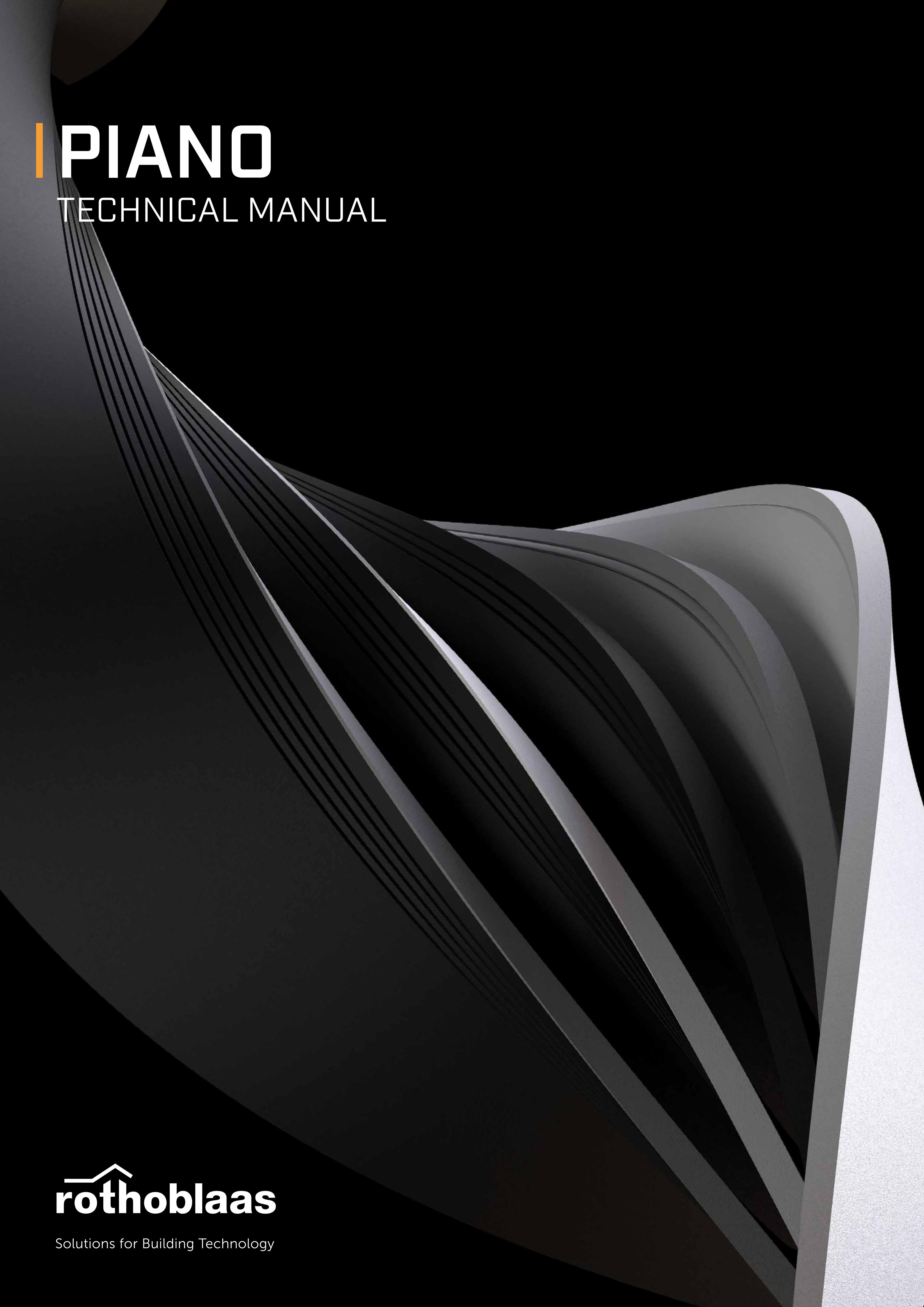


PIANO

TECHNICAL MANUAL

rothoblaas

Solutions for Building Technology

CONTENTS

CE
ETA-23/0193

PIANO

RESILIENT SOUNDPROOFING PROFILE

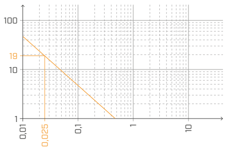
CODES AND DIMENSIONS

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

page 10



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)

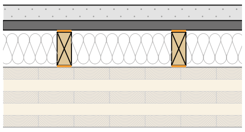
page 12

K_{ij} values entered in ETA

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

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

page 36



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

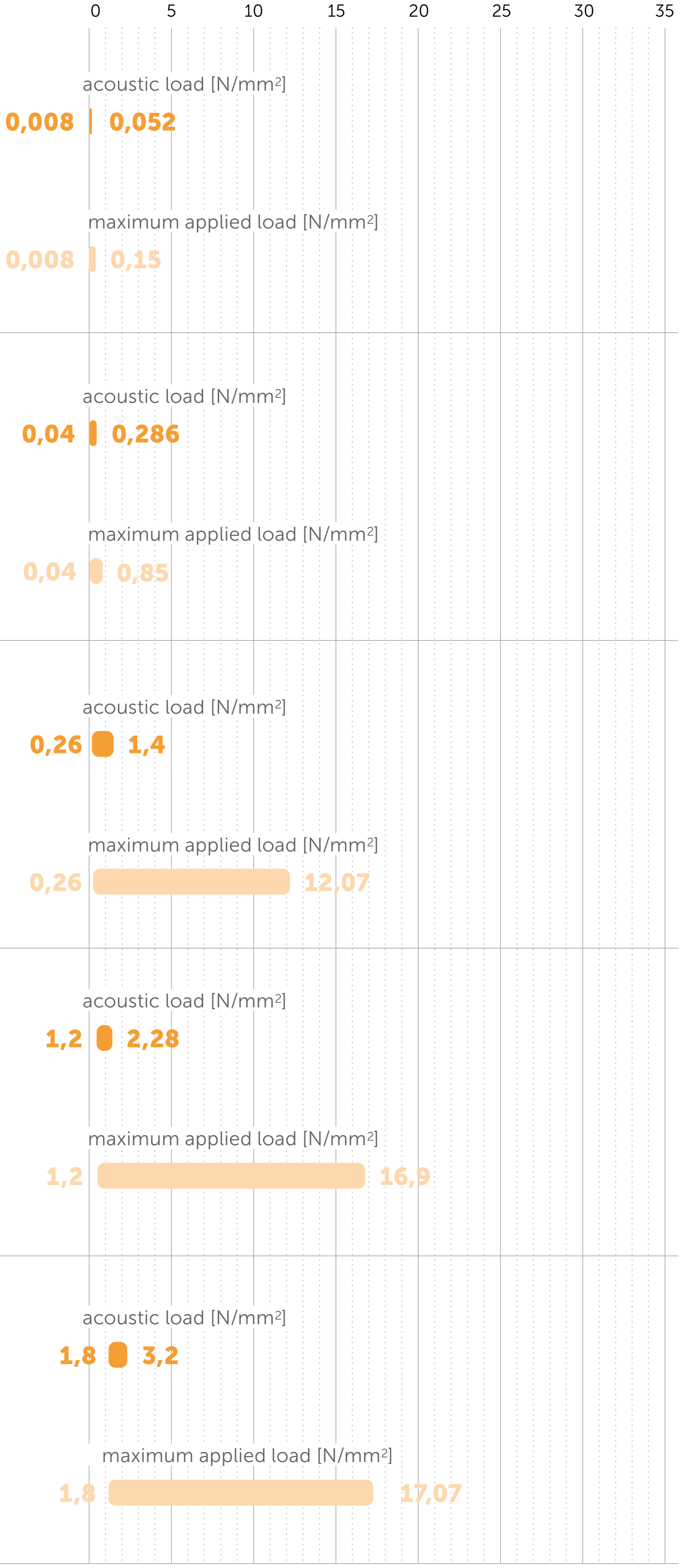
products		thickness	acoustic improvement $\Delta_{l,ij}$(1)	elastic modulus in compression E_c
PIANO A		**6** mm	**> 4** dB	**0,23** N/mm^2
PIANO B		**6** mm	**> 4** dB	**1,08** N/mm^2
PIANO C		**6** mm	**> 4** dB	**7,92** N/mm^2
PIANO D		**6** mm	**> 4** dB	**22,1** N/mm^2
PIANO E		**6** mm	**> 4**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

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)
0,5 N/mm^2 - **0,5** N/mm^2	**0,186 - 0,238**	acoustic load [N/mm^2] **0,008** - **0,052** maximum applied load [N/mm^2] **0,008** - **0,15**
1,75 N/mm^2 - **2,07** N/mm^2	**0,308 - 0,372**	acoustic load [N/mm^2] **0,04** - **0,286** maximum applied load [N/mm^2] **0,04** - **0,85**
9,35 N/mm^2 - **11,61** N/mm^2	**0,272 - 0,306**	acoustic load [N/mm^2] **0,26** - **1,4** maximum applied load [N/mm^2] **0,26** - **12,07**
20,3 N/mm^2 - **25,81** N/mm^2	**0,297 - 0,349**	acoustic load [N/mm^2] **1,2** - **2,28** maximum applied load [N/mm^2] **1,2** - **16,9**
54,8 N/mm^2 - **67,08** N/mm^2	**0,243 - 0,253**	acoustic load [N/mm^2] **1,8** - **3,2** maximum applied load [N/mm^2] **1,8** - **17,07**



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(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.

$$\mathbf{Q}_{linear} = \mathbf{q}_{gk} + 0,5\ \mathbf{q}_{vk}$$

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).

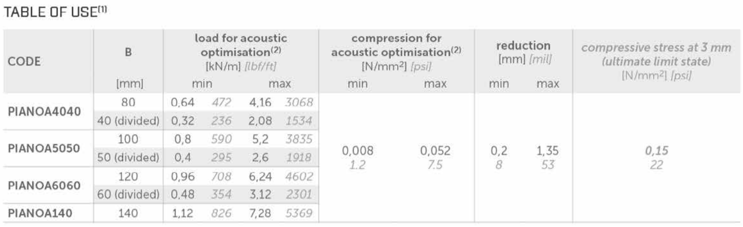


TABLE OF USE[1]

CODE	B	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]*
	[mm]	min		max		min	max	min	max	
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*					

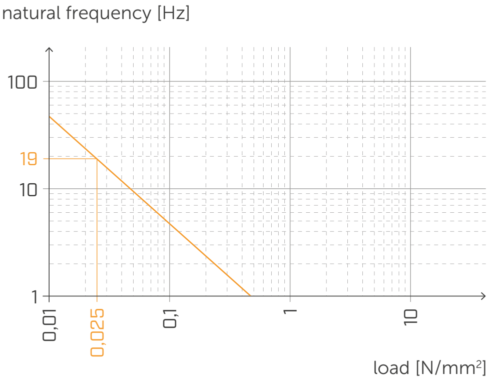
Note: The static behaviour of the material in compression is evaluated, considering that the deformations due to the loads are static. This is because a building is not affected by significant movement phenomena, nor dynamic deformation.

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/mm^2 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.

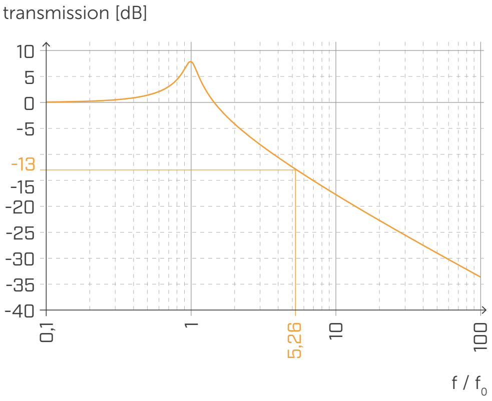


At this point, the degree of transmission for the product under these load conditions can be calculated, referring to the design frequency of 100 Hz.

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

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.

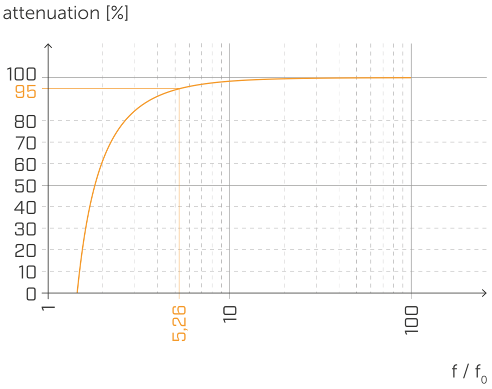
TRANSMISSION IS POSITIVE WHEN THE MATERIAL TRANSMITS AND IS NEGATIVE WHEN THE PROFILE BEGINS TO INSULATE. This means this figure shows that the product, loaded in this way, insulates 13 dB at a reference frequency of 100 Hz.



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.

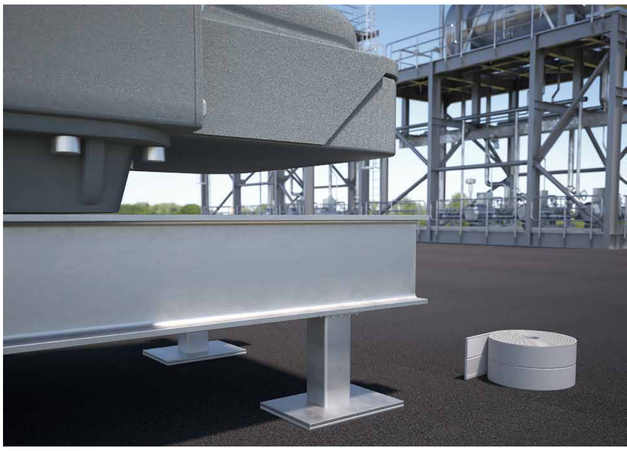
PARAMETERS TESTED ACCORDING TO ETA

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.

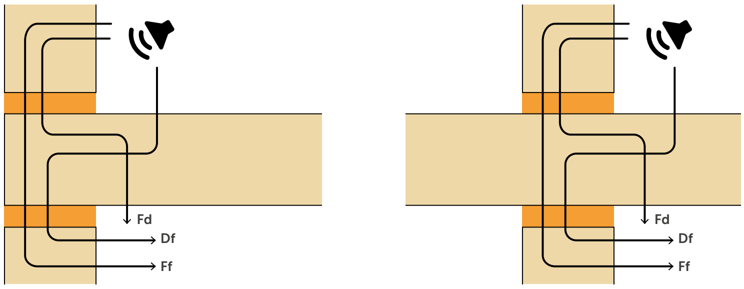


In buildings, **PIANO** is subject to static and quasi-static loading, so the dynamic elastic modulus is not as representative of the product's actual behaviour.

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.

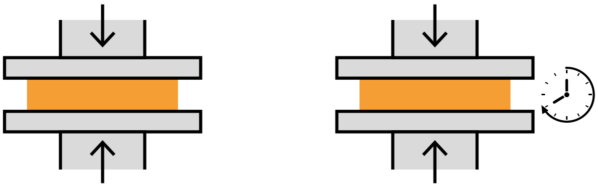


In the European Technical Assessment, the results are expressed clearly to avoid ambiguity in the configuration.

