CERTIFIED ACOUSTICS

Imprint

Publisher: Fural
Systeme in Metall GmbH
Cumberlandstraße 62
4810 Gmunden
Austria

State: July 2020

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Concept and design: stauss processform gmbh, Munich
Illustrations: stauss processform gmbh, Munich
Editor: Word Connection GmbH
Paper: MagnoVolume 250 g/m² & 130 g/m² (PEFC/06-39-16)
Font: DIN Pro Light & Medium
Print: Friedrich Druck & Medien GmbH
Zamenhofstrasse 43-45
4020 Linz
Austria
confirms the compensation of greenhouse gas emissions through additional climate protection projects.
ClimatePartner-ID 11293-2007-1001

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WE ARE ACOUSTIC CEILINGS

We are family!

Since the first half of 2019, the companies **Fural Systeme in Metall GmbH** in Gmunden (Austria), **Dipling Werk GmbH** in Frankfurt/Hungen (Germany) and **Metalit AG** in Büron (Switzerland) have constituted a strong, international corporate group in the acoustic ceiling sector.

In this international partnership, we are pooling decades of experience in development and production with the understanding of the needs of the respective regional markets.

We regard ourselves as quality leaders in acoustic ceilings, and therefore as your primary contact for aesthetically, technically and logistically challenging architectural and building projects.

"Metal acoustic ceilings are efficient, contemporary, sustainable and aesthetic structural components."
(Dirk Freytag, CTO)

The benefits of metal ceilings as acoustic ceilings

Our systems combine outstanding acoustic properties and a high-quality appearance with functionality and durability. This combination creates a pleasant room atmosphere that impresses developers and users alike. Architects and installers hold us in high regard for our easily installed, perfected acoustic metal ceiling systems and our service-oriented project handling.

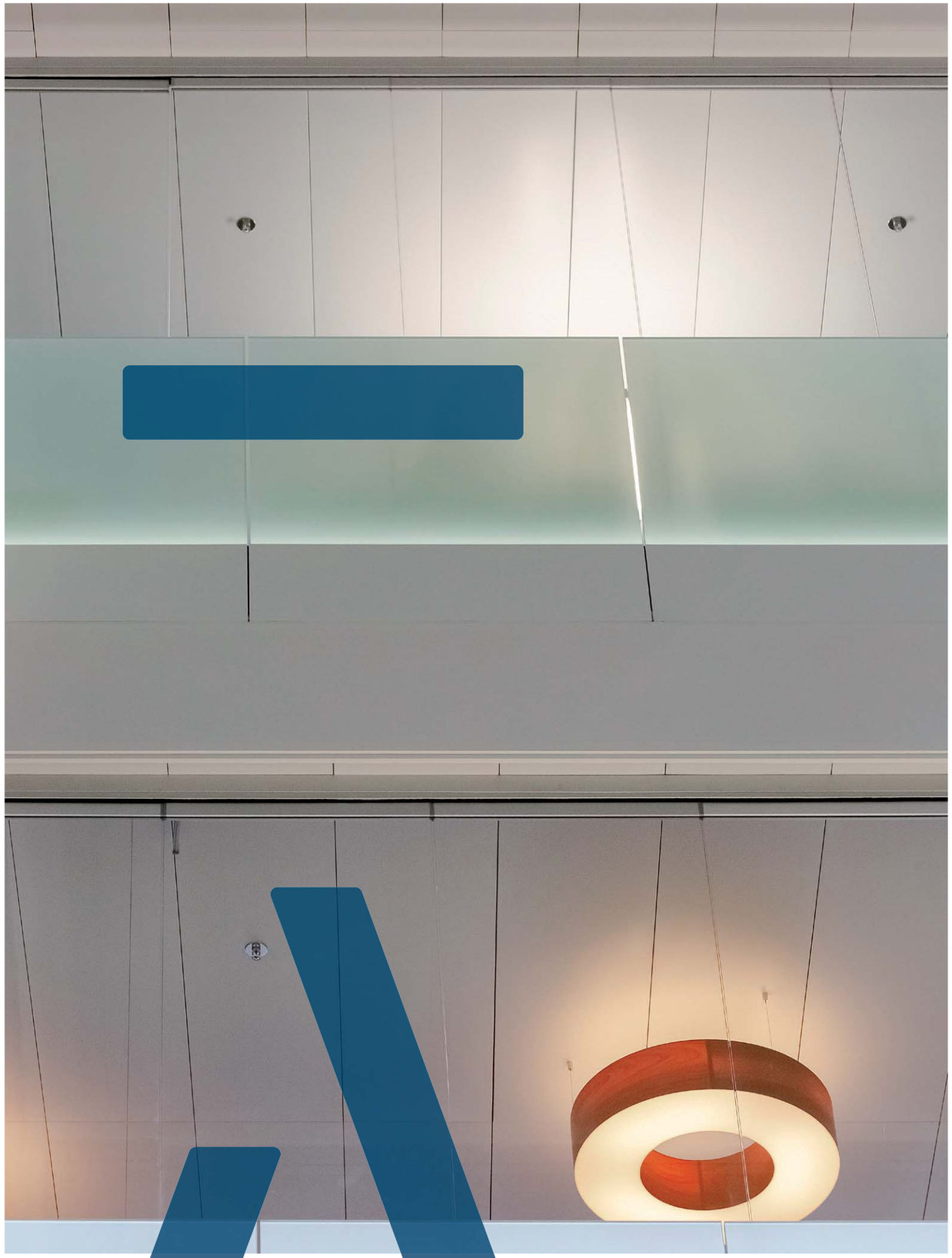
Our acoustic ceilings can also be fitted with additional functions, such as air conditioning (cooling, heating, ventilation) or lighting. Likewise, the product properties can be enhanced in terms of fire protection, hygiene (hospitals and laboratories) or resistance to ball impact (kindergartens, schools and sports halls). Ceiling components are manufactured on state-of-the-art production systems, which can produce everything from individual pieces to high volumes with maximum precision.
The metal ceilings are delivered with finished surfaces to the construction site, thereby ensuring quick and simple processing and short construction processes.

