup> [kN/m]		compression for acoustic optimisation <sup>(2)</sup> [N/mm <sup>2</sup> ]		deformation [mm]		compressive stress at 3 mm (ultimate limit state) [N/mm <sup>2</sup> ]
		from	a	from	a	from	a	
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					

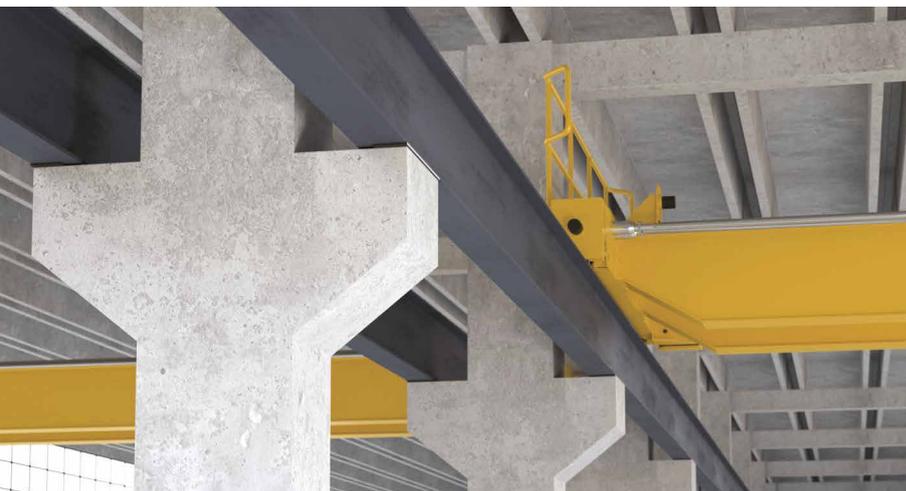
<sup>(1)</sup>The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression. It is possible to use profiles with loads outside the indicated range if the resonance frequency of the system and the deformation of the profile at the ultimate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

<sup>(2)</sup>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 $\Delta_{l,ij}$ <sup>(3)</sup>	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 $\tan \delta_{1Hz}$	ISO 4664-1	0,247
Damping factor $\tan \delta_{5Hz}$	ISO 4664-1	0,243
Damping factor $\tan \delta_{10Hz}$	ISO 4664-1	0,242
Damping factor $\tan \delta_{50Hz}$	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 $\sigma_{1mm}$	ISO 844	3,81 N/mm <sup>2</sup>
Compressive stress at 2 mm strain $\sigma_{2mm}$	ISO 844	8,36 N/mm <sup>2</sup>
Compressive stress at 3 mm strain $\sigma_{3mm}$	ISO 844	17,07 N/mm <sup>2</sup>
Reaction to fire	EN 13501-1	class E
Water absorption after 48h	ISO 62	< 1 %

<sup>(3)</sup>  $\Delta_{l,ij} = K_{ij,with} - K_{ij,without}$



## PERFORMANCE

Acoustic improvement tested:

$\Delta_{l,ij}$ <sup>(3)</sup> : > 4 dB

Maximum applied load  
(3 mm deformation):

**17,07 N/mm<sup>2</sup>**

Acoustic service load:

from **1,8 to 3,2 N/mm<sup>2</sup>**

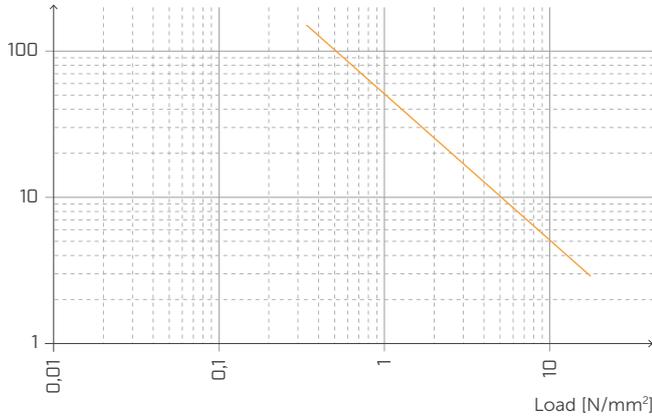
# STATIC LOAD

(buildings)



## NATURAL FREQUENCY AND LOAD

Natural frequency [Hz]



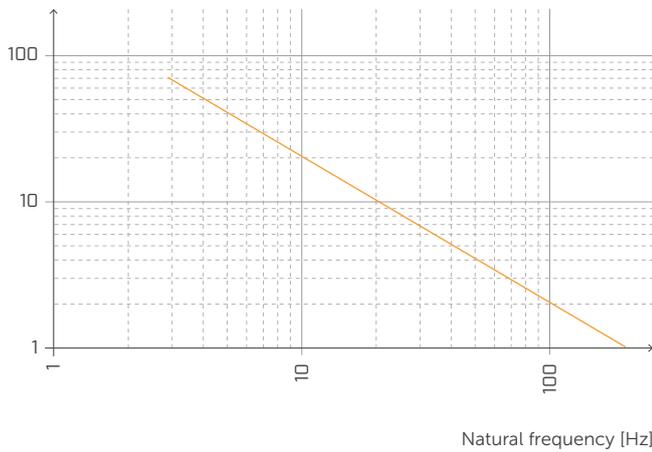
## DEFORMATION AND LOAD

Deformation [%]



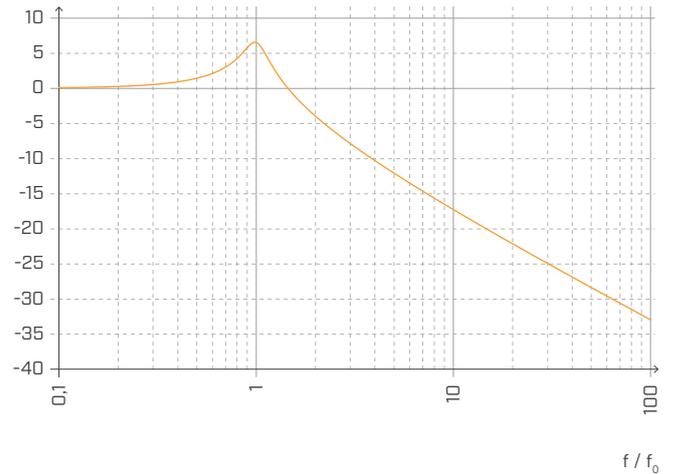
## DEFORMATION AND NATURAL FREQUENCY

Deformation [%]



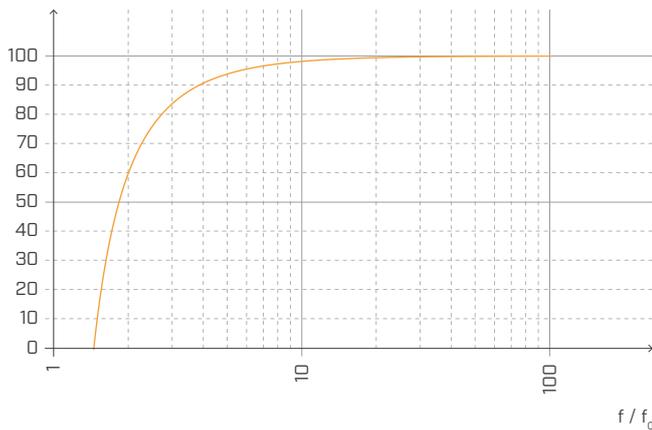
## TRANSMISSIBILITY

Transmission [dB]



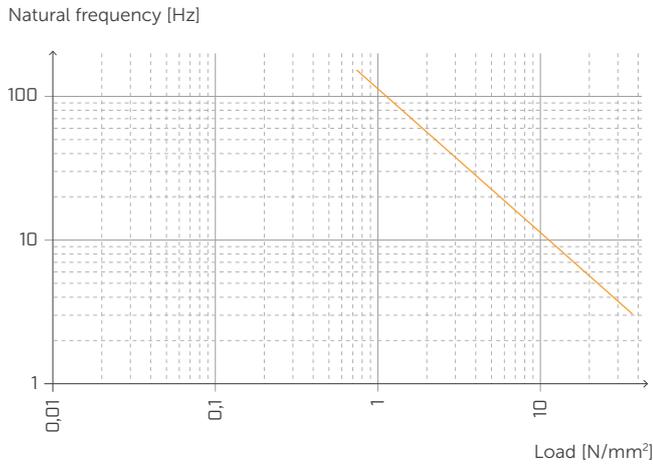
## ATTENUATION

Attenuation [%]

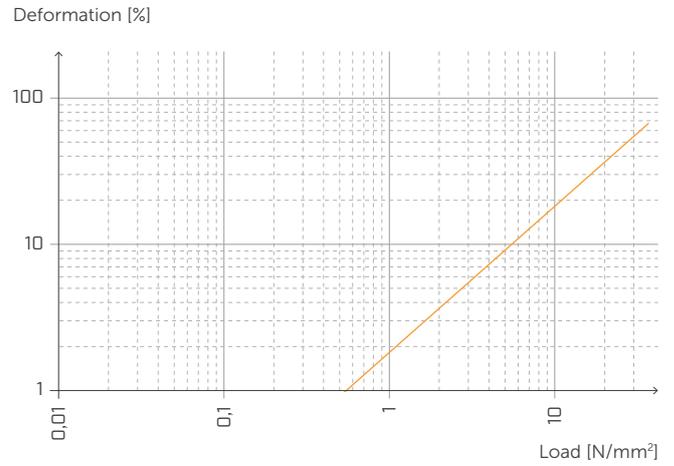


Normalised with respect to the resonance frequency with  $f = 20$  Hz.