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	load for acoustic optimisation(2) [kN/m]		compression for acoustic optimisation(2) [N/mm^2]		deformation [mm]		*compression at 3 mm deformation (ultimate limit state)* [N/mm^2]
	[mm]	from	to	from	to	from	to	
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/mm^2
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	0,08 N/mm^2
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	0,15 N/mm^2
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/mm^2

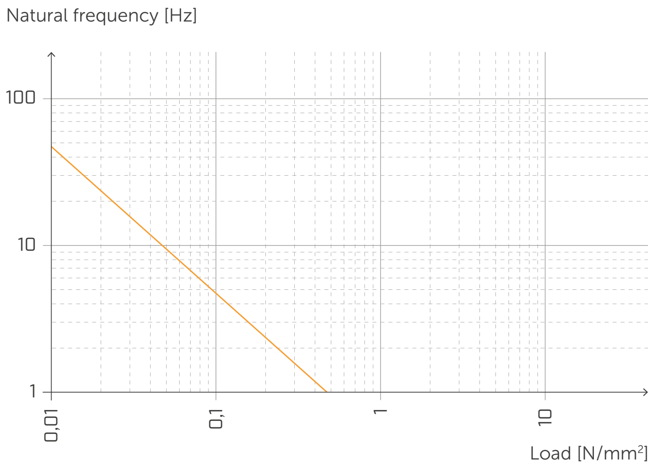
Acoustic service load:

from **0,008** to **0,052** N/mm^2

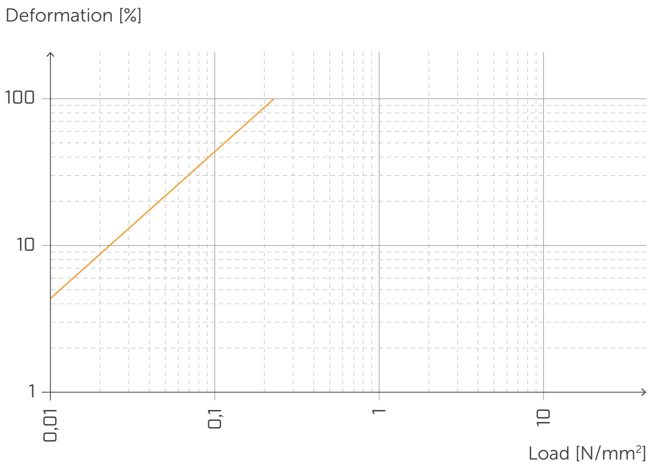
STATIC LOAD

(buildings)

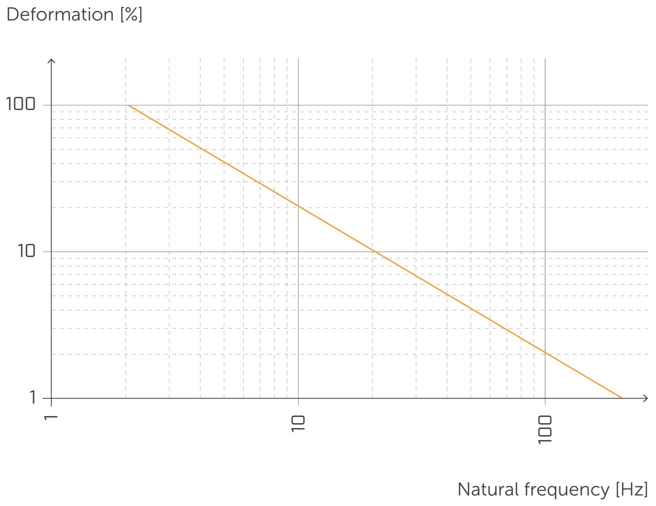
NATURAL FREQUENCY AND LOAD



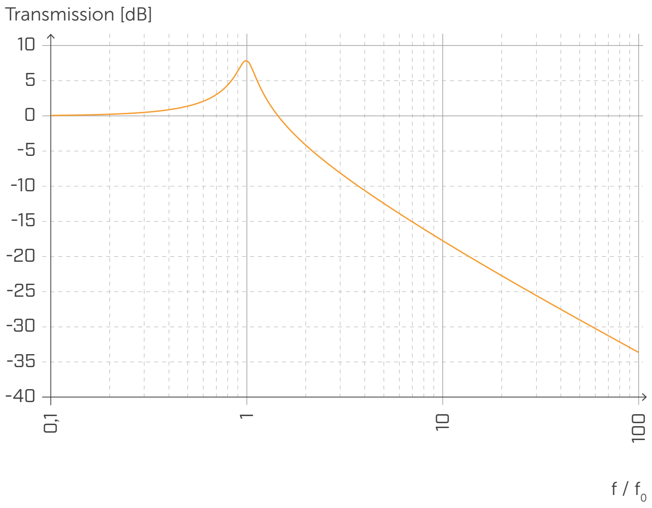
DEFORMATION AND LOAD



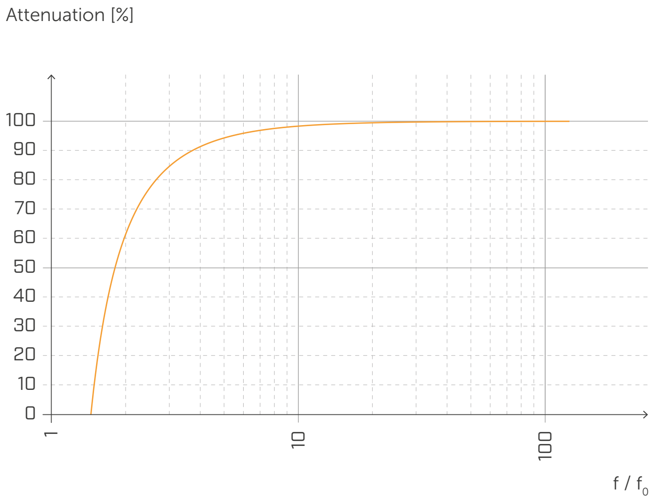
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION

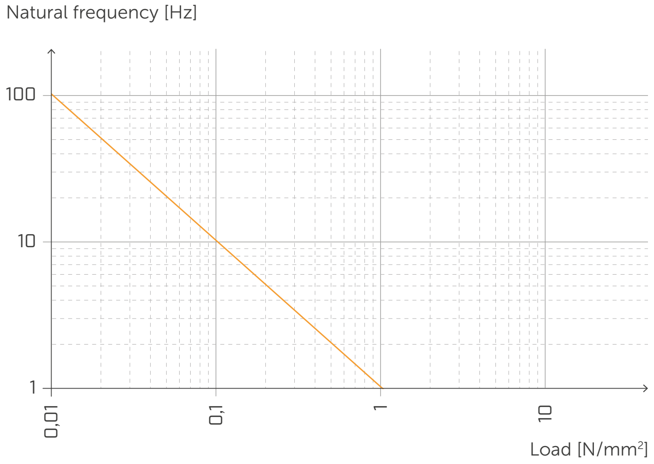


Normalised with respect to the resonance frequency with f = 20 Hz.

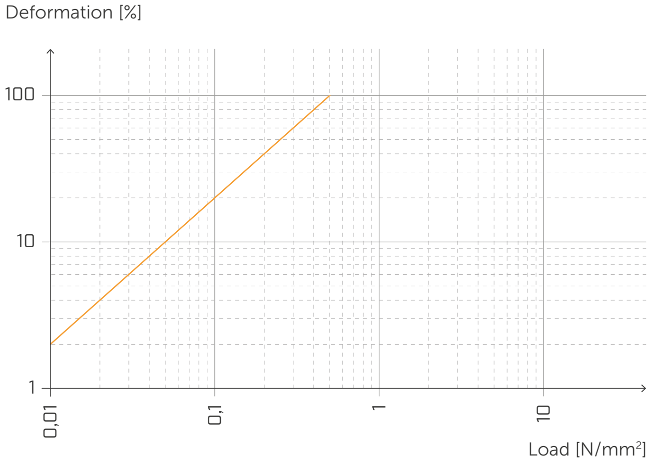
DYNAMIC LOAD
(machines and vibration)

5 Hz

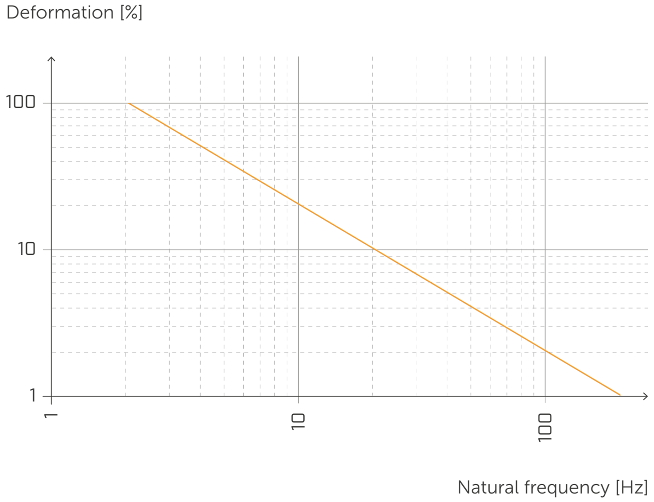
NATURAL FREQUENCY AND LOAD



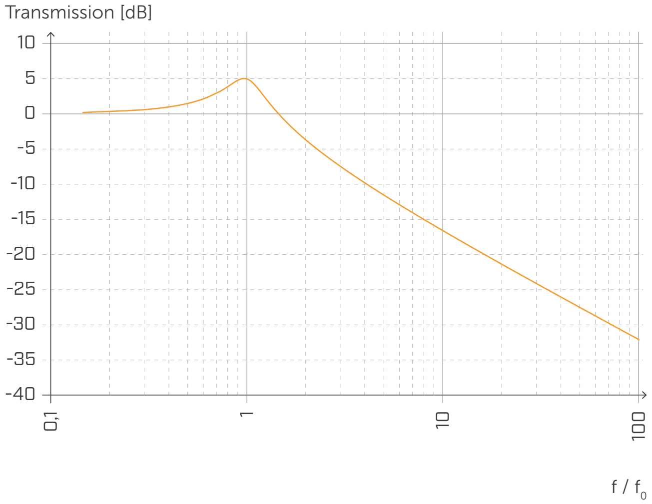
DEFORMATION AND LOAD



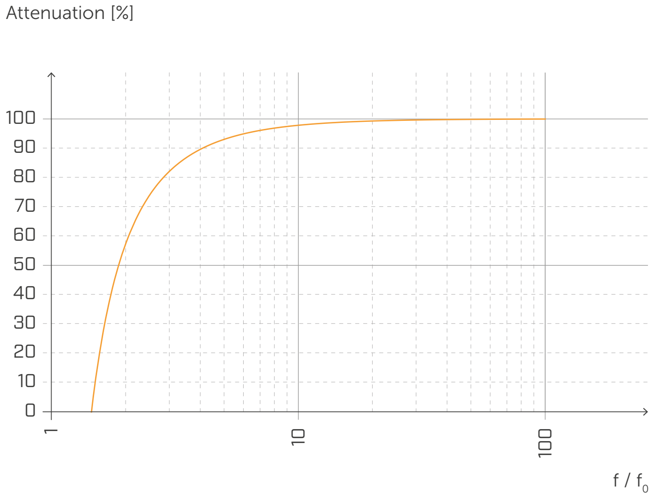
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



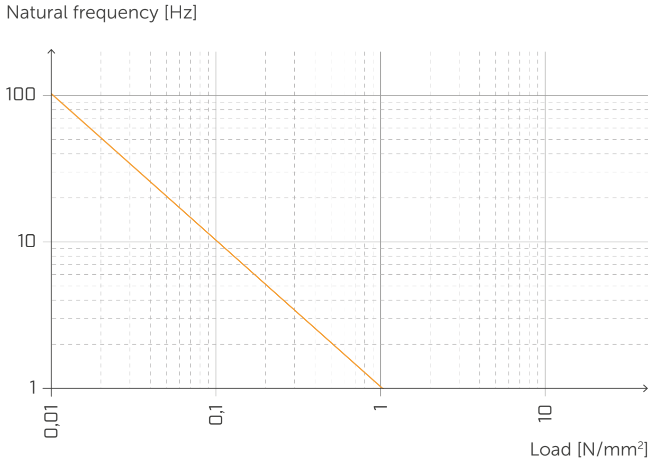
Normalised with respect to the resonance frequency with f = 6 Hz.

DYNAMIC LOAD

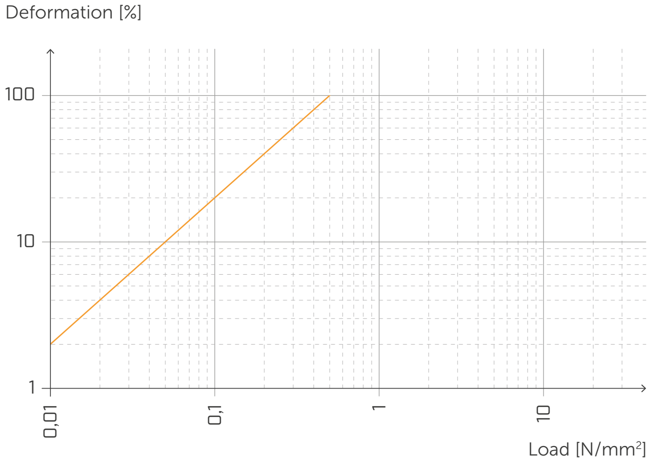
(machines and vibration)

50 Hz

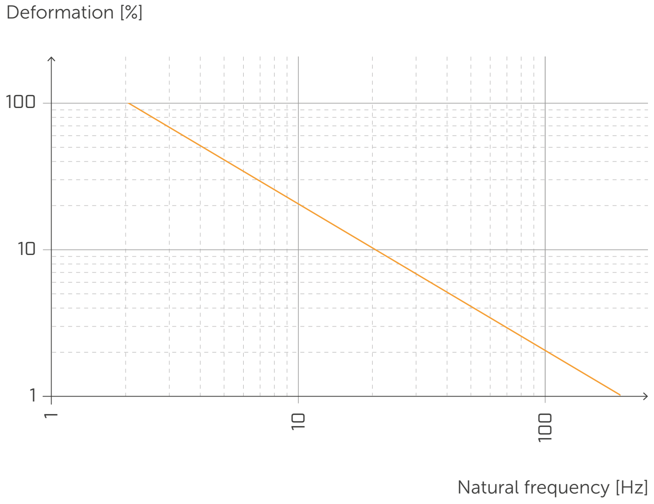
NATURAL FREQUENCY AND LOAD



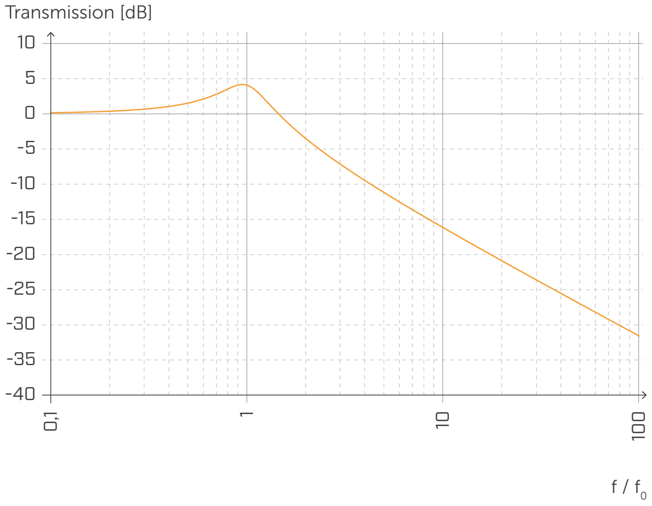
DEFORMATION AND LOAD



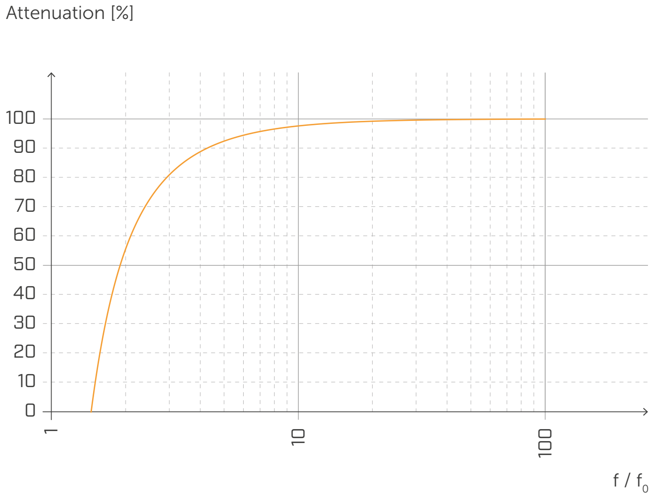
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