Our products are sustainable, because they consist of easily processed materials that can either be reused or straightforwardly recycled.

Metal acoustic ceilings impress with their

- Aesthetics (e.g. expanded metal)
- Functionality
- High value
- Sustainability
- Quality
- Durability
- Hygiene
- Easy serviceability
- Combination with fire protection

Bison Offices, Sursee
- Leuenberger Architects
- Atrium
- Perforation Rd 1.5 – 22 %
- Colour RAL9016 traffic white
- Hang-in system H28

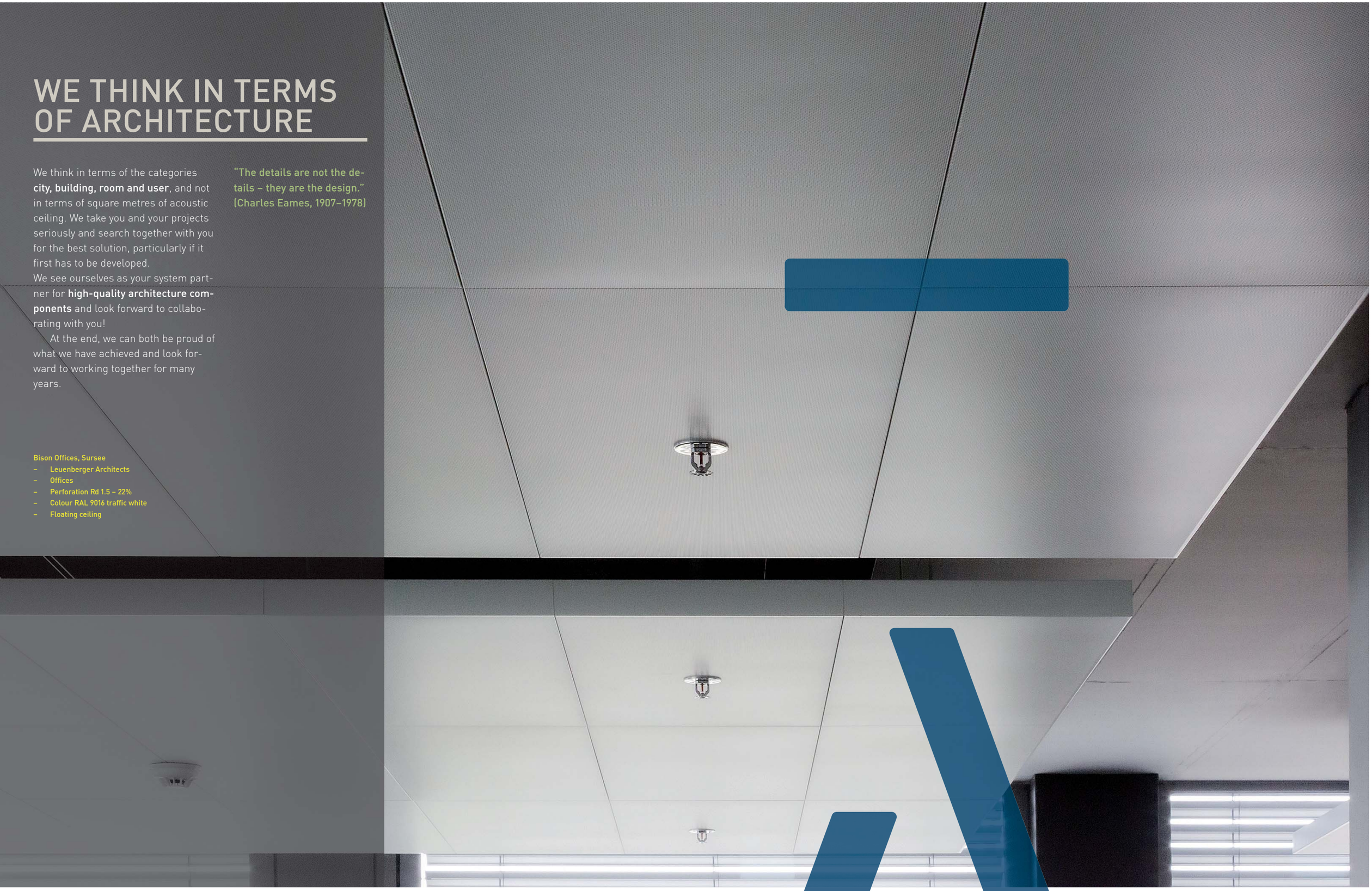


WE THINK IN TERMS OF ARCHITECTURE

We think in terms of the categories **city, building, room and user**, and not in terms of square metres of acoustic ceiling. We take you and your projects seriously and search together with you for the best solution, particularly if it first has to be developed.
We see ourselves as your system partner for **high-quality architecture components** and look forward to collaborating with you!

At the end, we can both be proud of what we have achieved and look forward to working together for many years.

"The details are not the details – they are the design."
(Charles Eames, 1907–1978)



Bison Offices, Sursee
- Leuenberger Architects
- Offices
- Perforation Rd 1.5 – 22%
- Colour RAL 9016 traffic white
- Floating ceiling

WHY USE METAL FOR ACOUSTIC CEILINGS?

Metal ceilings are hard, but thanks to the materials and operations used in their production, they act as perfect broadband absorbers. The starting point is sheet steel or aluminium with a low material thickness (0.5–1.0 mm). In combination with various hole patterns/perforations, the acoustic fleece and the overlying ceiling void, very good sound absorption values are achieved.