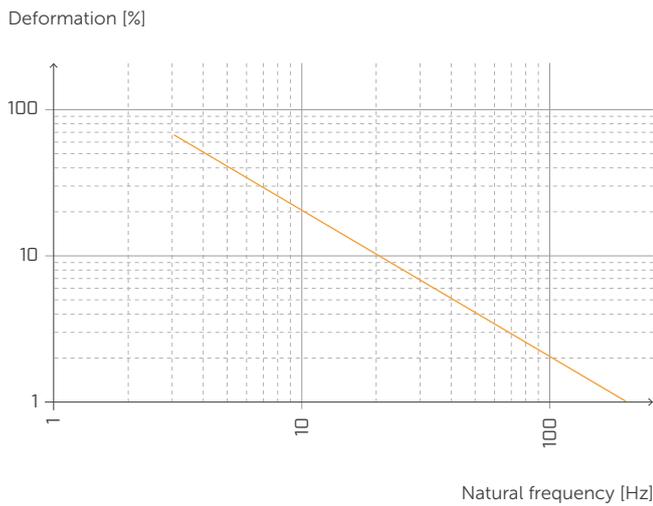
**NATURAL FREQUENCY AND LOAD**



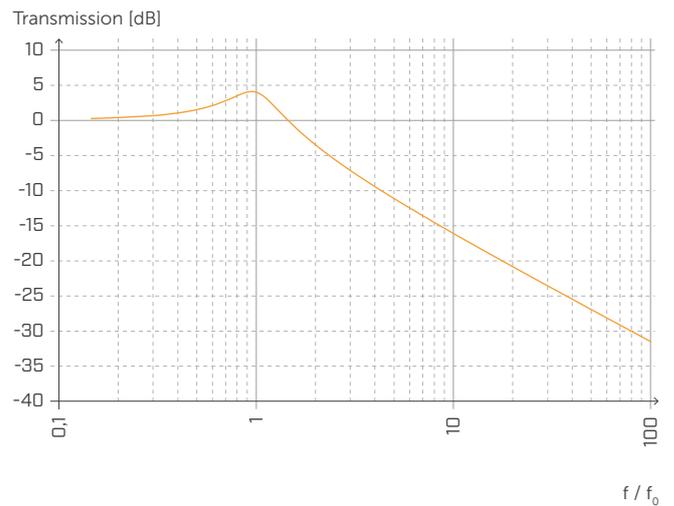
**DEFORMATION AND LOAD**



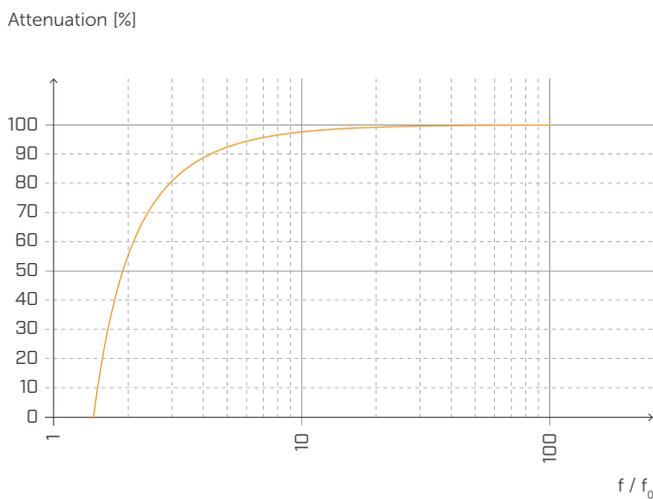
**DEFORMATION AND NATURAL FREQUENCY**



**TRANSMISSIBILITY**

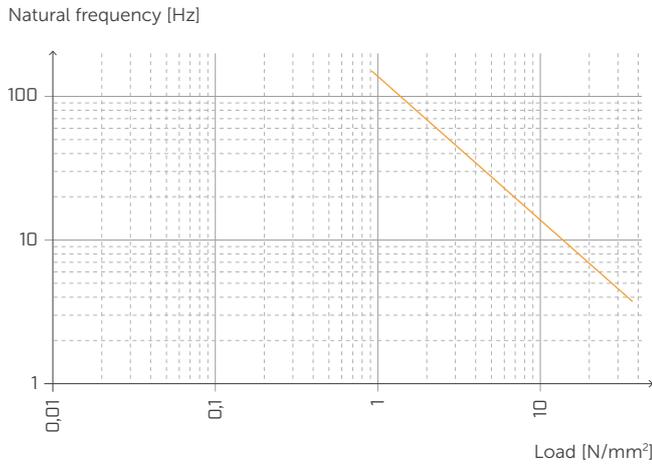


**ATTENUATION**

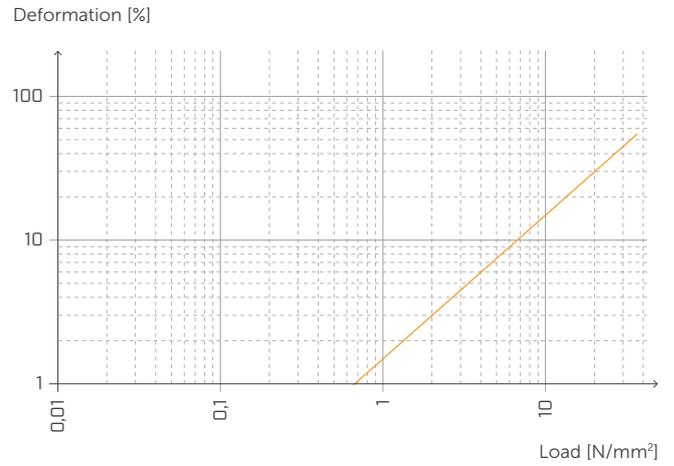


Normalised with respect to the resonance frequency with f = 6 Hz.