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

PIANO B

TABLE OF USE(1)

CODE	B	load for acoustic optimisation(2) [kN/m]		compression for acoustic optimisation(2) [N/mm^2]		deformation [mm]		*compression at 3 mm deformation (ultimate limit state)* *[N/mm^2]*
	[mm]	from	to	from	to	from	to	
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					

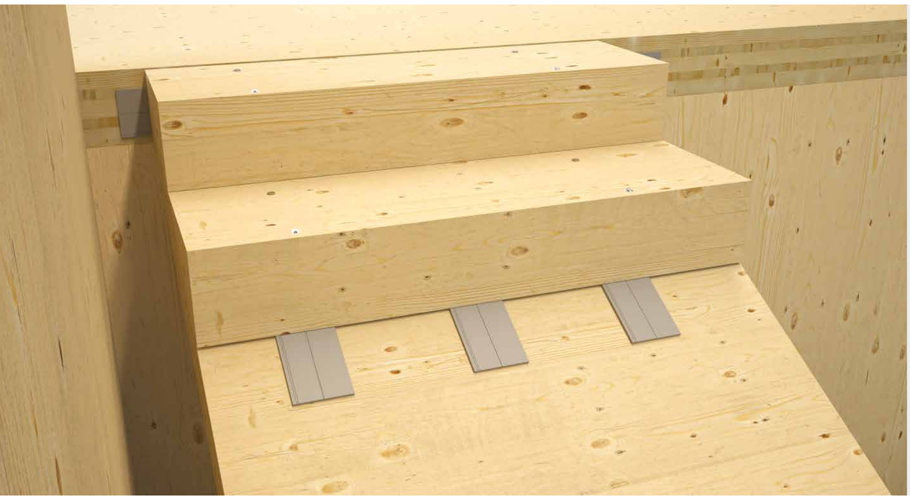
(1) The reported load ranges here are optimised with respect to the acoustic and static behaviour of the material in compression. It is possible to use profiles with loads outside the indicated range if the resonance frequency of the system and the deformation of the profile at the ultimate limit state 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/mm^2
Compressive stress at 2 mm strain σ_{2mm}	ISO 844	0,31 N/mm^2
Compressive stress at 3 mm strain σ_{3mm}	ISO 844	0,85 N/mm^2
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/mm^2

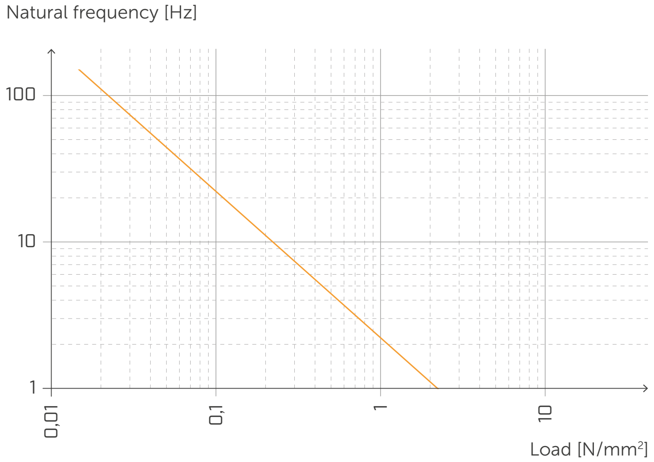
Acoustic service load:

from **0,04** to **0,27** N/mm^2

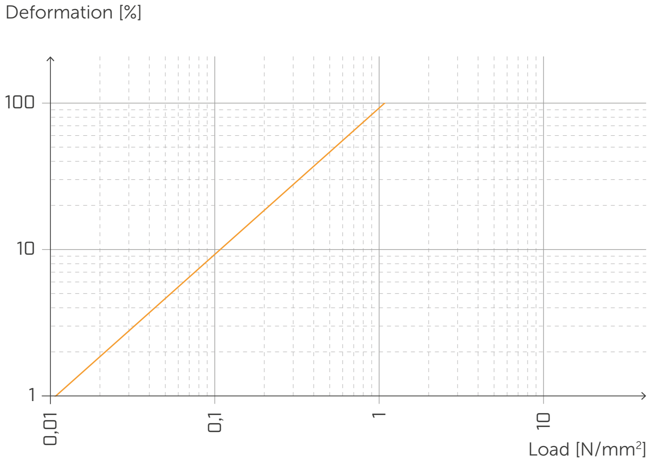
STATIC LOAD

(buildings)

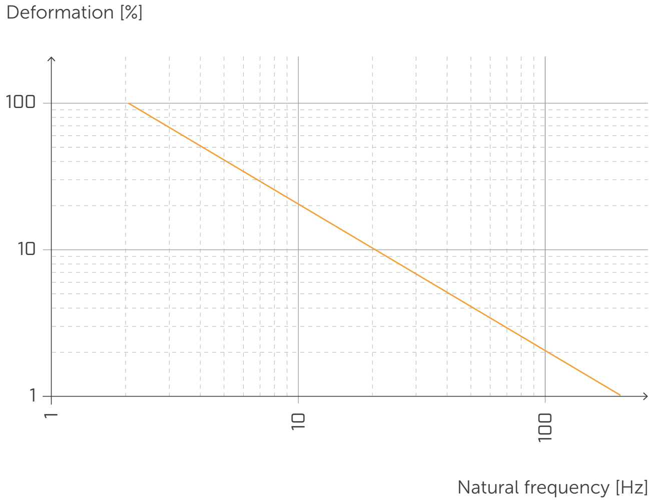
NATURAL FREQUENCY AND LOAD



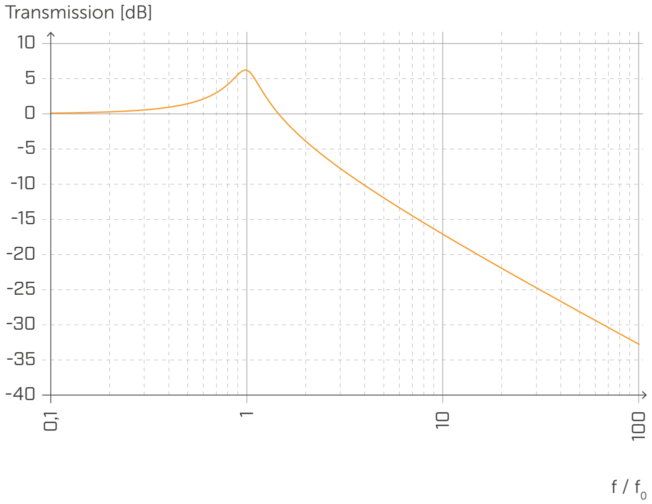
DEFORMATION AND LOAD



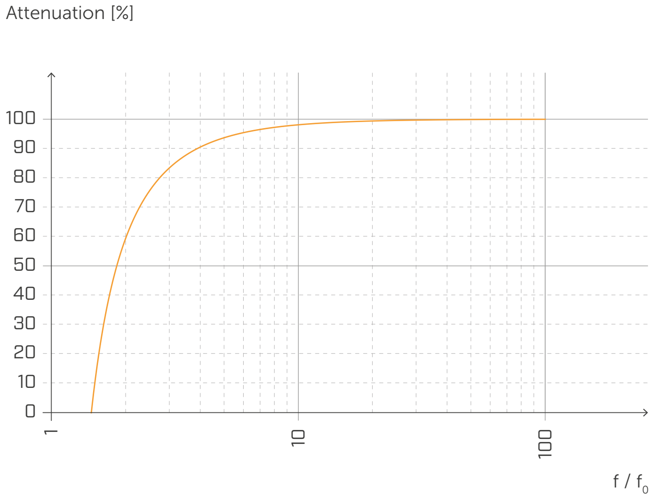
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



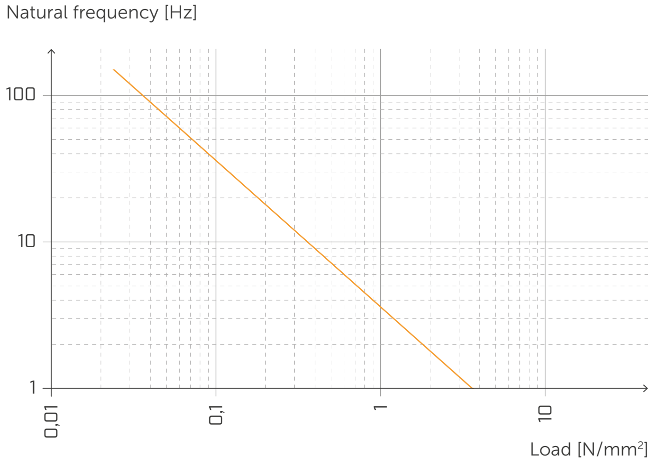
Normalised with respect to the resonance frequency with f = 20 Hz.

DYNAMIC LOAD

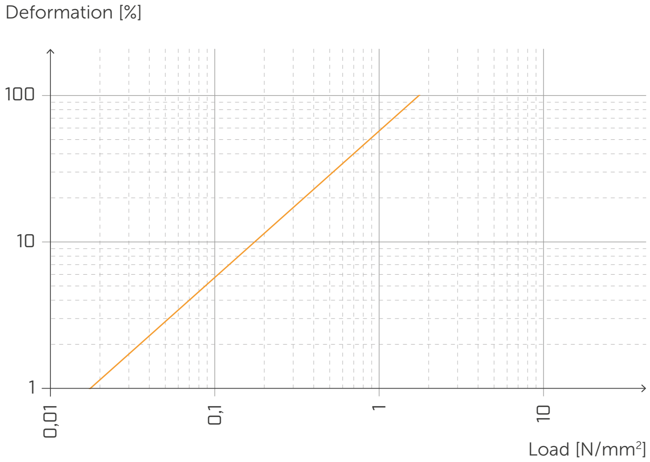
(machines and vibration)

5 Hz

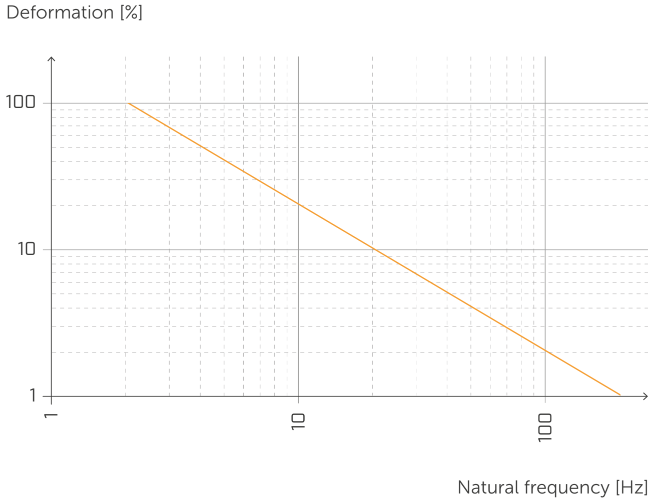
NATURAL FREQUENCY AND LOAD



DEFORMATION AND LOAD



DEFORMATION AND NATURAL FREQUENCY



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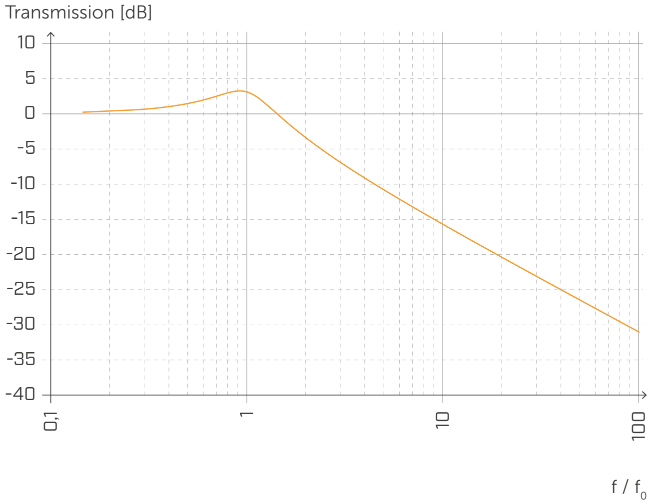
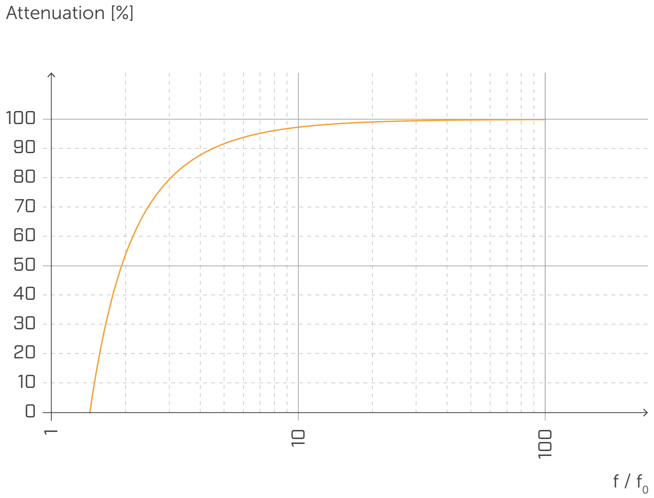


ATTENUATION



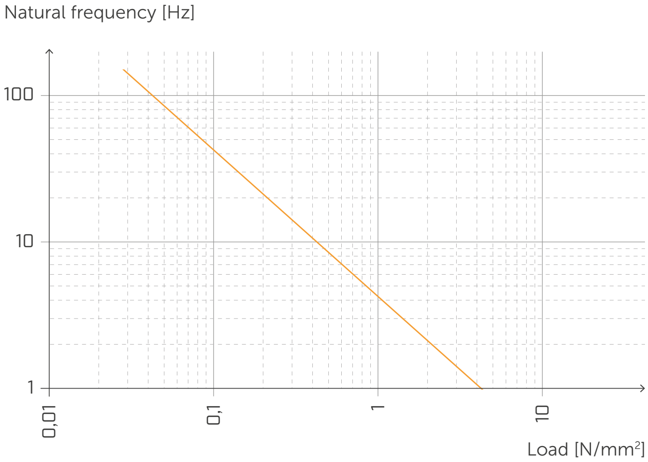
Normalised with respect to the resonance frequency with f = 6 Hz.