A metal ceiling alone allows a room to be made acoustically comfortable. The processing steps result in sturdy yet lightweight designs. The modularly produced system parts arrive at the installation location with finished surfaces. This means that rooms are ready for occupation after a short construction period. Comprehensive tests provide for various acoustic and structural design options. Our products and systems are characterised by:

- Delivery with finished surfaces
- Dust-free delivery and installation
- Durability
- Cleanability/hygiene
- Resistance to ball impact
- Serviceability
- Reversibility
- Reusability
- Unmixed recycling
- Large selection of possible perforations
- Easy, precise integration of technical elements, e.g. lighting and ventilation
- Optimum combinability with heating and cooling elements
- Aesthetics (we offer numerous colours and different surfaces, e.g. our light-scattering Parzifal® hydro-stove-enamel lacquer)

"Our hands and machines make metal soft, open and light. It becomes a material that complies with contemporary architecture and its processes."
(Christian Demmelhuber, Managing Director Fural, Metalit, Dipling)

Office building, Töging
- Hinterschwepfinger Projekt GmbH
- Atrium
- Perforation Rg 0.7 - 4 %
- Colour RAL 9016 traffic white
- Floating ceiling

ACOUSTICS TERMINOLOGY

Sound and sound level

The term "sound" refers to localised vibration and the propagating waves. These can occur in air (**airborne sound**) or in solid materials (**structure-borne sound**). If floors, ceilings and stairs are stimulated to vibrate by footfall, this is referred to as **impact sound**.

The sound intensity is designated with sound level L and specified in the decibel (dB) unit.