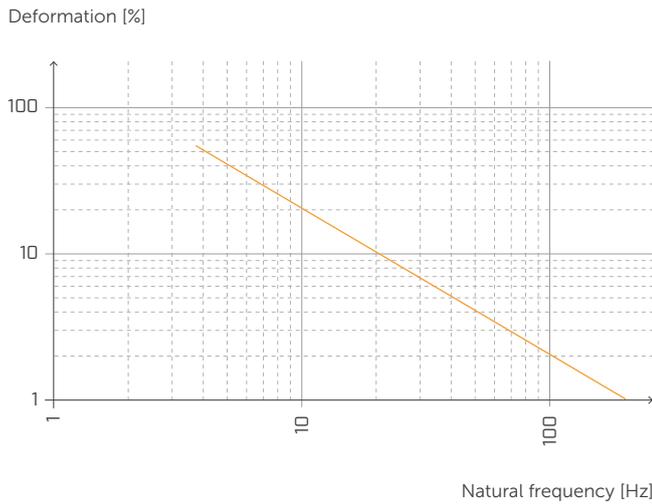
**NATURAL FREQUENCY AND LOAD**



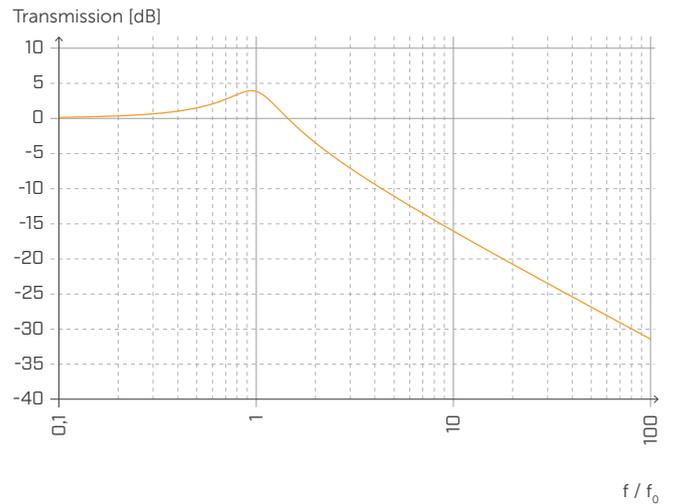
**DEFORMATION AND LOAD**



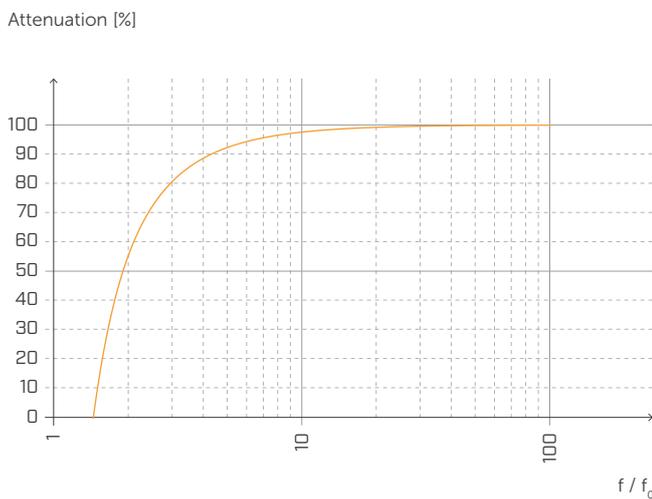
**DEFORMATION AND NATURAL FREQUENCY**



**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  $R_{ij,w}$ .

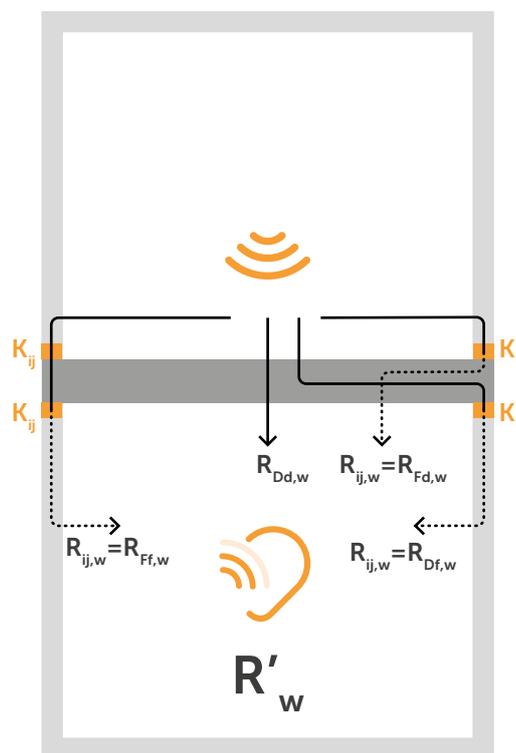
$$R'_w = -10 \log \left[ 10^{-\frac{R_{Dd,w}}{10}} + \sum_{i,j=1}^n 10^{-\frac{R_{ij,w}}{10}} + \frac{A_0}{S_s} \sum_{j=1}^n 10^{-\frac{D_{n,j,w}}{10}} \right] (dB)$$

The sound reduction index for flanking transmission paths  $R_{ij,w}$  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;
- $\Delta R_i$ ,  $\Delta R_j$  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  $\Delta R_w$  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.

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

# 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.

$K_{ij}$  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

$$M = 10 \log(m_{i\perp} / m_i)$$

where:

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

Therefore, the transmitted vibration reduction value is:

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

for loads exceeding 750 kN/m<sup>2</sup> on a resilient layer with  $\Delta L_{min} = 5$  dB

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

where:

$G$  is the Young tangential module (MN/m<sup>2</sup>)  
 $t_i$  is the thickness of the resilient material (m)  
 $\rho_1$  and  $\rho_2$  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.

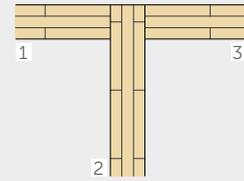
In the case of CLT structures weakly bound together, the side transmission contribution can be determined according to the following relations, valid if  $0,5 < (m_1/m_2) < 2$ .

## METHOD 1 - CALCULATING $K_{ijrigid}$

### Solution 1 - T-SHAPED JOINT

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

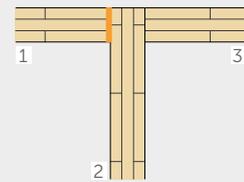
$$K_{12} = 5,7 + 5,7 M^2 = K_{23} \text{ dB}$$



### Solution 2 - T-SHAPED JOINT with resilient layer

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

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



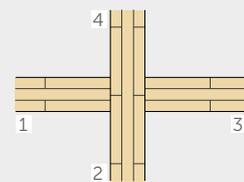
### Solution 3 - X-SHAPED JOINT

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

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

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

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



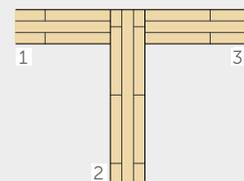
## METHOD 2 - CALCULATING $K_{ijrigid}$

### Solution 1 - T-SHAPED JOINT

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

$$f_k = 500 \text{ Hz}$$

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



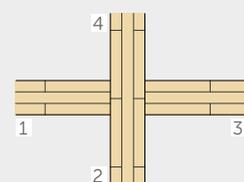
### Solution 1 - X-SHAPED JOINT

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

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

$$f_k = 500 \text{ Hz}$$

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



# THE SIMPLIFIED METHOD

A CALCULATION EXAMPLE USING EN ISO 12354

## INPUT DATA

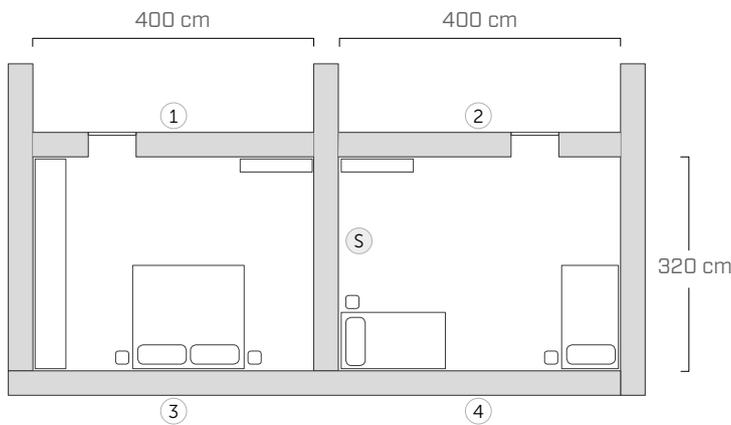
The EN ISO 12354 norms provide two methods to calculate the acoustic performance of a partition: a detailed method and the simplified method.

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.

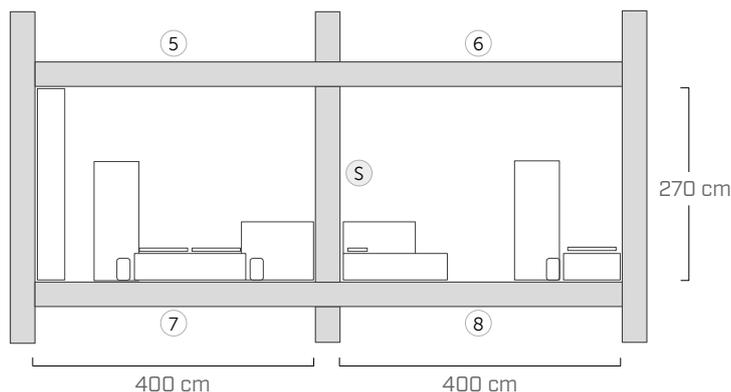
In order to determine the acoustic performance of assembly from the acoustic performance of its components, it is important to determine for every junction element:

- 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](http://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  $R_{ij}$  calculated using the equation:

$$R_{ij,w} = \frac{R_{i,w} + R_{j,w}}{2} + \Delta R_{ij,w} + K_{ij} + 10 \log \frac{S}{I_0 I_{ij}} (dB)$$

## ■ 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.

$$R'_w = 51 \text{ dB} \quad R_w = 53 \text{ dB}$$

## ACOUSTIC CHARACTERISTICS OF THE ASSEMBLIES

Path of transmission	S [m <sup>2</sup> ]	R <sub>w</sub> [dB]	m' [kg/m <sup>2</sup> ]
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<sub>ij</sub>

Path of transmission	R <sub>ij</sub> [dB]	Path of transmission	R <sub>ij</sub> [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