DYNAMIC LOAD

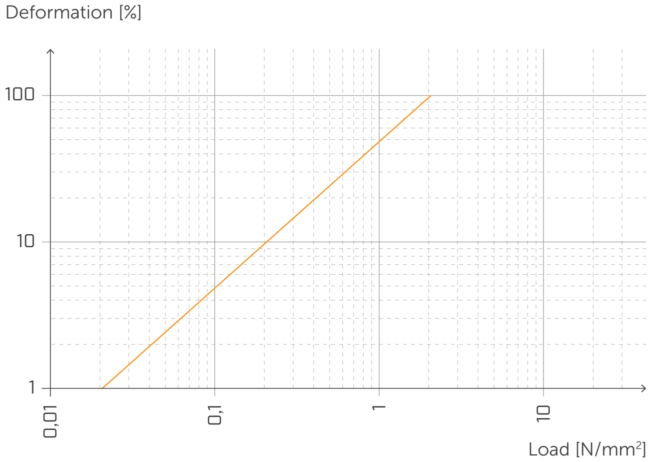
(machines and vibration)

50 Hz

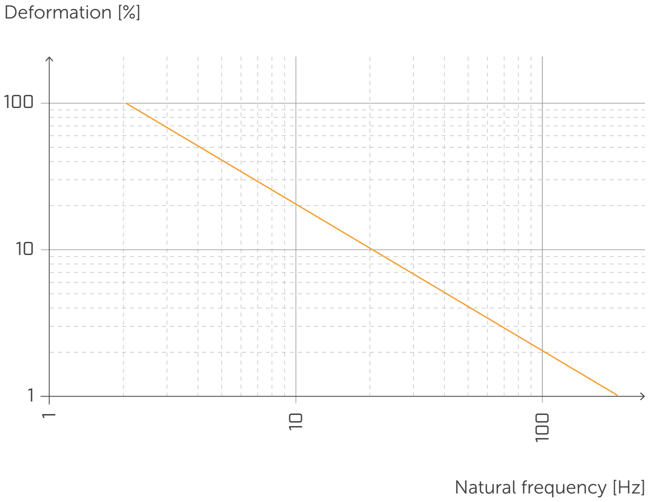
NATURAL FREQUENCY AND LOAD



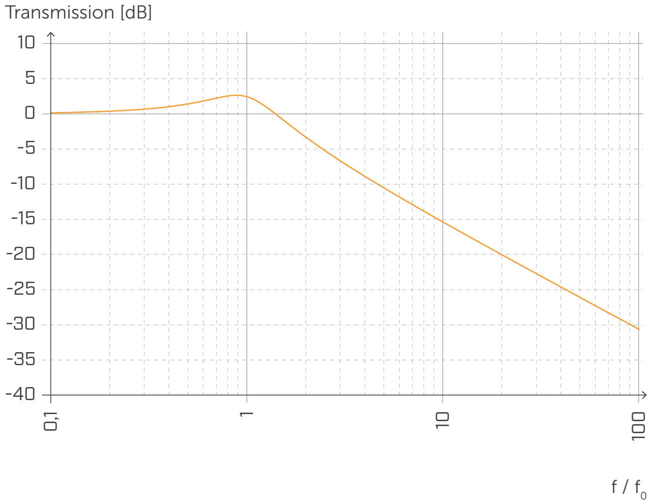
DEFORMATION AND LOAD



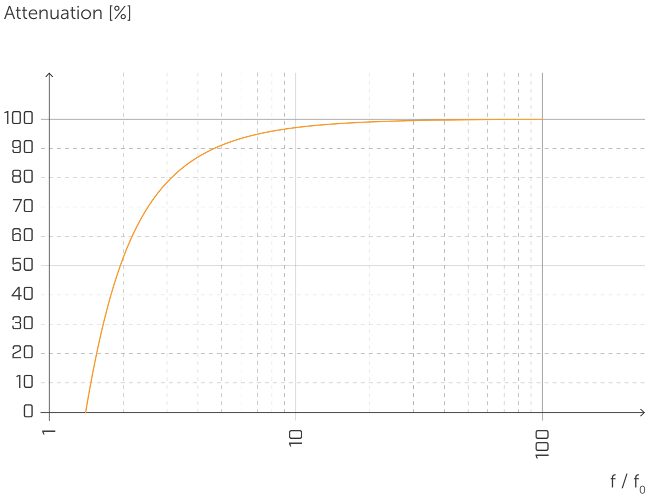
DEFORMATION AND NATURAL FREQUENCY



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

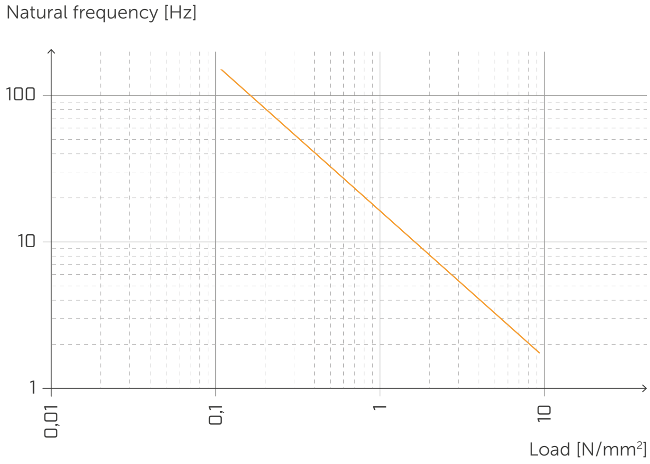
Acoustic service load:

from **0,12** to **1,4** N/mm2

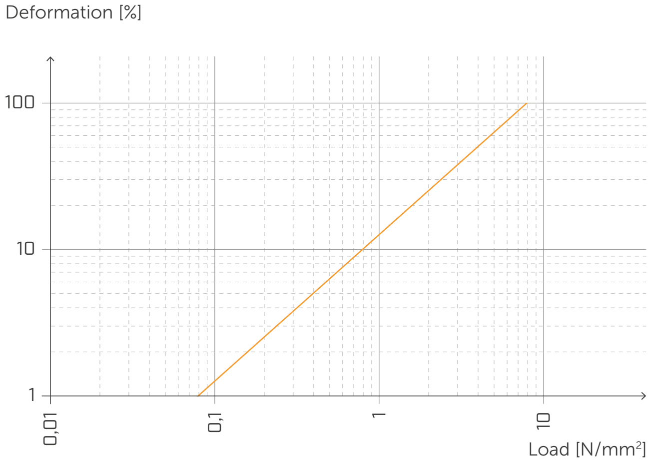
STATIC LOAD

(buildings)

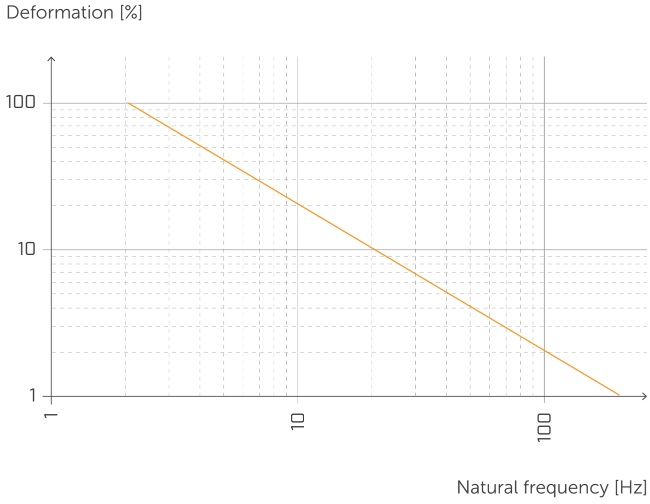
NATURAL FREQUENCY AND LOAD



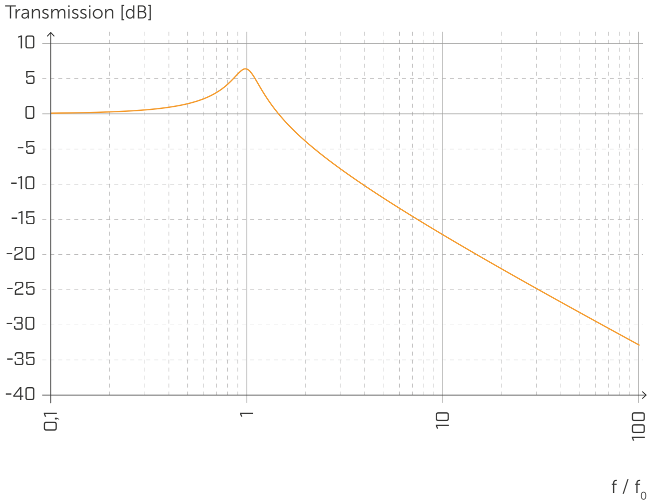
DEFORMATION AND LOAD



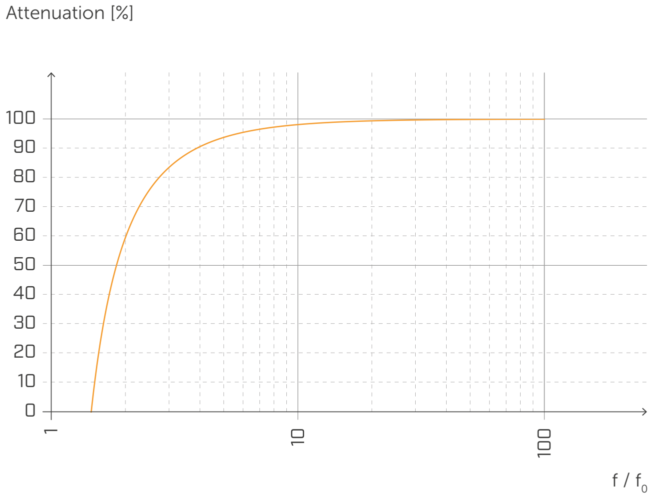
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



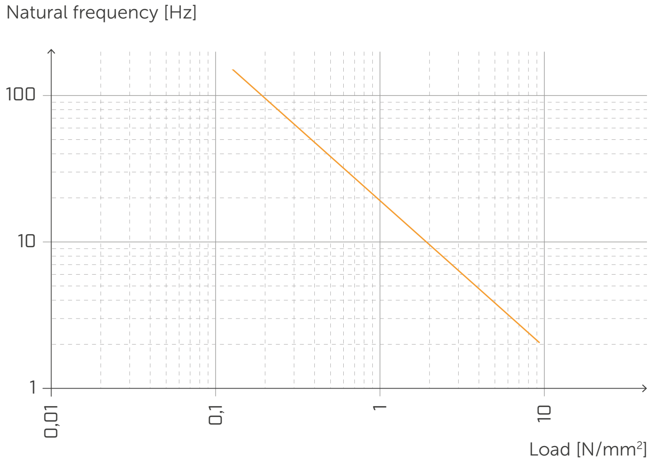
Normalised with respect to the resonance frequency with f = 20 Hz.

DYNAMIC LOAD

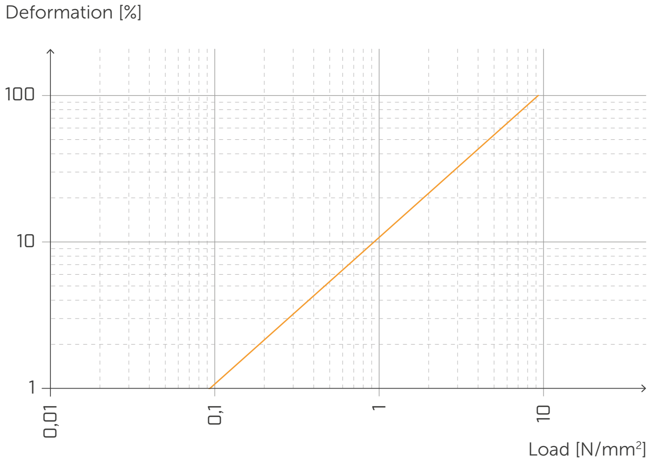
(machines and vibration)

5 Hz

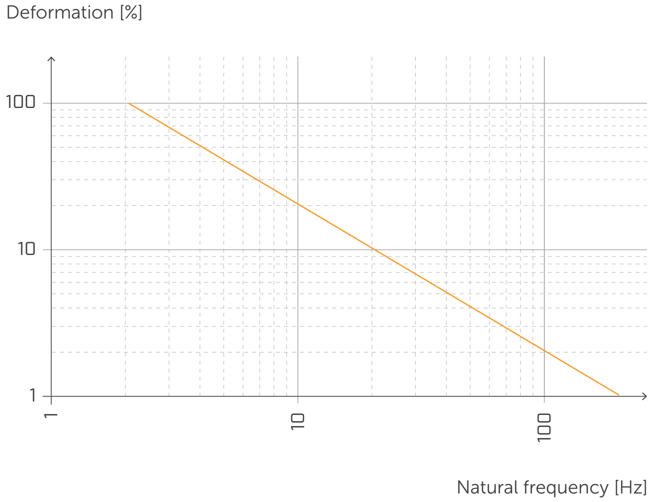
NATURAL FREQUENCY AND LOAD



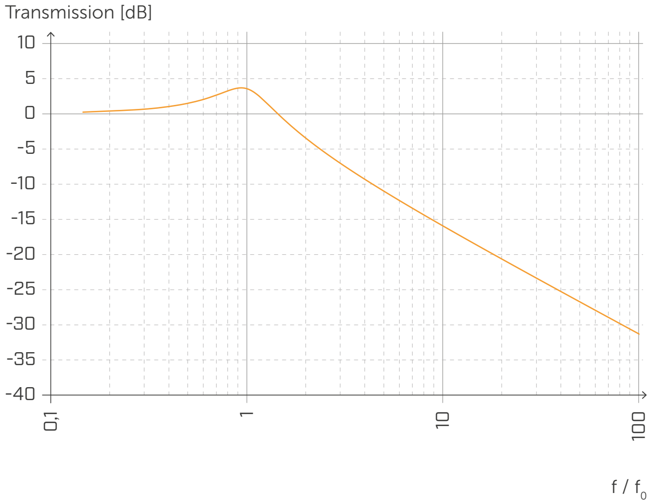
DEFORMATION AND LOAD



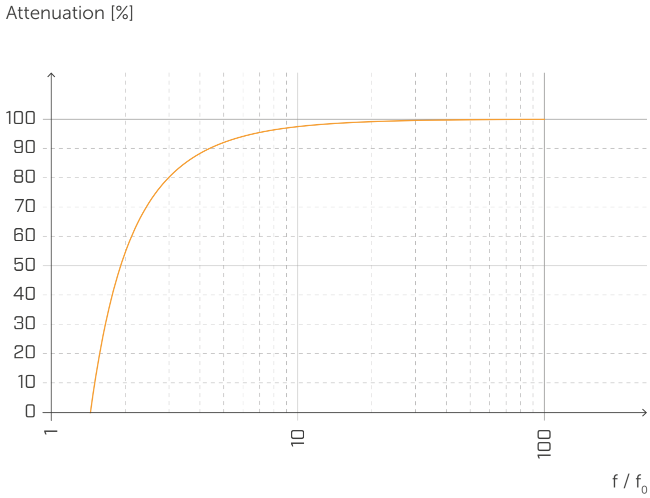
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



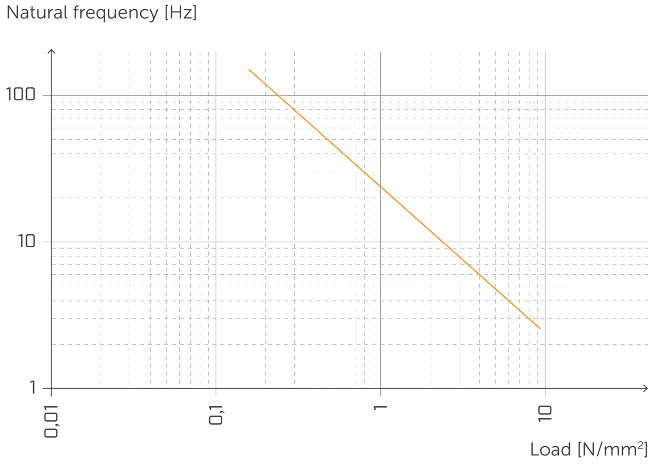
Normalised with respect to the resonance frequency with f = 6 Hz.