Acoustic quality

The term "acoustic quality" describes the interaction of the acoustic factors of a room for such sound events as music or speech with reference to the individual location of the person listening.

Rather than any physical properties of the room, the acoustic quality describes audio-physiological and audio-psychological effects on the listeners.

Acoustic quality is therefore not a clearly ascertainable quantity. It also depends on individual and subjective factors, for example on hearing capacity and listening experience.

However, the aim of a good acoustic plan should also be to include people with poorer hearing and therefore to achieve generally good average audibility.

Sound absorption area

The so-called **equivalent sound absorption area**, A, of a component is calculated by multiplying its area with the sound absorption coefficient, α.

All boundary surfaces, S_i, of a room have individual sound absorption coefficients, α_i, which allows the equivalent sound absorption area, A_i, to be determined for each partial area:

$$A_i = \alpha_i \times S_i (m^2)$$

The total equivalent sound absorption area, A, is calculated by adding up the individual amounts:

$$A_{total} = \alpha_1 \times S_1 (m^2) + \alpha_2 \times S_2 (m^2) + \ldots$$

Reverberation time

The reverberation time, T_{60}, is a measure of the time required for the sound pressure to reduce to 1/1000 of its initial value after the sound source becomes silent.

This value is usually determined for a centre frequency (500 Hz or 1000 Hz) and specified accordingly.

The reverberation time increases in proportion to the volume of the room and in inverse proportion to the equivalent sound absorption area, A.

Sabine formula

In the field of technical acoustics, reverberation time T is calculated with the "Sabine formula":

$$T = V \div A \times 0.163$$

"V" describes the room volume and "A" the equivalent sound absorption area in m^2.

What do abbreviations α_s, α_p, α_w and NRC A stand for?

α_s ($alpha_s$) describes the so-called **one-third-octave** value. In a close spacing of thirds, 18 different sound absorption values are measured between 100 and 5000 Hz (100 Hz, 125 Hz, 160 Hz, 200 Hz, 250 Hz, 315 Hz, 400 Hz, 500 Hz, 630 Hz, 800 Hz, 1000 Hz, 1250 Hz, 1600 Hz, 2000 Hz, 2500 Hz, 3150 Hz, 4000 Hz and 5000 Hz). A value of 1.0 means complete absorption, while a value of 0.0 means complete reflection.

α_p ($alpha_p$) describes the so-called **practical sound absorption coefficient**. Three on-third-octave values α_s are used to calculate an **octave value** α_p. In addition 6 frequencies are represented (125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz).

α_w ($alpha_w$) describes the so-called **weighted sound absorption coefficient**. This is frequency-dependent and specified as a single-number value rounded to the nearest 0.05. The α_w value can be supplemented with so-called "shape indicators". These state that the measured values in the low (L), mid (M) or high (H) frequency range are better than those identified by the α_w value (see index word "shape indicators").

NRC A specifies the average of the sound absorption at octave values 250 Hz, 500 Hz, 1000 Hz and 2000 Hz, rounded to the nearest 0.05. A noise reduction coefficient of 0.80 stands for an average sound absorption of 80%.

Shape indicators (L/M/H)

The weighted sound absorption coefficient, α_w, can be supplemented with so-called "shape indicators", expressed by the letters L, M and H (low, mid, high), in which frequency ranges the sound absorption level is particularly high.

- L Particularly good absorption up to 250 Hz
- M Particularly good absorption at 500 Hz to 1000 Hz
- H Particularly good absorption at 2000 Hz to 4000 Hz

Absorber classes

According to DIN EN 11654, acoustic elements are assigned to absorber class A, B, C, D or E based on their sound absorption coefficient.

- A Extremely absorbent α_w 0.90–1.00
- B Highly absorbent α_w 0.80-0.85
- C Very absorbent α_w 0.60-0.75
- D Absorbent α_w 0.30-0.55
- E Slightly absorbent α_w 0.15-0.25

Longitudinal sound insulation $D_{n,f,w}$

In buildings with a skeleton construction – typically nearly all new office buildings today – the individual rooms are separated by lightweight partition walls. The ceilings are suspended.

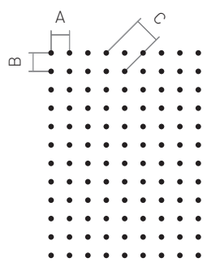
The cavity that this creates between raw ceiling and suspended ceiling acts as a sound transmission path which must be compensated for with longitudinal sound insulation.