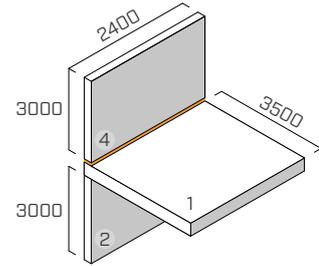
Download all the documentation about the project from [www.rothoblaas.com](http://www.rothoblaas.com)

# 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)



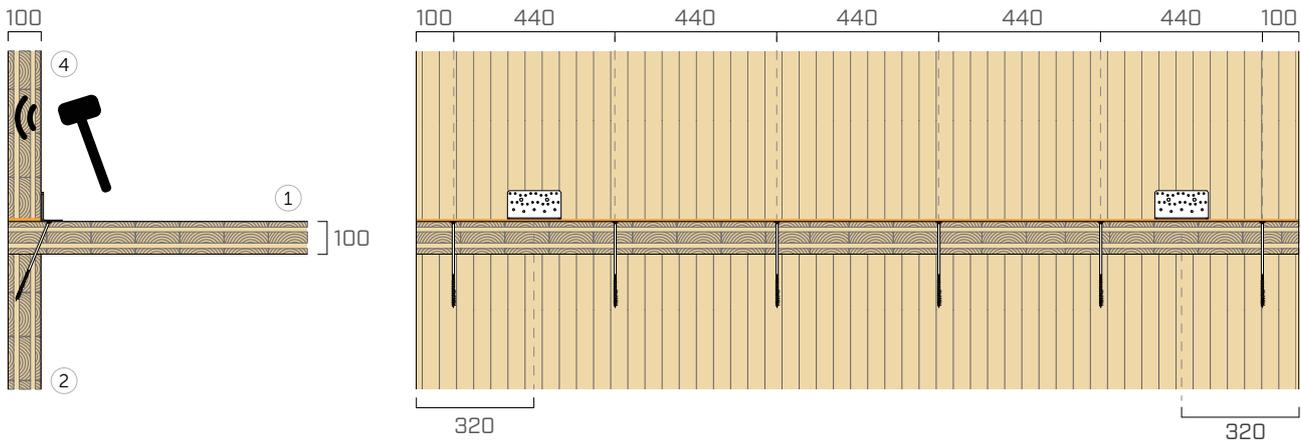
## FASTENING SYSTEM

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** [kN/m²]: 125



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

$$\overline{K}_{14} = 18,7 \text{ dB}$$

$$\overline{K}_{14,0} = 14,4 \text{ dB}$$

$$\Delta_{l,14} = 4,4 \text{ dB}$$

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

$$\overline{K}_{12} = 13,9 \text{ dB}$$

$$\overline{K}_{12,0} = 14,6 \text{ dB}$$

$$\Delta_{l,12} = -0,7 \text{ dB}$$

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

$$\overline{K}_{24} = 24,3 \text{ dB}$$

$$\overline{K}_{24,0} = 20,4 \text{ dB}$$

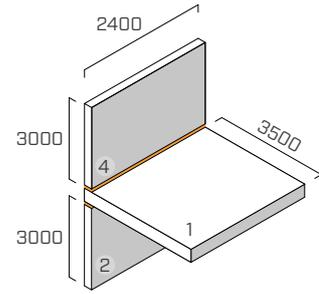
$$\Delta_{l,24} = 3,9 \text{ dB}$$

# 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

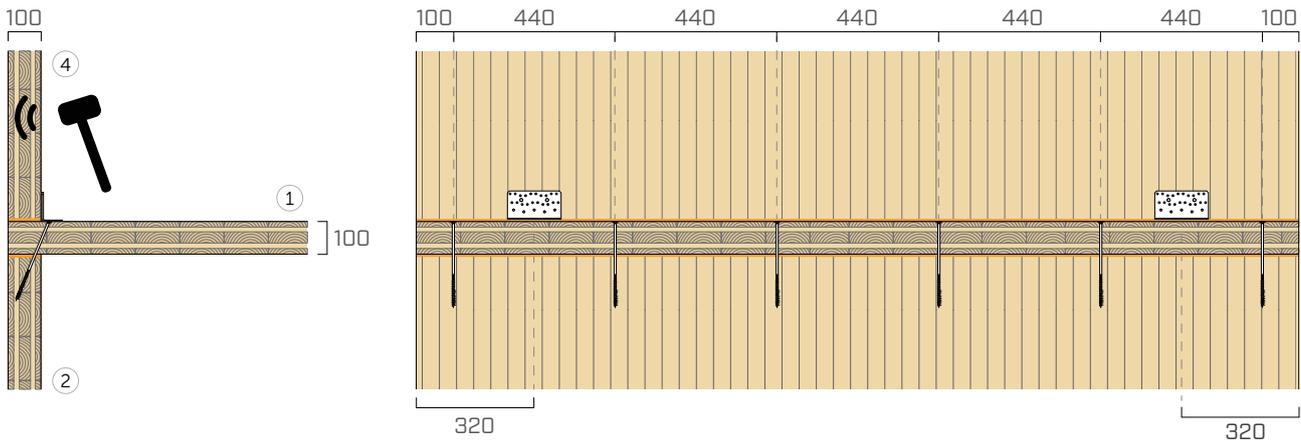
### PIANO C

**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

$$\overline{K}_{14} = 17,6 \text{ dB}$$

$$\overline{K}_{14,0} = 13,3 \text{ dB}$$

$$\Delta_{l,14} = 4,3 \text{ dB}$$

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

$$\overline{K}_{12} = 17,6 \text{ dB}$$

$$\overline{K}_{12,0} = 14,5 \text{ dB}$$

$$\Delta_{l,12} = 3,1 \text{ dB}$$

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

$$\overline{K}_{24} = 23,4 \text{ dB}$$

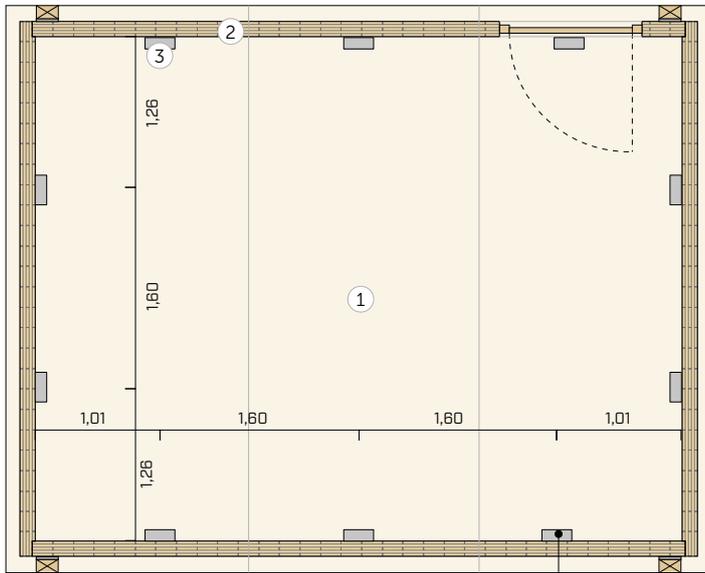
$$\overline{K}_{24,0} = 17,3 \text{ dB}$$

$$\Delta_{l,24} = 6,1 \text{ dB}$$

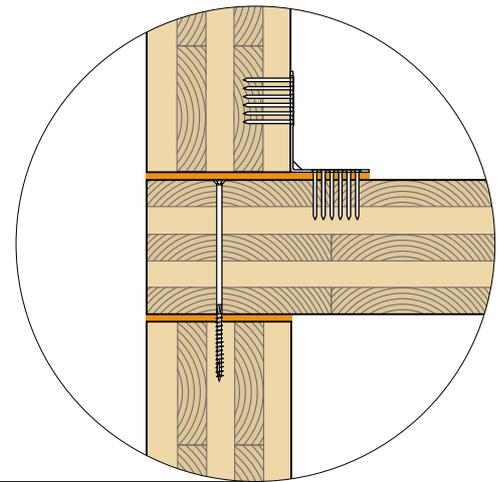
# SOLUTIONS FOR LIGHTWEIGHT FLOORS

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

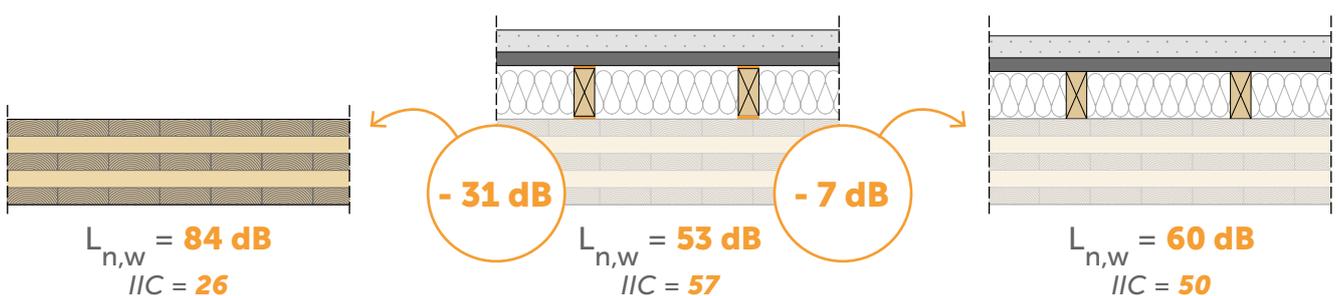


The receiving and transmitting rooms have a floor area of 21.5 m<sup>2</sup> (5.24 m length; 4.10 m width). The volume of the transmitting room is 53.0 m<sup>3</sup>, and the volume of the receiving room 85.0 m<sup>3</sup>.