DYNAMIC LOAD

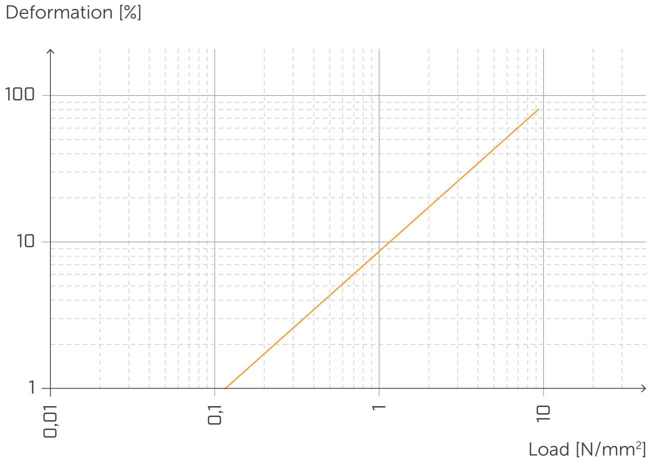
(machines and vibration)

50 Hz

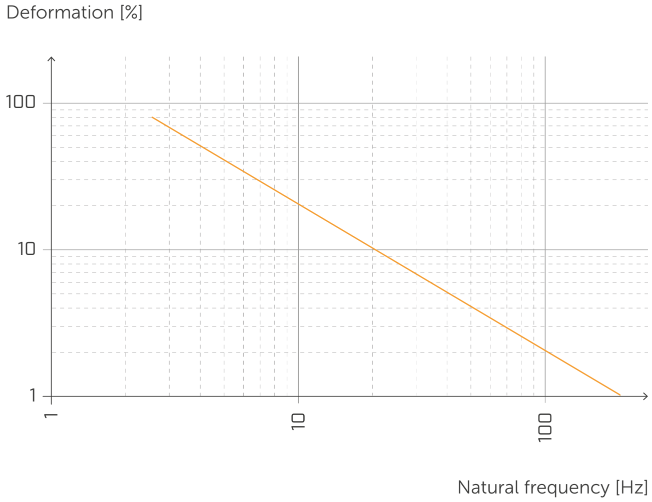
NATURAL FREQUENCY AND LOAD



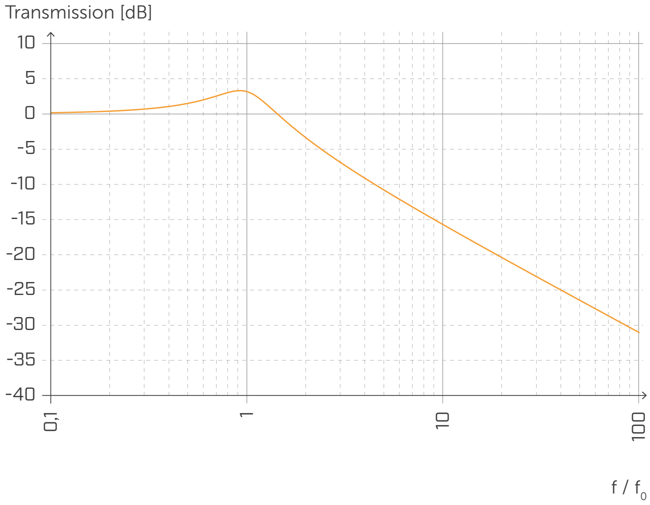
DEFORMATION AND LOAD



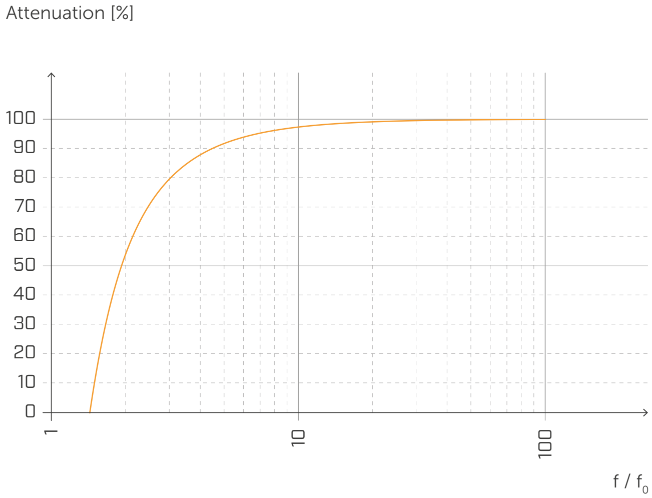
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



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

PIANO 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

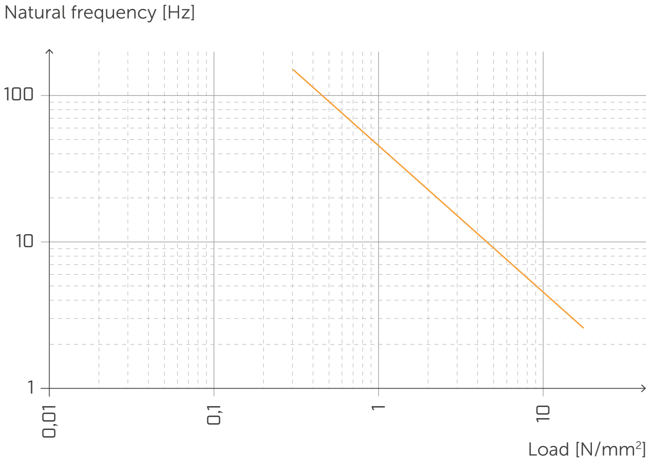
Acoustic service load:

from **1,2** to **2,28** N/mm²

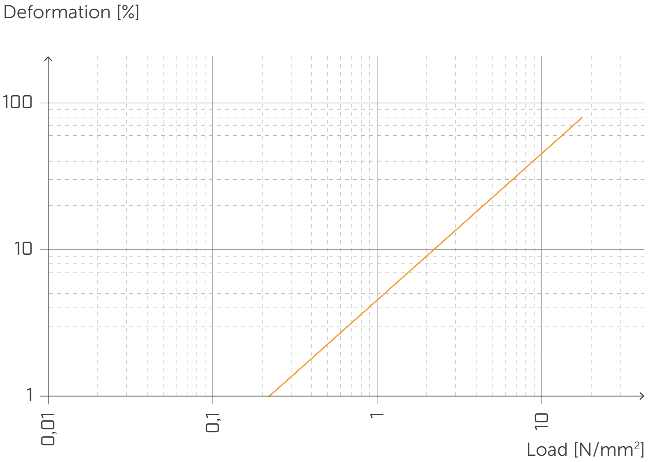
STATIC LOAD

(buildings)

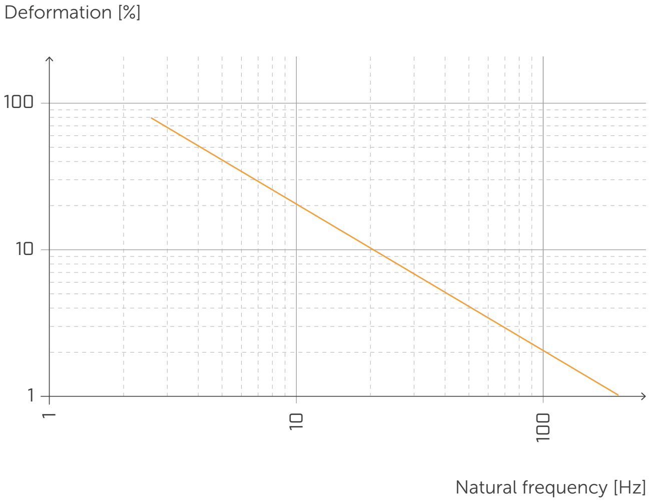
NATURAL FREQUENCY AND LOAD



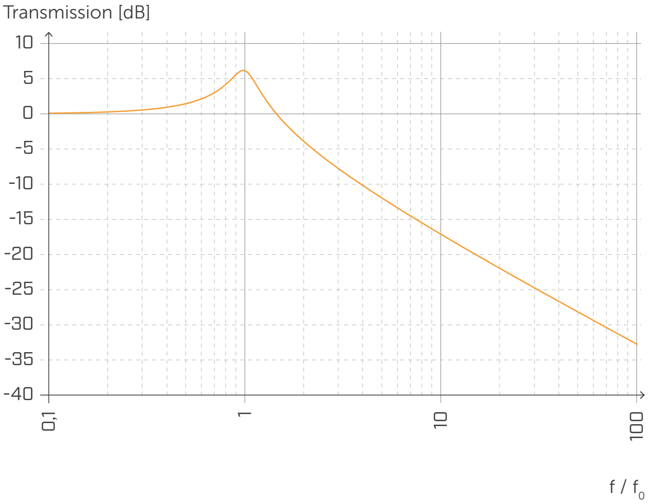
DEFORMATION AND LOAD



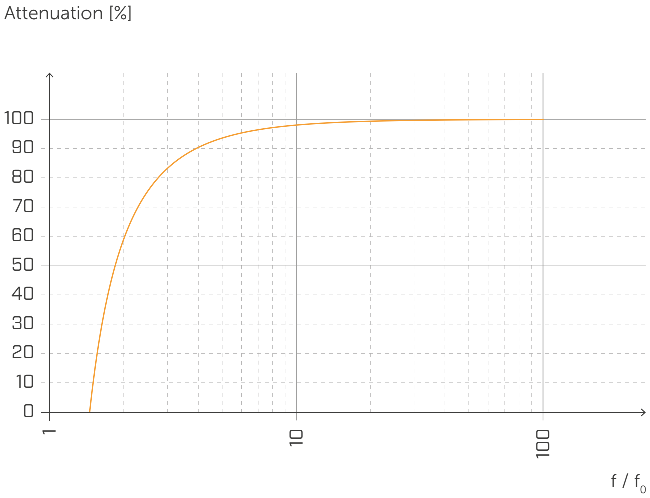
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



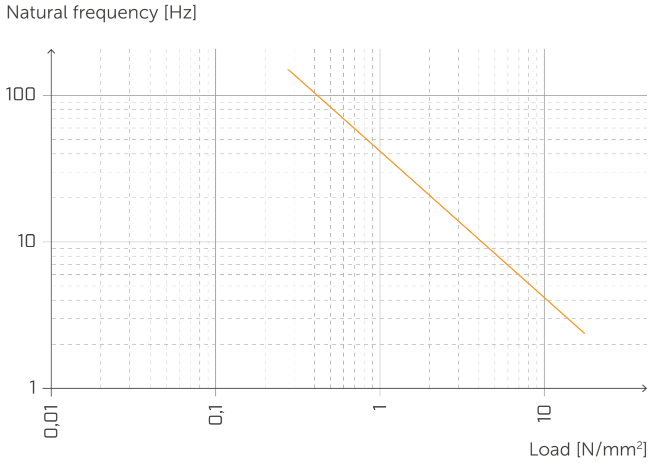
Normalised with respect to the resonance frequency with f = 20 Hz.

DYNAMIC LOAD

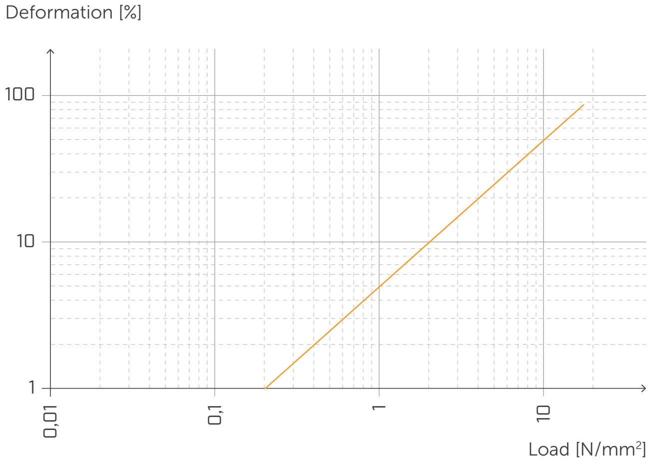
(machines and vibration)

5 Hz

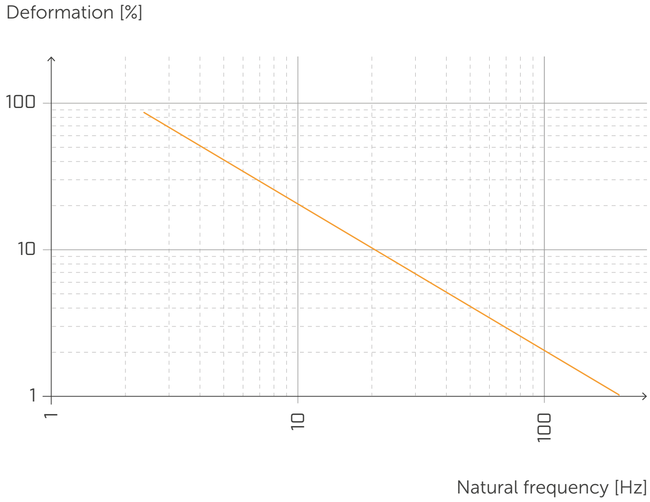
NATURAL FREQUENCY AND LOAD



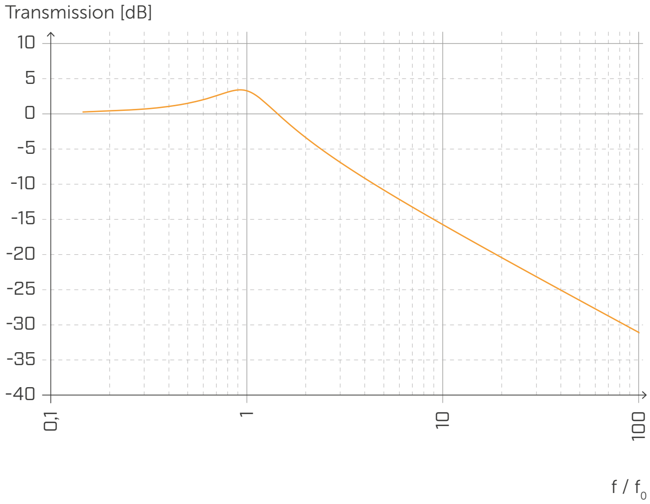
DEFORMATION AND LOAD



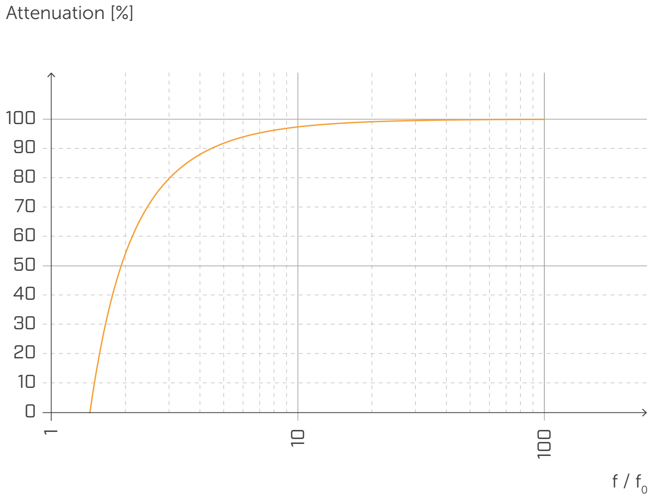
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



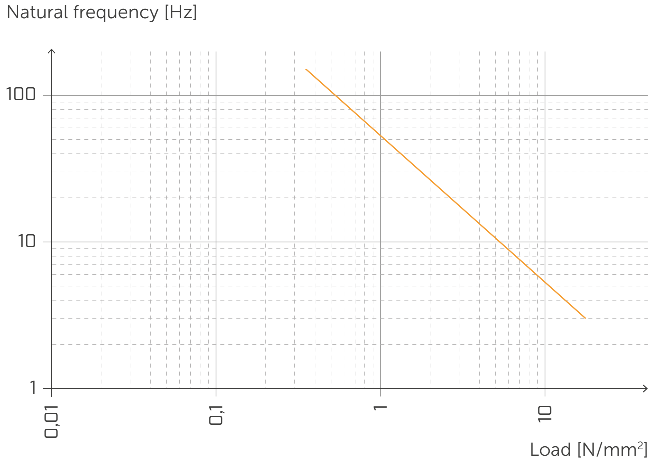
Normalised with respect to the resonance frequency with f = 6 Hz.