The longitudinal sound insulation can be implemented with vertical or horizontal compartmentalisation.

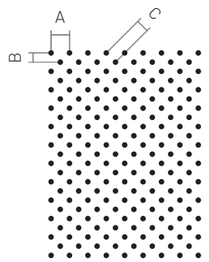
The longitudinal sound insulation is determined according to EN ISO 717-1 and specified as a weighted normalised flanking sound level difference **$D_{n,f,w}$** in **dB** units.

Here "$D_{n,f}$" describes the normalised flanking level difference for flanking components (e.g. suspended ceilings). "$_w$" means that the measured values have been weighted in accordance with normative specifications. The specified numerical value is the value read from the reference curve at 500 Hz.

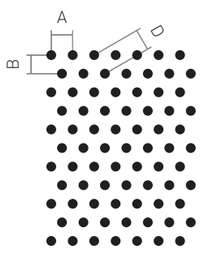
The reference curve is not shown in the test report diagrams.



Rg



Rd



Rv

Perforation sizing

- A Horizontal spacing
- B Vertical spacing
- C Diagonal spacing 45°
- D Offset spacing 60°

PRACTICAL EXAMPLE

"The best indicator of a tremendous improvement in room acoustics is the behaviour of pupils and teachers. Performance has increased and the teachers are far less stressed after lessons."
(Gerhard Kolb, Headmaster of Gmunden Polytechnic School)

Gmunden Polytechnic School
- Computer lab
- Ceiling:
  Clip-in system
  Perforation Rg 0.7 – 4 %
  RAL 9010 pure white
- Wall cladding:
  Clip-in system
  Perforation Rg 0.7 – 4 %
  RAL 9010 pure white

School construction

In common with many other schools, Gmunden Polytechnic School had huge problems with the acoustics in its classrooms. The effects were evident in restless students and overburdened teachers.

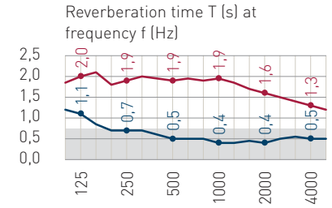
The initial situation was assessed analytically by building physicists and suggestions for improvement were developed methodically.

With metal acoustic ceilings and metal acoustic walls from Fural, it was possible to achieve huge improvements in room acoustics.

At the same time, the visual appearance of the equipped classrooms was significantly improved with the precisely prefabricated fittings.

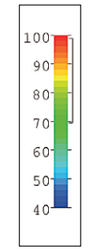
Reverberation time

The reverberation time is the best known room acoustic criterion. It is defined as the time in which the sound pressure level decreases by 60 dB after switching off the sound source. In the practical example of Gmunden Polytechnic School, the average reverberation time improved from ~ 1.7 s to the 0.6 s required by DIN 18041.



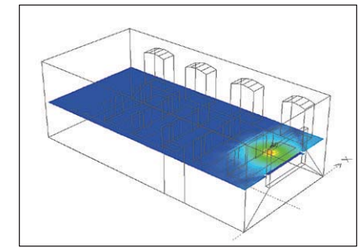
D50 definition

The so-called "D50 definition" is a key room acoustics parameter. The larger the value, the more clearly the sound signal is perceived. In order to ensure good speech intelligibility, this value should be greater than 50%.



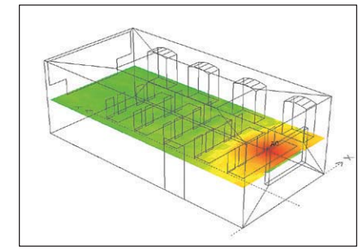
The speaker is not understood.

The acoustic analysis of the situation before project start shows that speech intelligibility was below standard practically in the entire room.



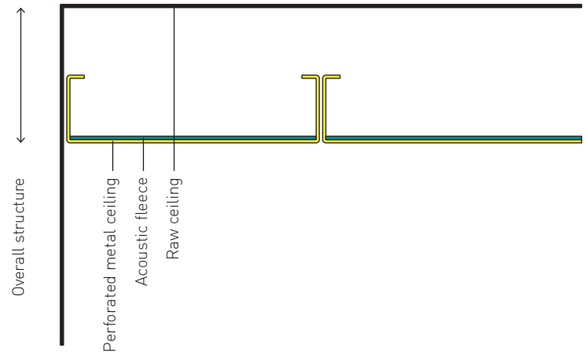
The speaker is understood in the entire room.