addition of the dry system **with PIANO**

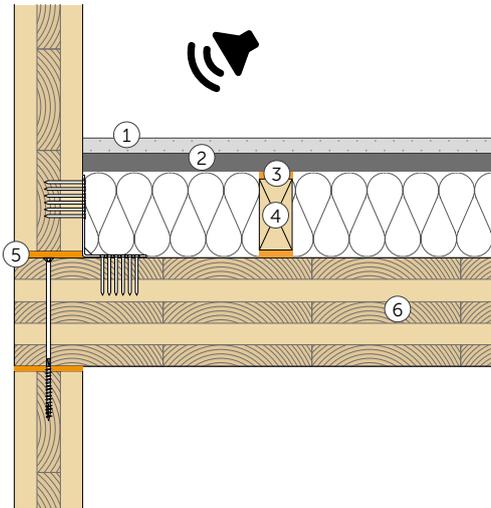
addition of dry system **without PIANO**



# LABORATORY MEASUREMENT | FLOOR 1

AIRBORNE SOUND INSULATION

REFERENCE STANDARD: ISO 16283-1



## FLOOR

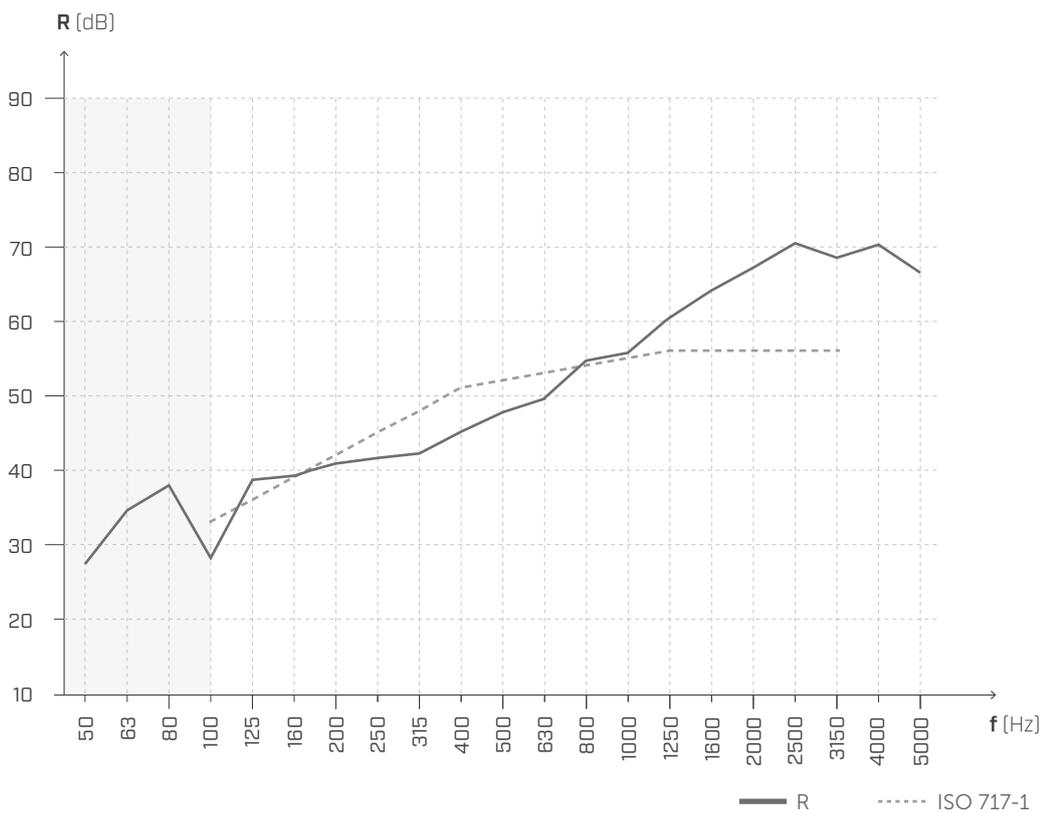
Surface = 21,5 m<sup>2</sup>

Mass = 167 kg/m<sup>2</sup>

Receiving room volume = 75,52 m<sup>3</sup>

- ① reinforced gypsum-fibre board (44 kg/m<sup>2</sup>) (t: 32 mm)
- ② high density cardboard and sand panels (34,6 kg/m<sup>2</sup>) (t: 30 mm)
- ③ **PIANO A**
- ④ wood batten 50 x 100 mm
- ⑤ **XYLOFON - XYL35**
- ⑥ CLT (t: 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

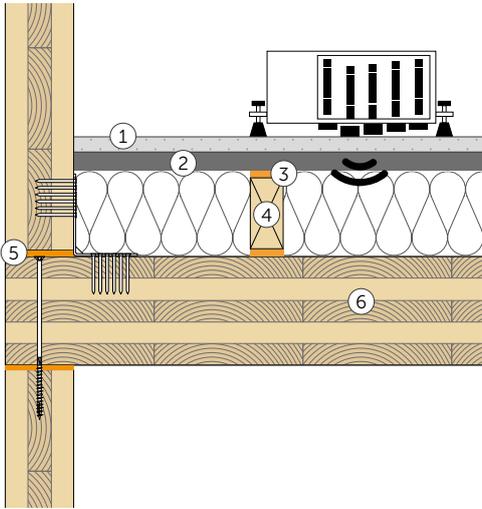
$R_w (C; C_{tr}) = 52 (0; -7) \text{ dB}$

Testing laboratory: Universität Innsbruck Arbeitsbereich für Holzbau Technikstraße 13A - 602 Innsbruck.

Test protocol: M02\_L\_220906\_Balkenaufbau-Entkoppelung\_oben\_unten.