DYNAMIC LOAD

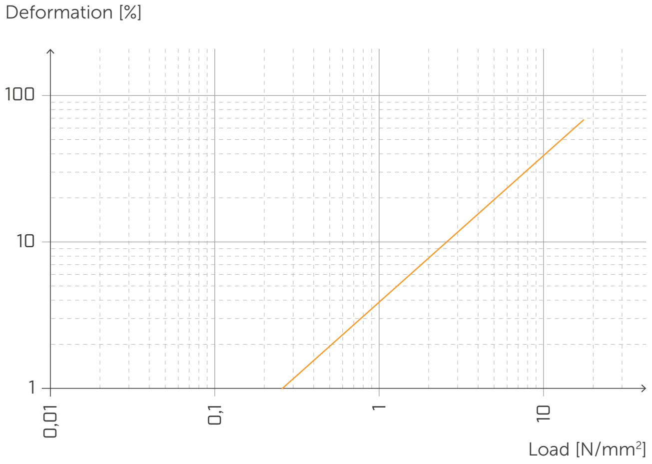
(machines and vibration)

50 Hz

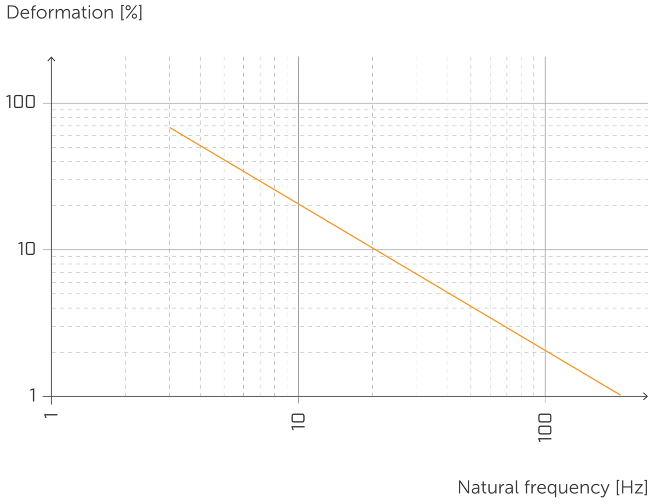
NATURAL FREQUENCY AND LOAD



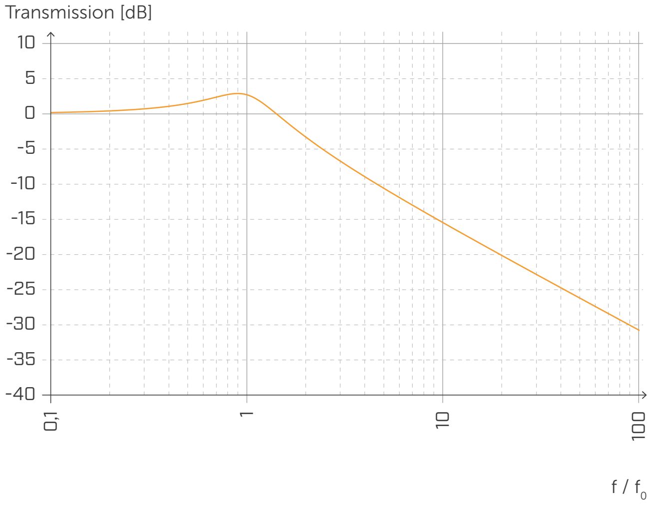
DEFORMATION AND LOAD



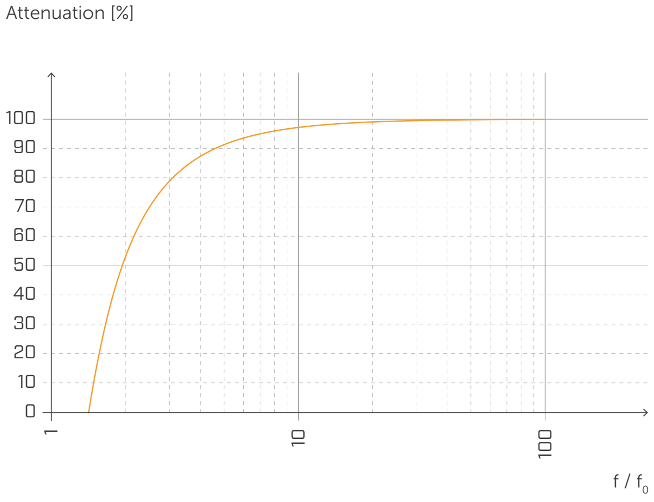
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



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

PIANO E

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]
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):

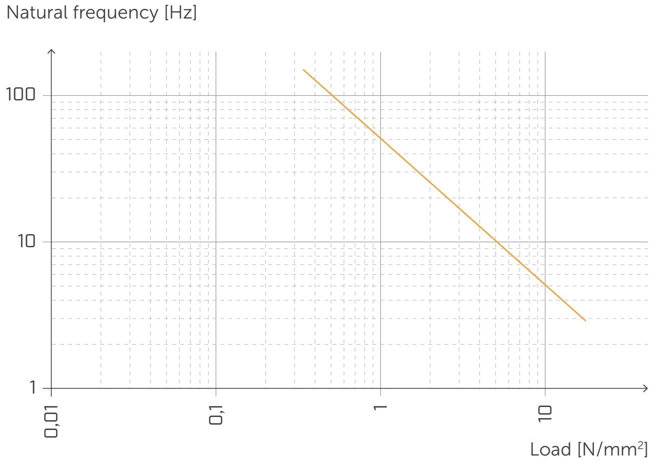
17,07 N/mm²

Acoustic service load:

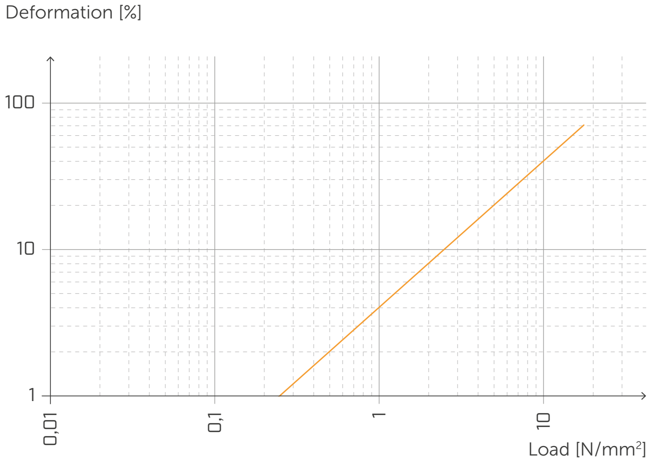
from **1,8** to **3,2** N/mm²

STATIC LOAD
(buildings)

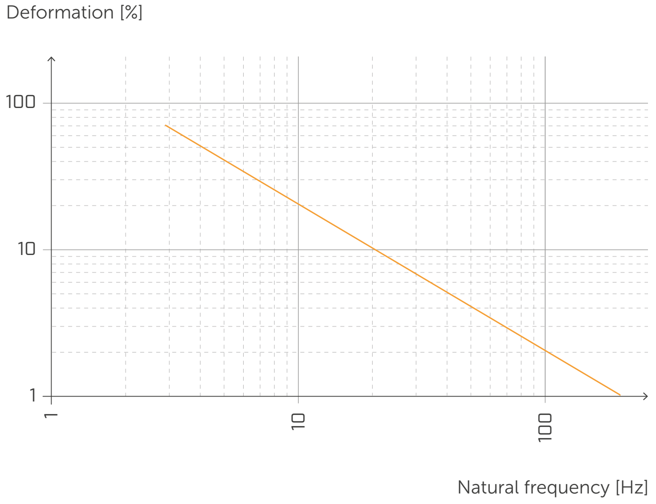
NATURAL FREQUENCY AND LOAD



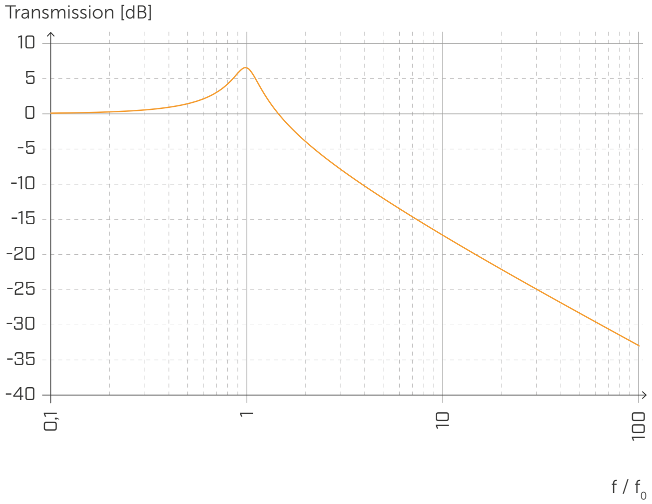
DEFORMATION AND LOAD



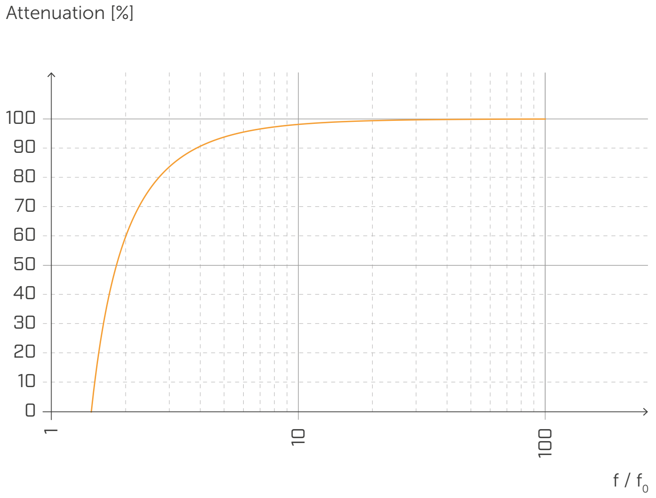
DEFORMATION AND NATURAL FREQUENCY



TRANSMISSIBILITY



ATTENUATION



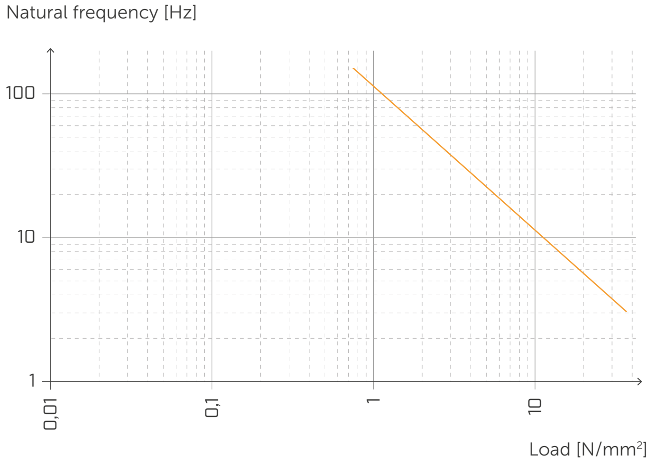
Normalised with respect to the resonance frequency with f = 20 Hz.