After installing the acoustic metal ceiling Fural Rg 2.5 – 16 % and acoustic wall cladding Fural Rg 0.7 – 1 %, speech intelligibility rose in the entire room to values between 70 and 98%. The values achieved are much higher than standard.



METAL CEILINGS 1

Tissot Arena, Bienne

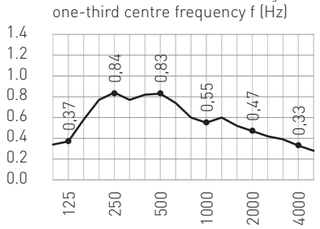


Fural
Rg 0.7 - 1 %

Perforation Ø	0.7 mm
Hole content	1 %
Max. perforation width	1,197 mm
Des. acc. to DIN 24041	Rg 0.70 - 6.00
Horizontal spacing	6.00 mm →
Vertical spacing	6.00 mm ↓
Diagonal spacing	8.48 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



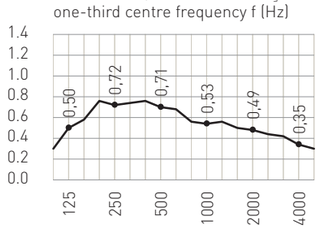
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 231/2007
NRC	0.65
α_w	0.50 (LM)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 0.7 - 1.5 %

Perforation Ø	0.7 mm
Hole content	1.5 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rg 0.70 - 5.00
Horizontal spacing	5.00 mm →
Vertical spacing	5.00 mm ↓
Diagonal spacing	7.07 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



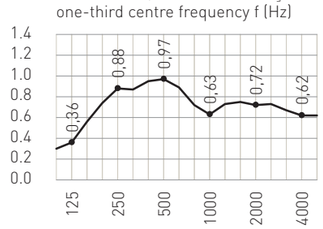
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	04.12.2019 M 105629
NRC	0.60
α_w	0.50 (L)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 0.7 - 4 %

Perforation Ø	0.7 mm
Hole content	4 %
Max. perforation width	1,197 mm
Des. acc. to DIN 24041	Rg 0.70 - 3.00
Horizontal spacing	3.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.24 mm ↘
Perforation direction	→

Sound absorption

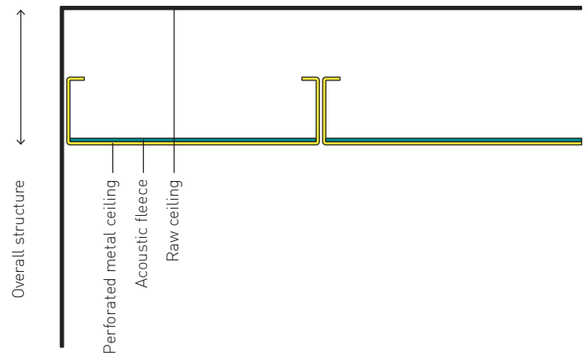
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 219/2007
NRC	0.80
α_w	0.75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

METAL CEILINGS 2

Training centre, Berne

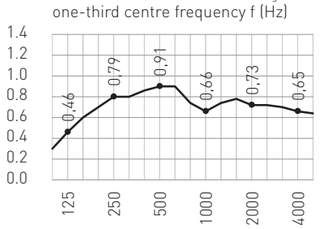


Fural
Rg 0.8 - 6 %

Perforation Ø	0.8 mm
Hole content	6 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rg 0.80 - 3.00
Horizontal spacing	3.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.24 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



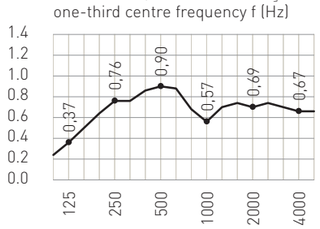
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09.06.2017 M 105629/17
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 0.8 - 11 %

Perforation Ø	0.8 mm
Hole content	11 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rd 0.80 – 2.12
Horizontal spacing	3.00 mm →
Vertical spacing	1.50 mm ↓
Diagonal spacing	2.12 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



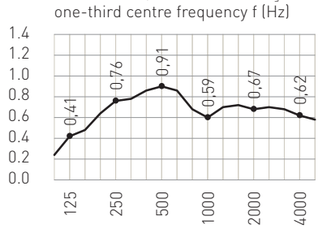
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09.06.2017 M 105629/18
NRC	0.75
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 0.9 - 7 %