# LABORATORY MEASUREMENT | FLOOR 2

IMPACT SOUND INSULATION  
REFERENCE STANDARD ISO 10140-3

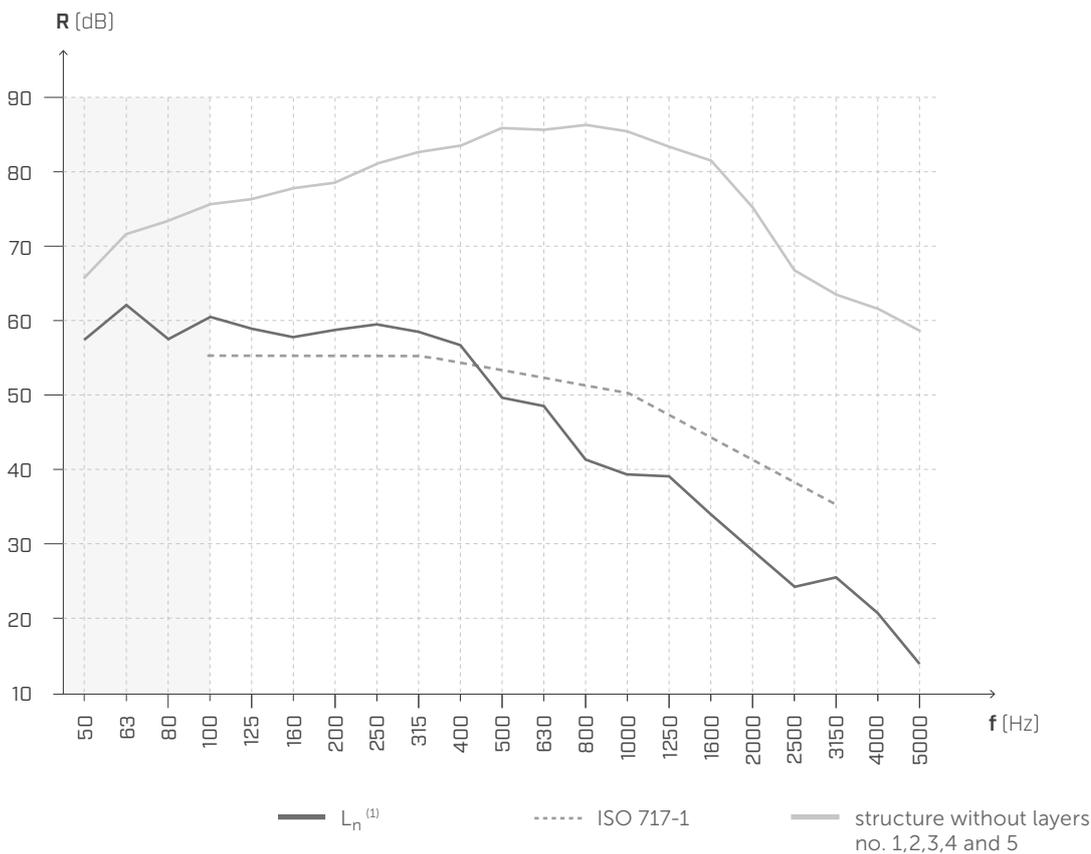


## FLOOR

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

- ① reinforced gypsum-fibre board (44 kg/m<sup>2</sup>) (t: 32 mm)
- ② high density cardboard and sand panels (34,6 kg/m<sup>2</sup>) (t: 30 mm)
- ③ PIANO A
- ④ wood batten 50 x 100 mm
- ⑤ XYLOFON - XYL35
- ⑥ CLT (t: 160 mm)

## IMPACT SOUND INSULATION



f [Hz]	L <sub>n</sub> <sup>(1)</sup> [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

$L'_{n,w}(C_l) = 53 (-1) \text{ dB}$

IIC = 57

$\Delta L'_{n,w} = -31 \text{ dB}$

$\Delta IIC = 31$

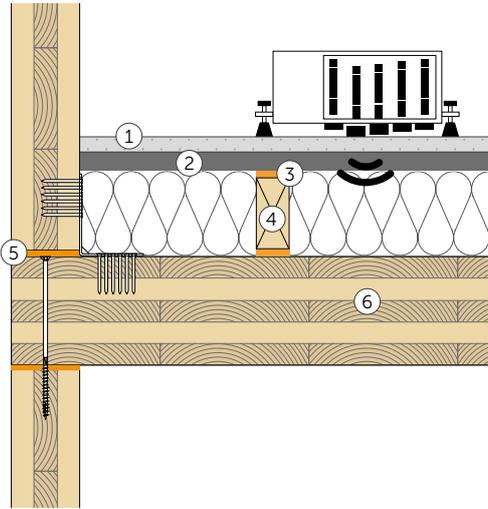
Testing laboratory: Universität Innsbruck Arbeitsbereich für Holzbau  
Technikerstraße 13A - 602 Innsbruck.  
Test protocol: M02\_L\_220906\_Balkenaufbau-Entkoppelung\_oben\_unten.

NOTES:  
(1) Decrease due to the addition of layers no. 3 and no. 5.

# LABORATORY MEASUREMENT | FLOOR 2 - COMPARATIVE ANALYSIS

## IMPACT SOUND INSULATION

REFERENCE STANDARD ISO 10140-3



### FLOOR

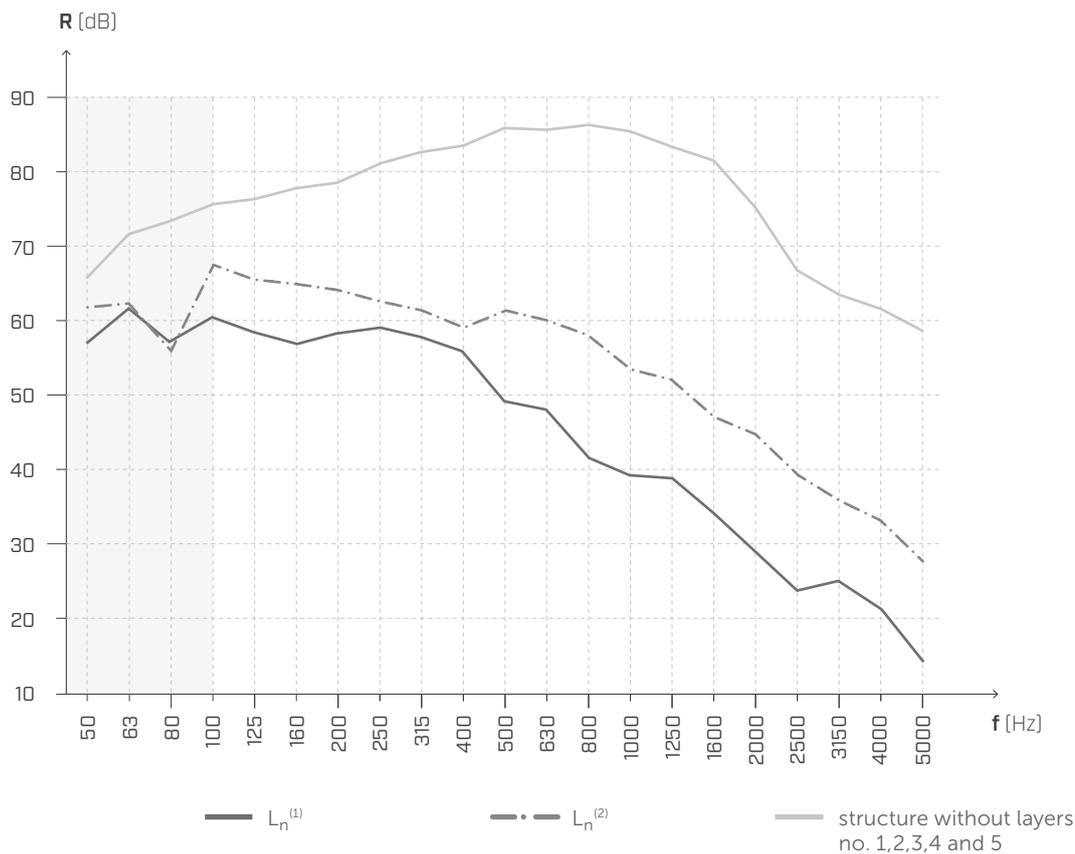
Surface = 21,5 m<sup>2</sup>

Mass = 167 kg/m<sup>2</sup>

Receiving room volume = 75,52 m<sup>3</sup>

- ① reinforced gypsum-fibre board (44 kg/m<sup>2</sup>) (t: 32 mm)
- ② high density cardboard and sand panels (34,6 kg/m<sup>2</sup>) (t: 30 mm)
- ③ **PIANO A**
- ④ wood batten 50 x 100 mm
- ⑤ **XYLOFON - XYL35**
- ⑥ CLT (t: 160 mm)

## IMPACT SOUND INSULATION



f [Hz]	L <sub>n</sub> <sup>(1)</sup> [dB]	L <sub>n</sub> <sup>(2)</sup> [dB]
50	57,1	62,3
63	62,1	62,7
80	57,3	56,2
100	60,8	68,2
125	58,8	66,7
160	57,2	66,1
200	58,6	65,4
250	59,4	63,5
315	58,2	62,6
400	56,6	59,7
500	49,6	61,8
630	48,4	60,5
800	41,2	58,0
1000	39,2	54,2
1250	39,0	52,5
1600	34,6	47,8
2000	29,0	45,4
2500	24,9	39,4
3150	25,4	36,9
4000	21,9	34,8
5000	13,0	27,3

$$L'_{n,w}(C_I)^{(1)} = 53 (-1) \text{ dB}$$

$$IIC = 57$$

Dry floor without PIANO

$$L'_{n,w}(C_I)^{(2)} = 60 (-1) \text{ dB}$$

$$IIC = 50$$

**Testing laboratory:** Universität Innsbruck Arbeitsbereich für Holzbau 0 Technikerstraße 13A - 602 Innsbruck.

**Test protocol:** M02\_L\_220906\_Balkenaufbau-Entkoppelung\_oben\_unten.

### NOTES:

(1) Decrease due to the addition of layers no. 3 and no. 5.

(2) Increase due to the absence of layers no. 3 and no. 5.