DYNAMIC LOAD

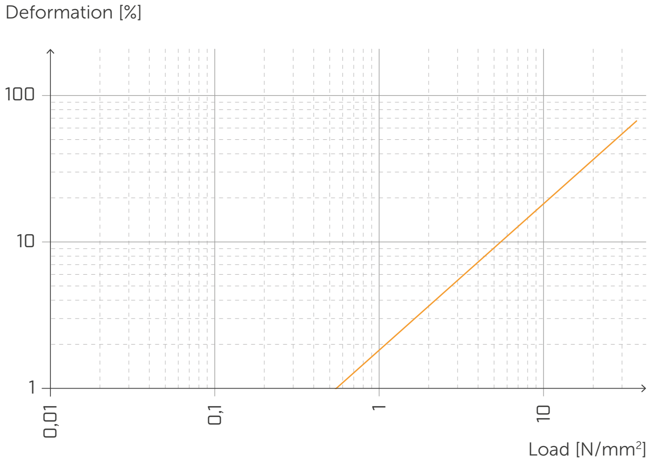
(machines and vibration)

5 Hz

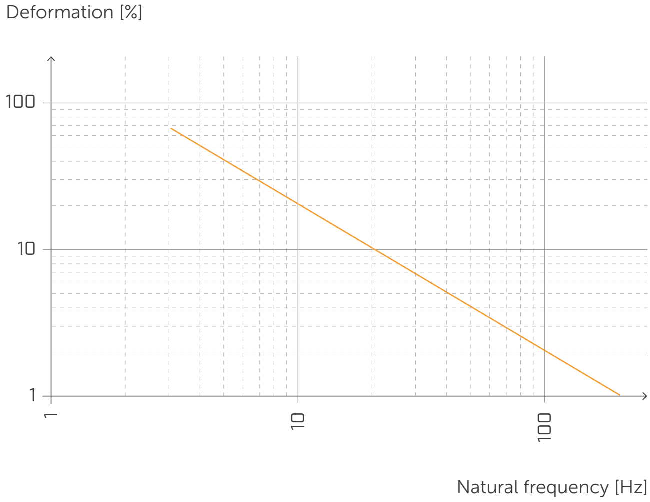
NATURAL FREQUENCY AND LOAD



DEFORMATION AND LOAD



DEFORMATION AND NATURAL FREQUENCY



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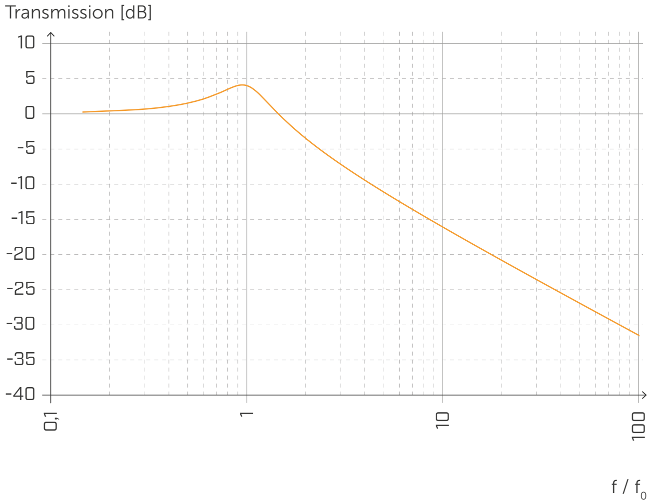

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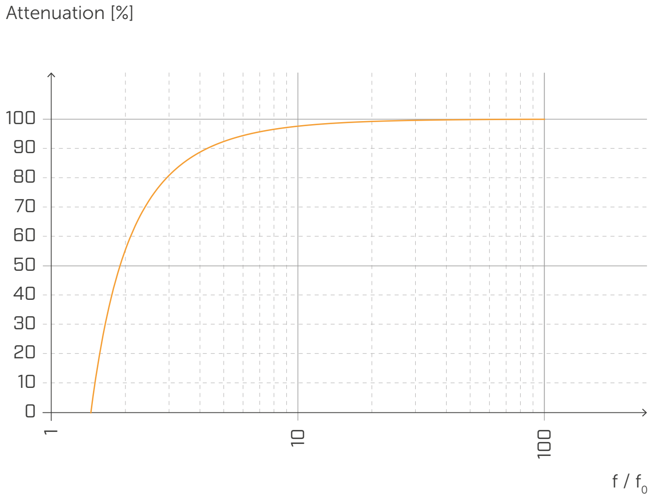


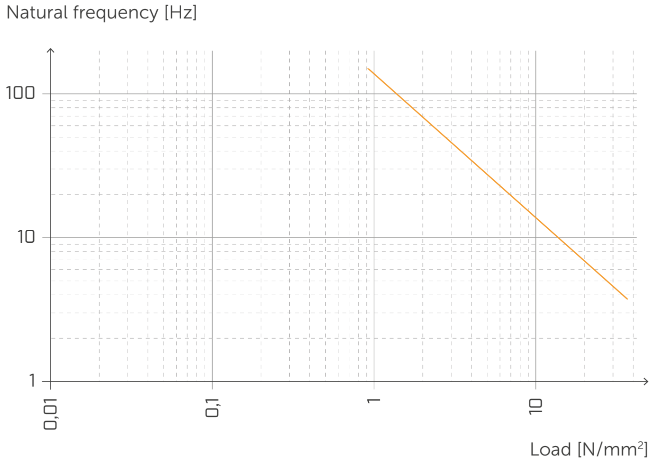
Normalised with respect to the resonance frequency with f = 6 Hz.

DYNAMIC LOAD

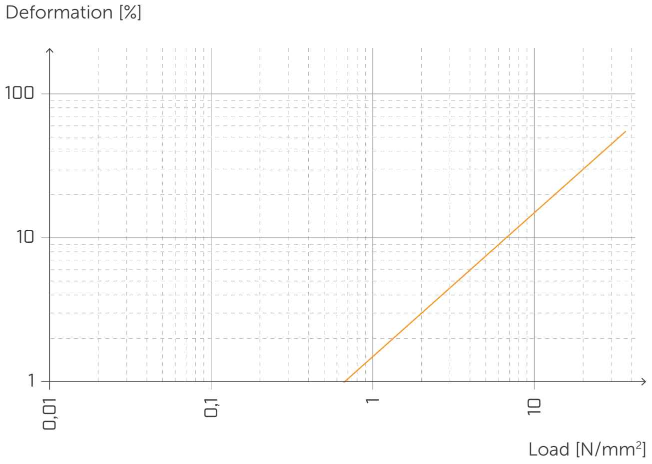
(machines and vibration)

50 Hz

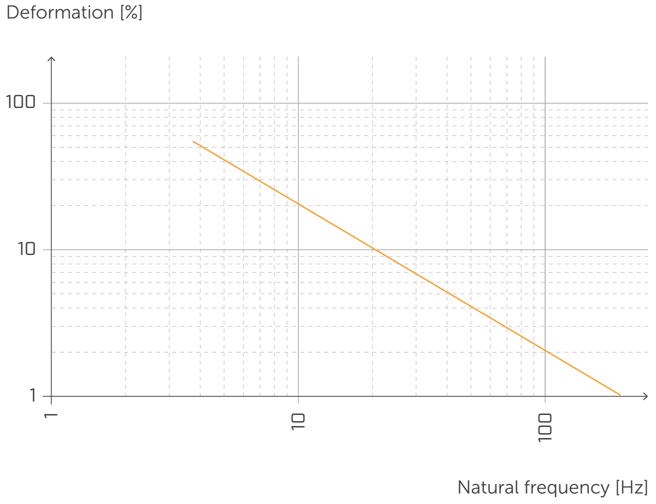
NATURAL FREQUENCY AND LOAD



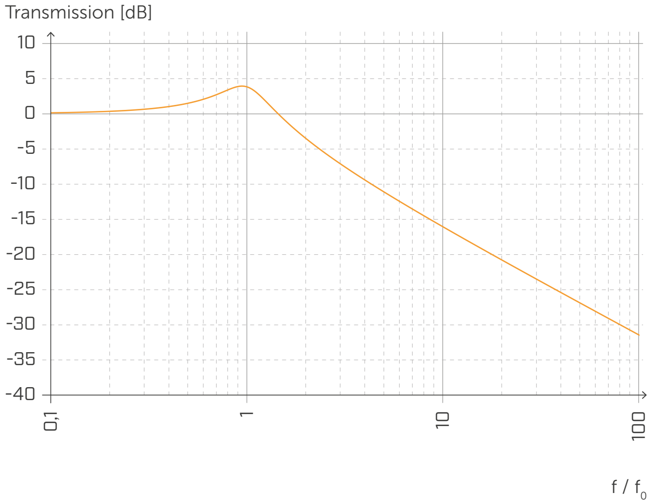
DEFORMATION AND LOAD



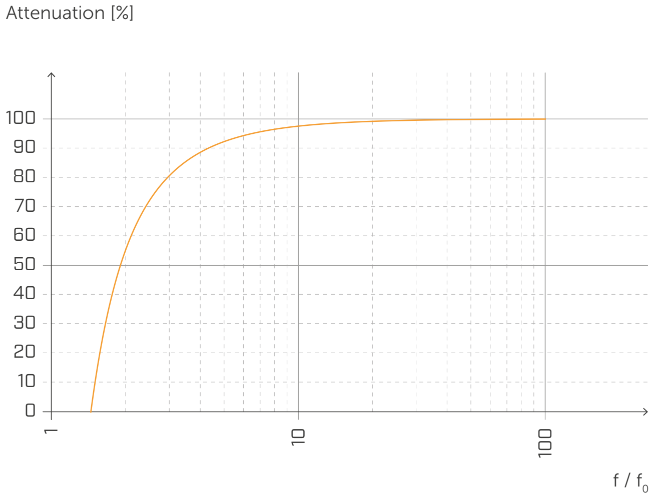
DEFORMATION AND NATURAL FREQUENCY



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 $R_{ij,w}$.

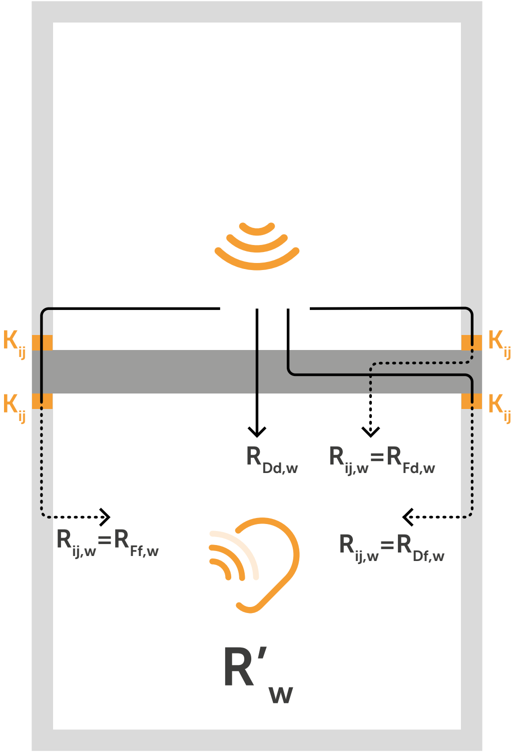
$$R'_w = -10\log\left[10^{-\frac{R_{Dd,w}}{10}} + \sum_{i,j=1}^{n} 10^{-\frac{R_{ij,w}}{10}} + \frac{A_0}{S_s}\sum_{j=1}^{n} 10^{-\frac{D_{n,j,w}}{10}}\right](dB)$$

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.

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

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

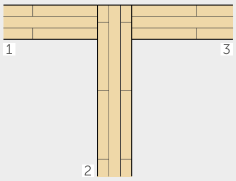
determined by the connecting elements.
In the case of CLT structures weakly bound together, the side transmission contribution can be determined according to the following relations, valid if $0,5 < (m_1/m_2) < 2$.

METHOD 1 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

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

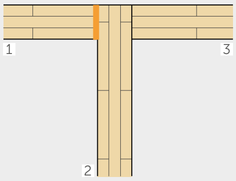
$K_{12}= 5,7 + 5,7\ M^2 = K_{23}$ dB



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



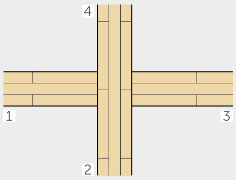
Solution 3 - X-SHAPED JOINT

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



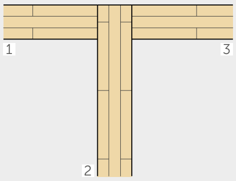
METHOD 2 - CALCULATING $K_{ijrigid}$

Solution 1 - T-SHAPED JOINT

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

f_k=500 Hz

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



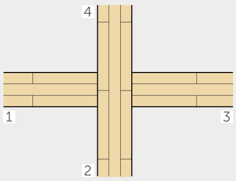
Solution 1 - X-SHAPED JOINT

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

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

f_k=500 Hz

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



THE SIMPLIFIED METHOD

A CALCULATION EXAMPLE USING EN ISO 12354

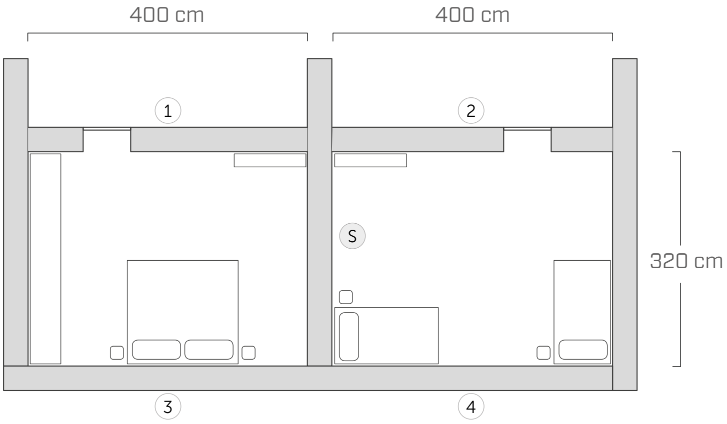
INPUT DATA

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

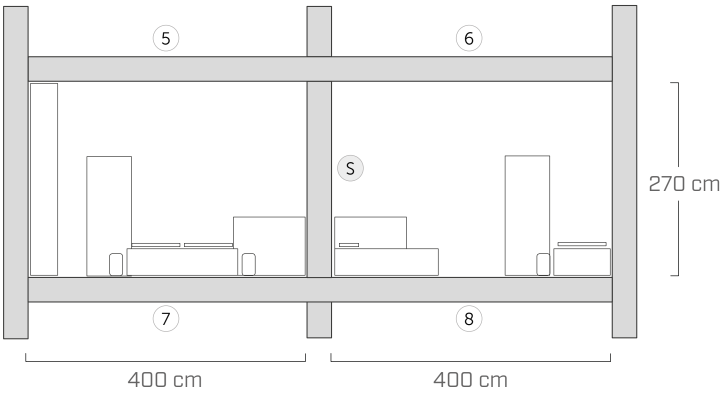
Regarding airborne sound insulation, the simplified calculation model predicts the apparent sound energy as a single value based on the acoustic performance of the elements involved in the junction. Below is an example of a calculation evaluating the apparent sound reduction index between two adjacent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

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

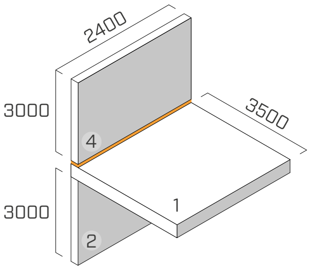
JOINT 5-6-S
X-shaped joint with resilient profile
detail 43

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

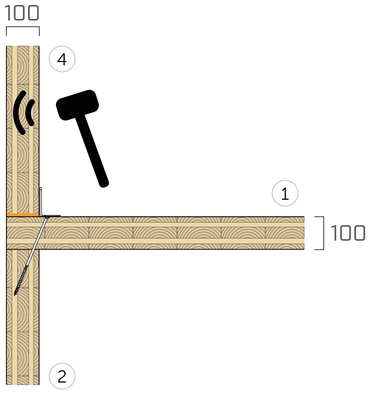
PIANO A

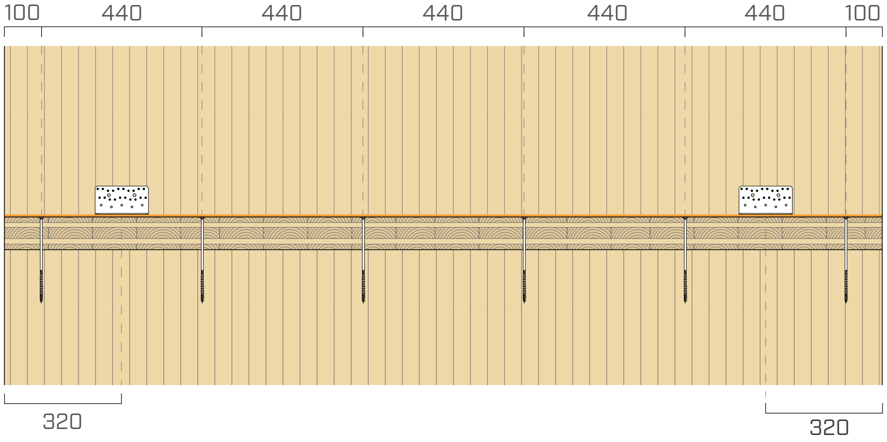
position: between the upper wall and the floor