Perforation Ø	0.9 mm
Hole content	7 %
Max. perforation width	1,020 mm
Des. acc. to DIN 24041	Rg 0.90 - 3.00
Horizontal spacing	3.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.24 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



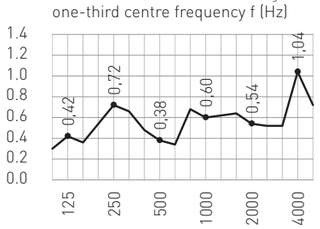
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30.09.2019 M 105629/44
NRC	0.75
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 0.9 - 14 %

Perforation Ø	0.9 mm
Hole content	14 %
Max. perforation width	1,020 mm
Des. acc. to DIN 24041	Rd 0.90 – 2.12
Horizontal spacing	3.00 mm →
Vertical spacing	1.50 mm ↓
Diagonal spacing	2.12 mm ↘
Perforation direction	→

Sound absorption

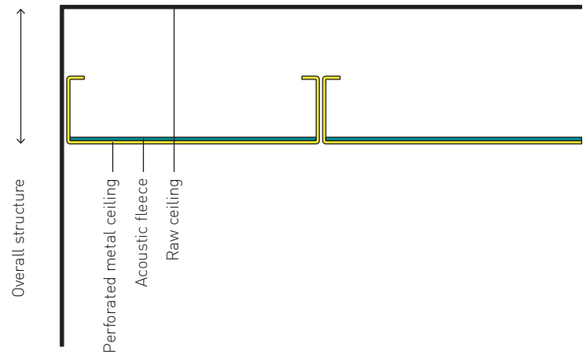
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	400 mm
Fleece	Bonded acoustic fleece
Test certificate	17.11.2012 7178-12-2
NRC	0.55
α_w	0.55 (LH)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o

METAL CEILINGS 3

Vektor, Stuttgart

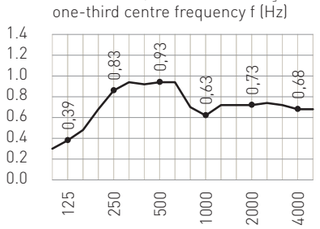


Fural
Rg 1.5 - 11 %

Perforation Ø	1.5 mm
Hole content	11 %
Max. perforation width	1,488 mm
Des. acc. to DIN 24041	Rg 1.50 - 4.00
Horizontal spacing	4.00 mm →
Vertical spacing	4.00 mm ↓
Diagonal spacing	5.65 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



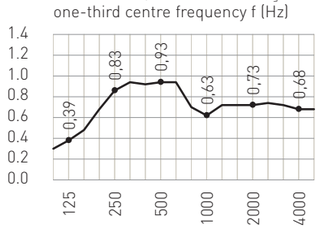
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/6
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 1.5 - 11 %

Perforation Ø	1.5 mm
Hole content	11 %
Max. perforation width	1,470 mm
Des. acc. to DIN 24041	Rd 1.50 - 4.00
Horizontal spacing	5.66 mm →
Vertical spacing	2.83 mm ↓
Diagonal spacing	4.00 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



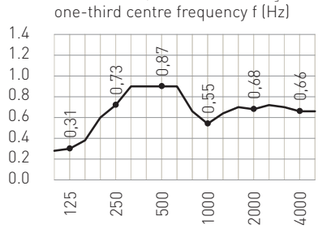
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/6
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 1.5 – 22 %

Perforation Ø	1.5 mm
Hole content	22 %
Max. perforation width	1,488 mm
Des. acc. to DIN 24041	Rd 1.50 – 2.83
Horizontal spacing	4.00 mm →
Vertical spacing	2.00 mm ↓
Diagonal spacing	2.83 mm ↘
Perforation direction	→

Sound absorption

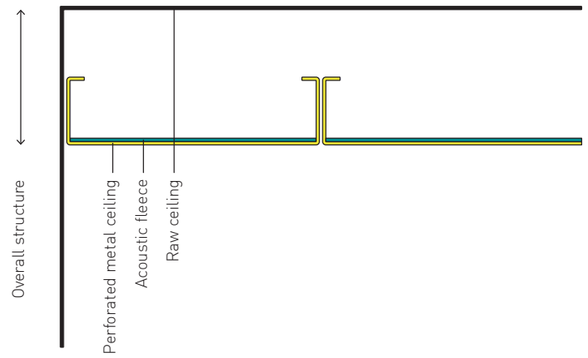
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/5
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