# LABORATORY MEASUREMENT | CLT FLOOR 3

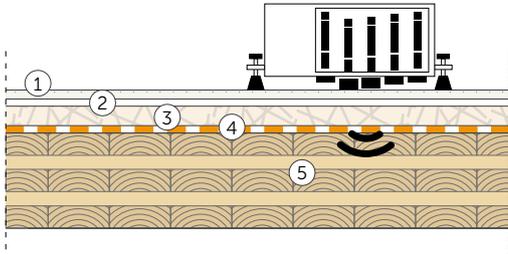
## IMPACT SOUND INSULATION

REFERENCE STANDARDS ASTM E1007 AND ISO 717- 2

### FLOOR

Receiving room volume = 45 m<sup>3</sup>

- ① LV vinyl flooring
- ② Underfloor (t: 3,5 mm)
- ③ Technical composite panel (t: 40 mm)
- ④ **PIANO A** (t: 6 mm)
- ⑤ CLT (t: 172 mm)



## IMPACT SOUND NOISE INSULATION



f [Hz]	ANISPL [dB]
50	-
63	-
80	-
100	63
125	55
160	59
200	57
250	51
315	48
400	47
500	52
630	51
800	49
1000	46
1250	44
1600	43
2000	39
2500	37
3150	35
4000	-
5000	-

AIIC = **57**

L<sub>n,w</sub> = **53 dB**

AIIC = **31**

L<sub>n,w</sub> = **31 dB**

Test laboratory: Québec testing facility  
 Measurement date: 22/05/2025  
 Test protocol: T15\_2025

NOTES:  
 (1) Decrease due to the addition of layers no. 1,2,3 and no. 4.

# LABORATORY MEASUREMENT | CLT FLOOR 4

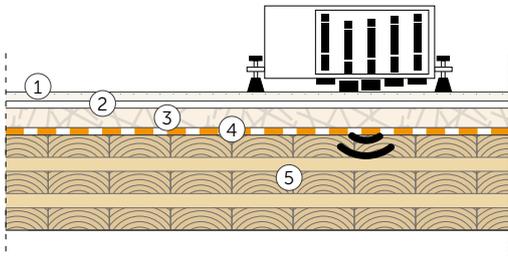
## IMPACT SOUND INSULATION

REFERENCE STANDARDS ASTM E1007 AND ISO 717- 2

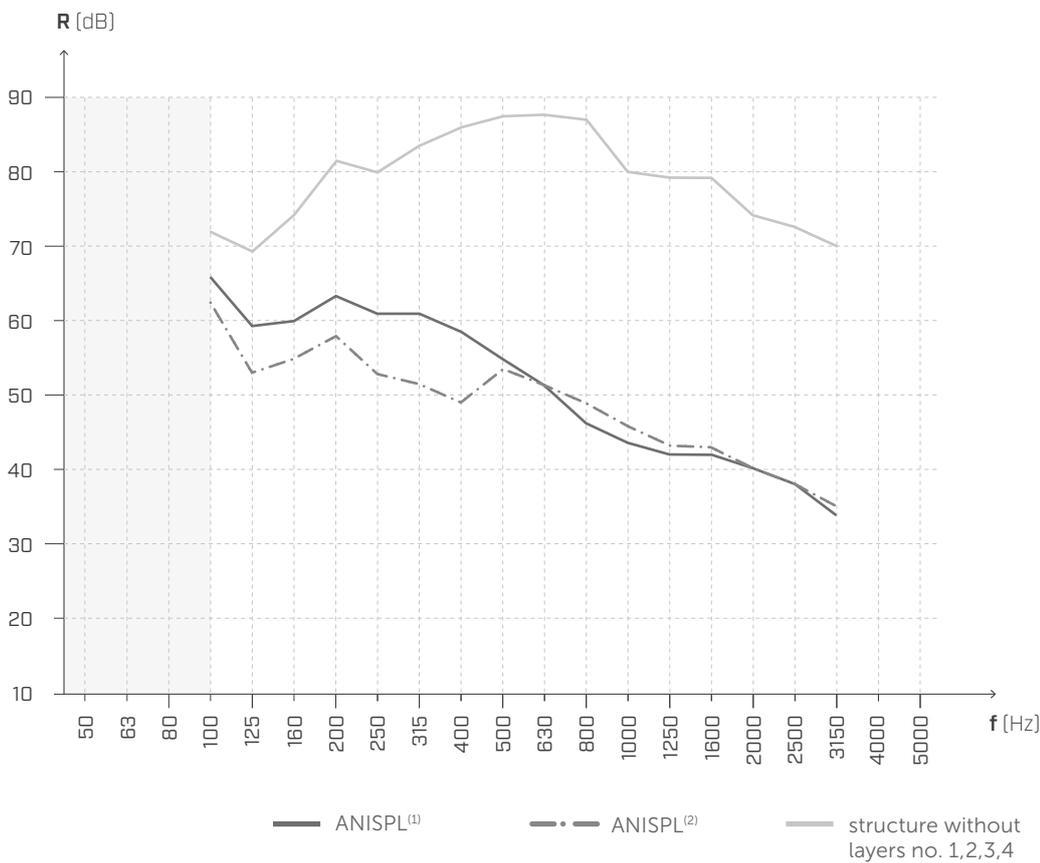
### FLOOR

Receiving room volume = 45 m<sup>3</sup>

- ① LV vinyl flooring
- ② Underfloor (t: 3,5 mm)
- ③ Technical composite panel (t: 40 mm)
- ④ **PIANO B** (t: 6 mm)
- ⑤ CLT (t: 172 mm)



## IMPACT SOUND NOISE INSULATION



f [Hz]	ANISPL <sup>(1)</sup> [dB]	ANISPL <sup>(2)</sup> [dB]
50	-	-
63	-	-
80	-	-
100	66	62
125	59	54
160	60	55
200	64	58
250	61	53
315	61	51
400	58	49
500	55	54
630	51	52
800	46	49
1000	44	46
1250	43	44
1600	43	44
2000	40	40
2500	38	38
3150	34	35
4000	-	-
5000	-	-

AIIC = **54**

$L_{n,w}^{(1)}$  = **56 dB**

AIIC = **58**

$L_{n,w}^{(2)}$  = **52 dB**

Test laboratory: Québec testing facility  
 Measurement date: 22/05/2025  
 Test protocol: T15\_2025

NOTES:  
 (1) Result without layer no. 2.  
 (2) Result for complete floor construction assembly