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

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

applied load [N/m^2]: 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

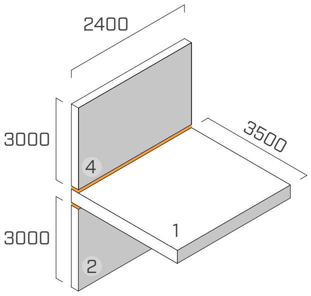
$\overline{K_{12}}$ = **13,9 dB** $\overline{K_{12,0}}$ = **14,6 dB** $\Delta_{l,12}$ = **-0,7 dB**

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

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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
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fastening pattern on CLT: 31 screws 5 x 50

RESILIENT PROFILE

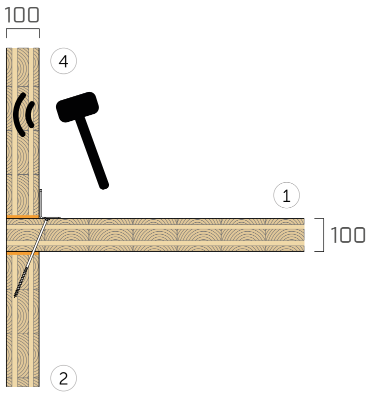
PIANO C

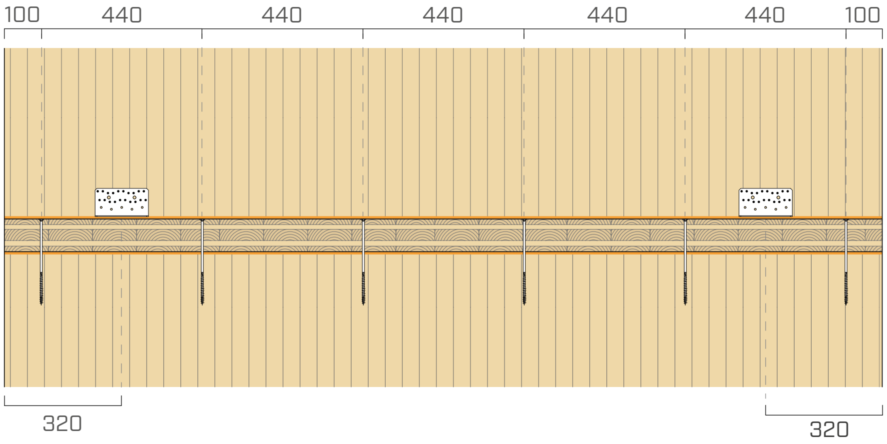
position: between the upper wall and the floor + between the floor and the lower wall

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**

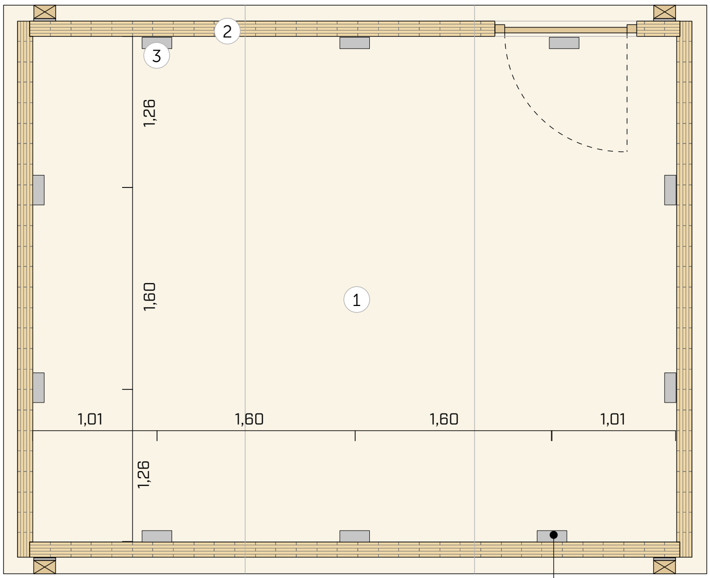
f [Hz]	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**
K_{24} [dB]	15,4	26,0	18,0	20,1	21,5	23,4	21,3	16,4	19,3	23,5	23,5	31,1	30,3	30,4	31,7	29,7

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

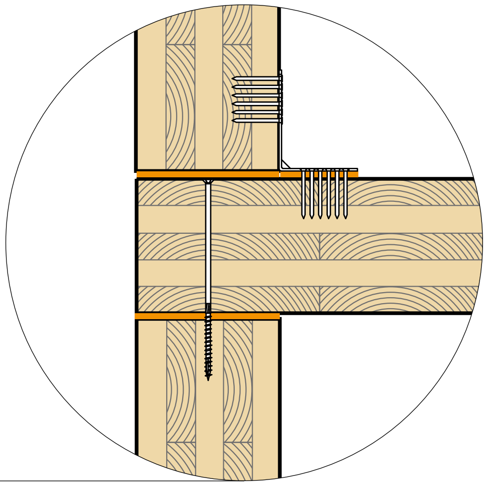
SOLUTIONS FOR LIGHTWEIGHT FLOORS

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

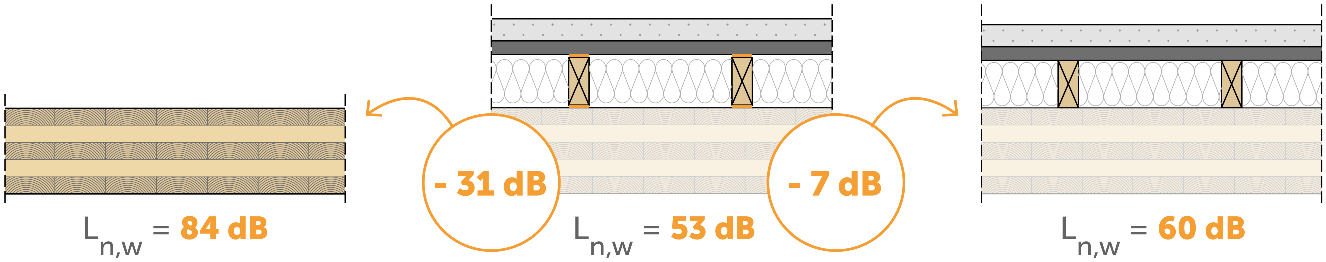


The receiving and transmitting rooms have a floor area of 21.5 m^2 (5.24 m lenght; 4.10 m width).
The volume of the transmitting room is 53.0 m^3, and the volume of the receiving room 85.0 m^3.



addition of the dry system
with PIANO

addition of dry system
without PIANO



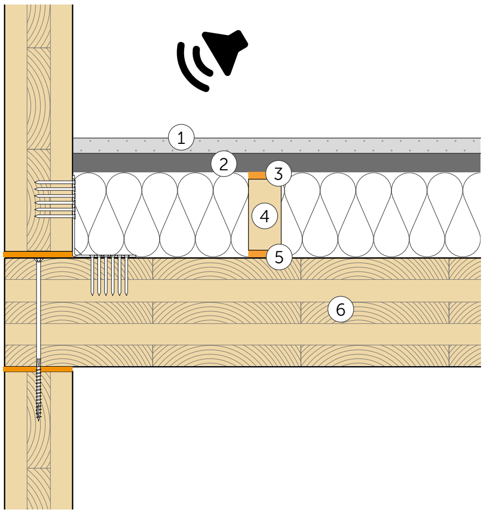
$L_{n,w}$ = **84 dB**
IIC = ***26***

$L_{n,w}$ = **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

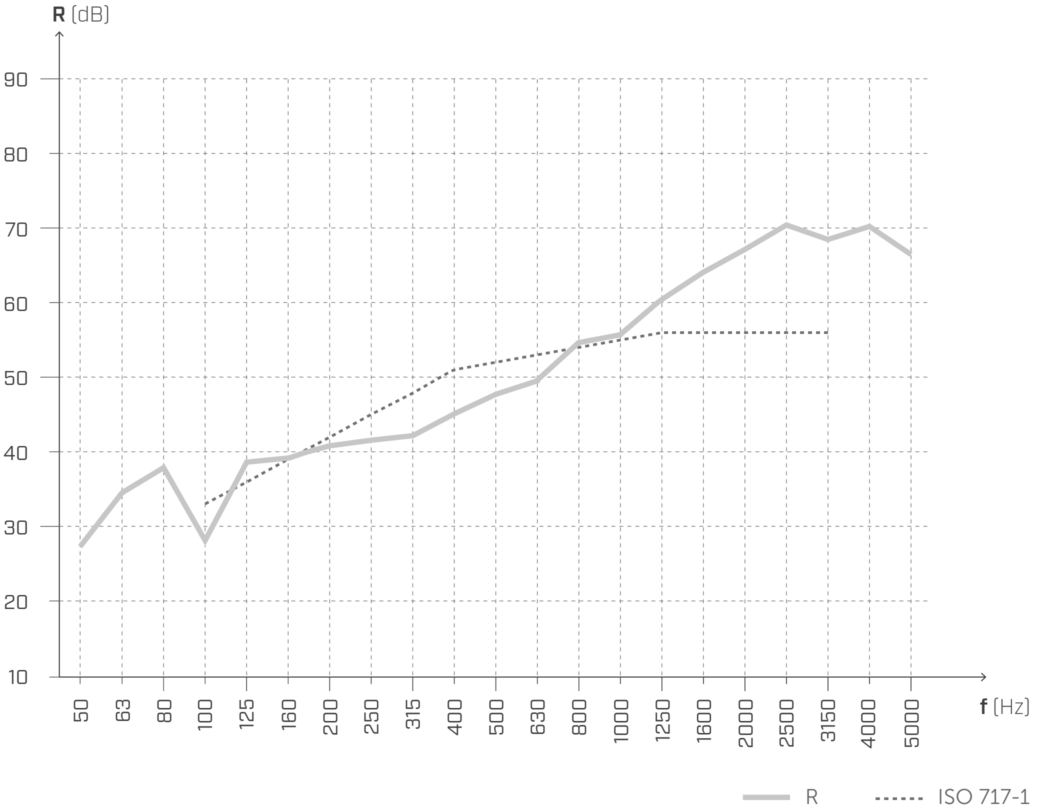


FLOOR SLAB

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

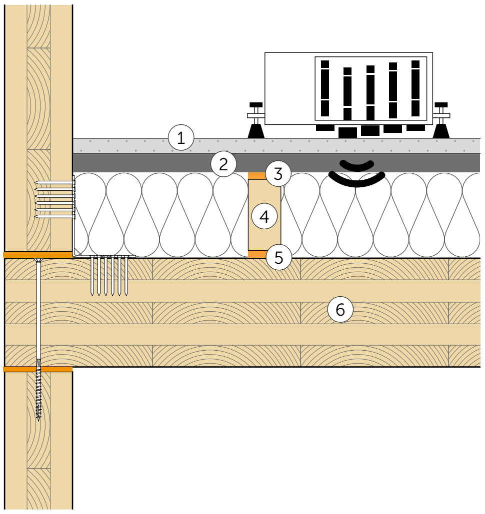
R_w $(C;C_{tr})$ = **52 (0; -7) dB**

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

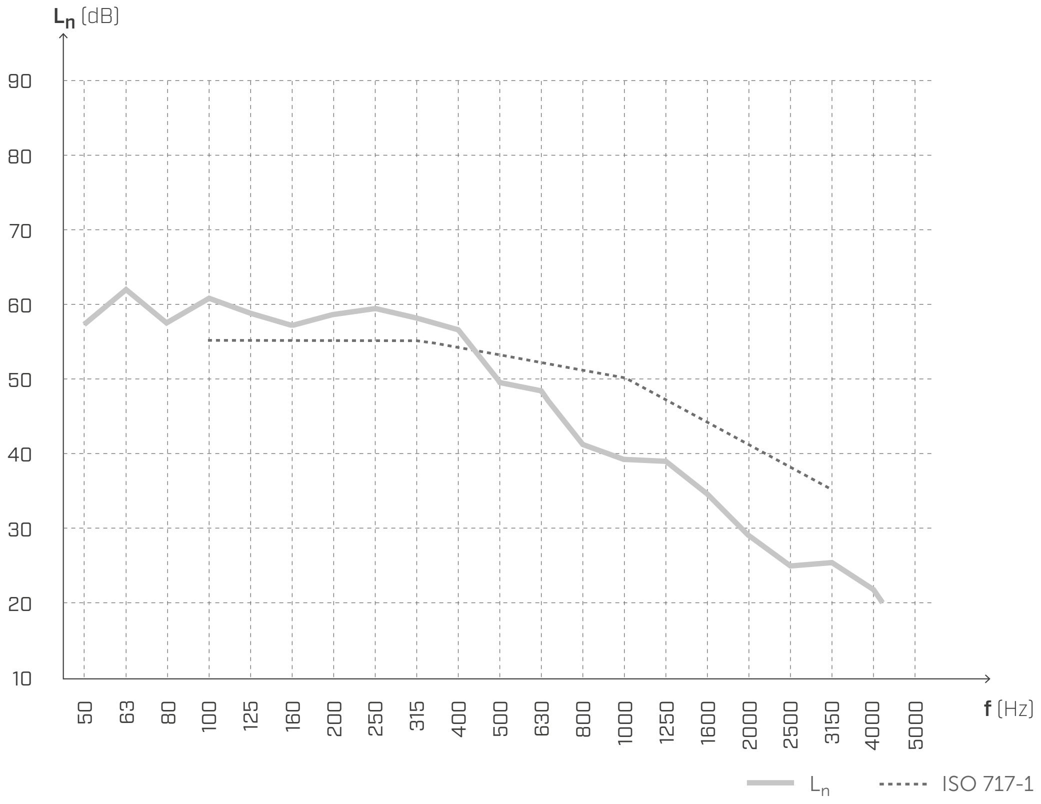


FLOOR SLAB

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



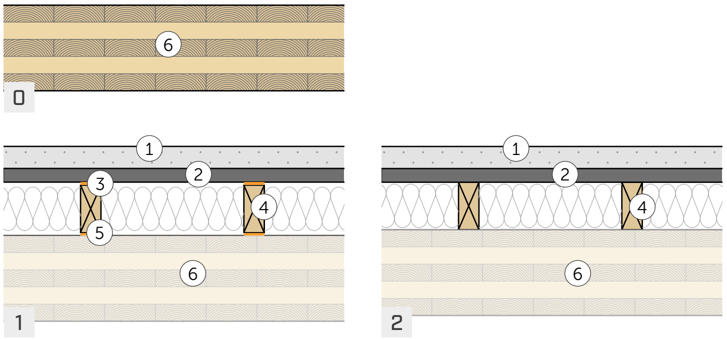
f [Hz]	**L_n** [dB]
50	57,1
63	62,1
80	57,3
100	60,8
125	58,8
160	57,2
200	58,6
250	59,4
315	58,2
400	56,6
500	49,6
630	48,4
800	41,2
1000	39,2
1250	39,0
1600	34,6
2000	29,0
2500	24,9
3150	25,4
4000	21,9
5000	13,0

$L'_{n,w,PIANO}$ (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.

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Rotho Blaas Srl

Via dell’Adige N.2/1 | 39040, Cortaccia (BZ) | Italia
Tel: +39 0471 81 84 00 | Fax: +39 0471 81 84 84
info@rothoblaas.com | www.rothoblaas.com