# LABORATORY MEASUREMENT | FRAME FLOOR 1

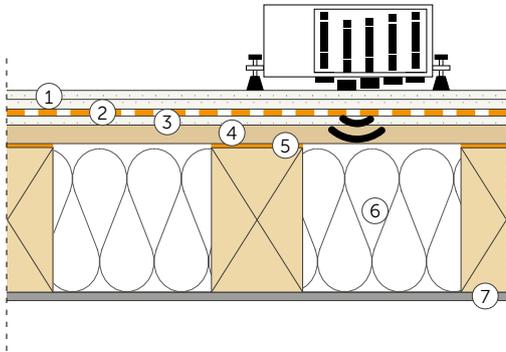
## IMPACT SOUND INSULATION

REFERENCE STANDARD EN ISO 10140-3 AND EN ISO 717-2

### FLOOR

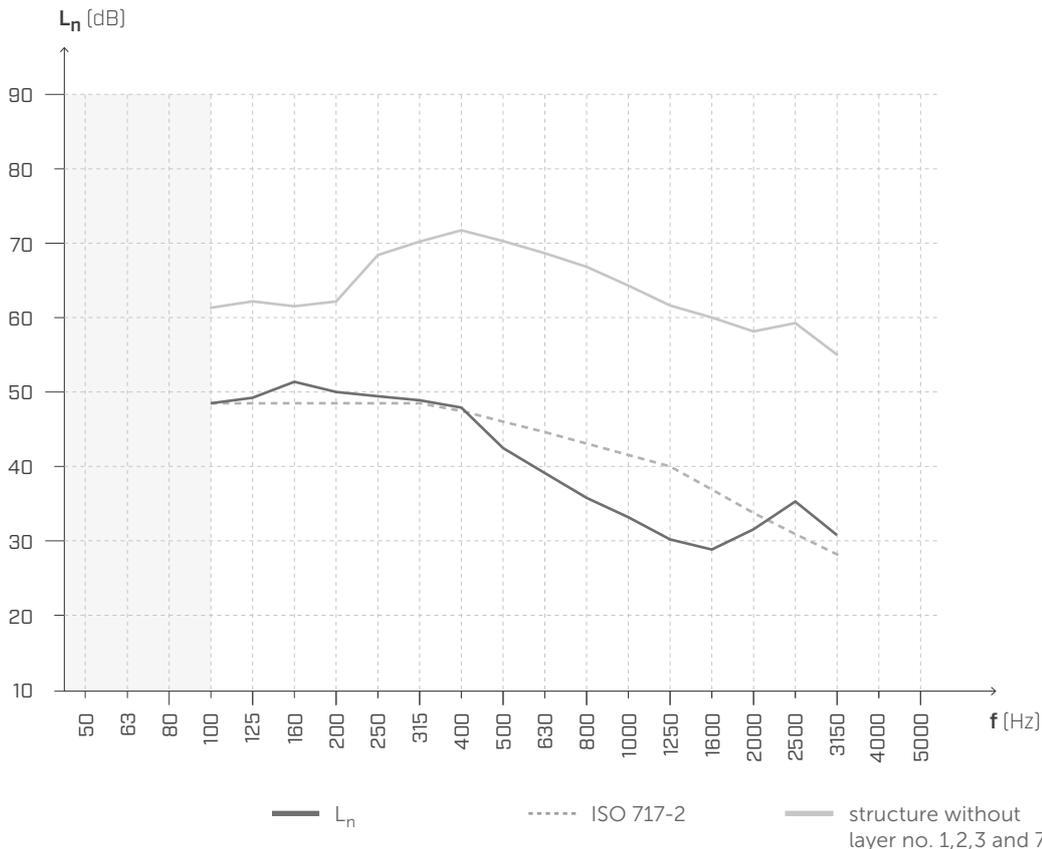
Surface = 11,5 m<sup>2</sup>

Receiving room volume = 86 m<sup>3</sup>



- ① 2 Gypsum fibre boards (t: 15 + 15 mm) (1200 kg/m<sup>3</sup>)
- ② SILENT FLOOR NET 3D (t: 20 mm)
- ③ Gypsum fibre board (t: 15 mm) (1200 kg/m<sup>3</sup>)
- ④ OSB panel (t: 18 mm)
- ⑤ PIANO A
- ⑥ Timber frame (t: 180 mm)  
timber uprights 120 x 180 mm  
1 x mineral wool (t: 120 mm) (60 kg/m<sup>3</sup>)  
1 x mineral wool (t: 60 mm) (40 kg/m<sup>3</sup>)
- ⑦ Plasterboard panel (t: 12,5 mm) (1024 kg/m<sup>3</sup>)

## IMPACT SOUND NOISE INSULATION



f [Hz]	Ln [dB]
50	-
63	-
80	-
100	48,1
125	49,3
160	51,9
200	50,3
250	49,9
315	48,7
400	47,3
500	43,8
630	39,9
800	36,2
1000	34,0
1250	30,7
1600	28,8
2000	31,5
2500	35,5
3150	30,5
4000	-
5000	-

$L_{n,w}(CI) = 45 \text{ dB}$

IIC = 65

$\Delta L_{n,w} = -23 \text{ dB}$

$\Delta IIC = 23$

Test laboratory: CSI Milano  
Measurement date: 01/09/2025

Test protocol: M10\_2025

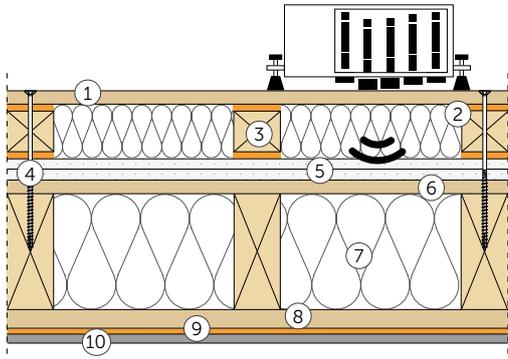
# LABORATORY MEASUREMENT | FRAME FLOOR 2

## IMPACT SOUND INSULATION

REFERENCE STANDARD ISO 10140-2 AND EN ISO 717-2

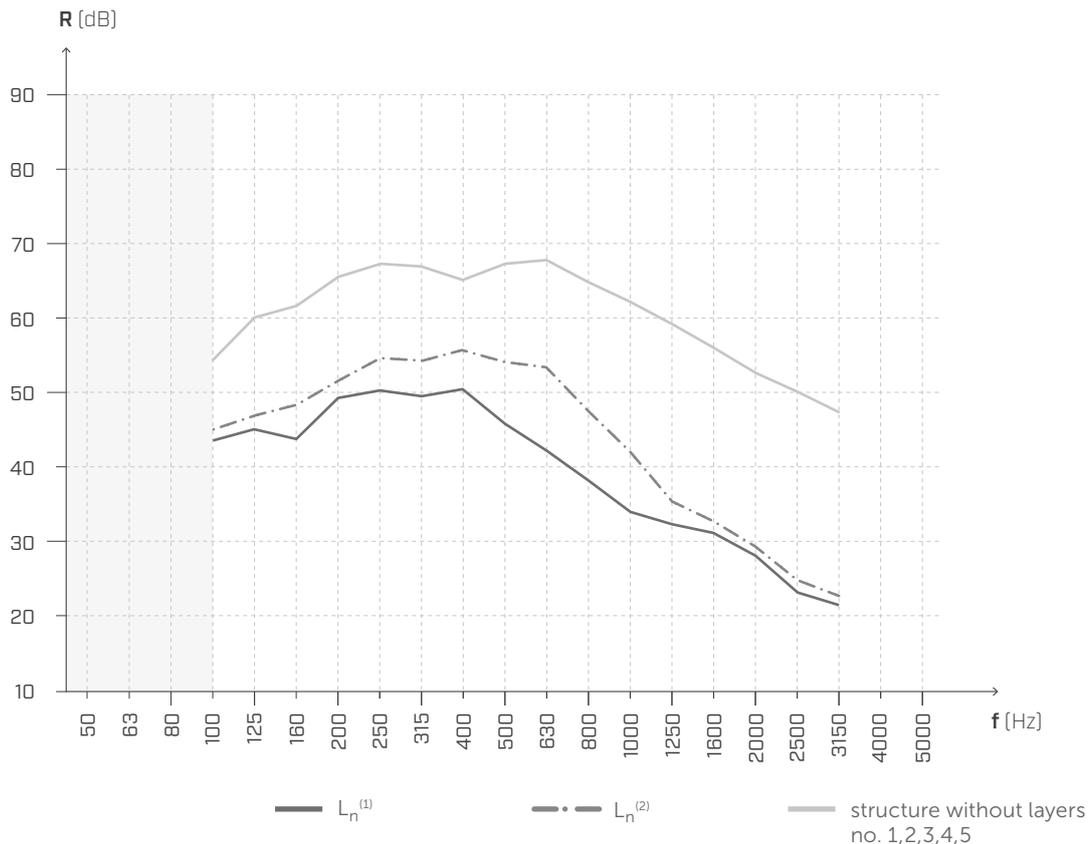
### FLOOR

Receiving environment volume = 45 m<sup>3</sup>



- ① OSB panel (t: 18 mm)
- ② **PIANO A** (t: 6 mm)
- ③ Solid wood batten 60 x 60 mm
- ④ HBS6160
- ⑤ 2 Gypsum fibre boards (t: 15 + 15 mm) (1200 kg/m<sup>3</sup>)
- ⑥ OSB panel (t: 18 mm)
- ⑦ Timber frame (t: 180 mm)  
timber uprights 120 x 180 mm  
1 x mineral wool (t: 120 mm) (60 kg/m<sup>3</sup>)  
1 x mineral wool (t: 60 mm) (40 kg/m<sup>3</sup>)
- ⑧ Timber battens 24 x 48 mm
- ⑨ **SILENT WALL BYTUM SA** (t: 4 mm)
- ⑩ Plasterboard panel (t: 12,5 mm) (1024 kg/m<sup>3</sup>)

## IMPACT SOUND NOISE INSULATION



f [Hz]	L <sub>n</sub> <sup>(1)</sup> [dB]	L <sub>n</sub> <sup>(2)</sup> [dB]
50	-	-
63	-	-
80	-	-
100	45,5	44,2
125	46,9	45,1
160	48,4	44,4
200	51,6	49,3
250	54,8	50,1
315	54,3	49,2
400	55,5	50,3
500	54,8	46,4
630	54,0	42,4
800	47,4	38,1
1000	41,5	34,9
1250	35,6	32,9
1600	32,9	31,6
2000	29,6	28,1
2500	24,5	23,4
3150	22,1	21,3
4000	-	-
5000	-	-

$L_{n,w}^{(1)} = 49 \text{ dB}$

$L_{n,w}^{(2)} = 42 \text{ dB}$

IIC = 61

IIC = 68

Test laboratory: CSI Milano  
Measurement date: 01/09/2025  
Test protocol: T18

NOTES:  
(1) Value resulting from the addition of the fastening system, layer no. 4  
(2) Reduction due to the absence of the fastening system, layer no. 4

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