The Edge, Amsterdam

METAL CEILINGS 4

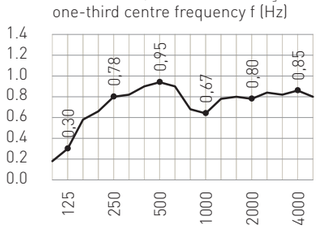


Fural
Rv 1.6 - 20 %

Perforation Ø	1.6 mm
Hole content	20 %
Max. perforation width	1,450 mm
Des. acc. to DIN 24041	Rv 1.60 - 3.50
Horizontal spacing	3.50 mm →
Vertical spacing	3.03 mm ↓
Offset spacing 60°	3.50 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



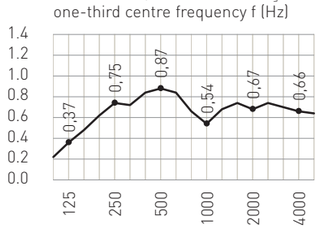
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 2
NRC	0.75
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 1.6 - 22 %

Perforation Ø	1.6 mm
Hole content	22 %
Max. perforation width	636.4 mm
Des. acc. to DIN 24041	Rd 1.60 - 3.00
Horizontal spacing	4.30 mm →
Vertical spacing	2.15 mm ↓
Diagonal spacing	3.00 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



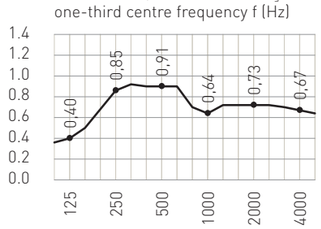
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09.06.2017 M 105629/19
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 1.8 - 10 %

Perforation Ø	1.8 mm
Hole content	10 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rg 1.80 - 4.95
Horizontal spacing	4.95 mm →
Vertical spacing	4.95 mm ↓
Diagonal spacing	7.00 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



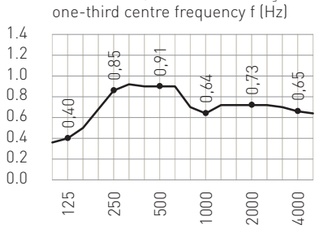
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/4
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 1.8 - 10 %

Perforation Ø	1.8 mm
Hole content	10 %
Max. perforation width	632 mm
Des. acc. to DIN 24041	Rd 1.80 – 4.95
Horizontal spacing	7.00 mm →
Vertical spacing	3.50 mm ↓
Diagonal spacing	4.95 mm ↘
Perforation direction	→

Sound absorption

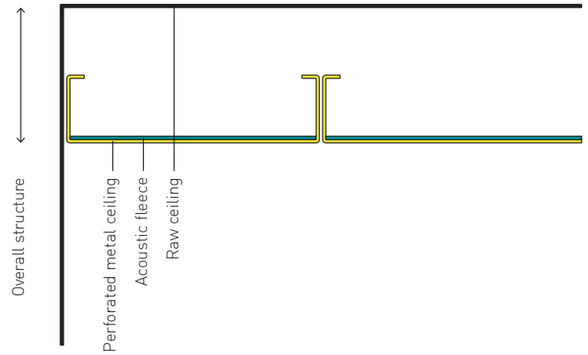
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/4
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

METAL CEILINGS 5

Terminal 3, Vienna Airport

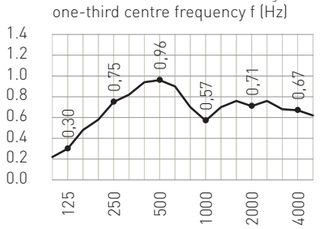


Fural
Rg 1.8 - 20 %

Perforation Ø	1.8 mm
Hole content	20 %
Max. perforation width	632 mm
Des. acc. to DIN 24041	Rg 1.80 - 3.57
Horizontal spacing	3.57 mm →
Vertical spacing	3.57 mm ↓
Diagonal spacing	5.04 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



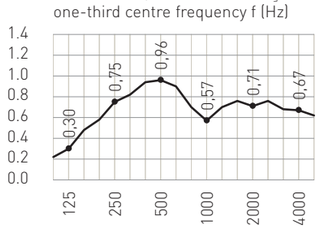
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 220/2007 Figure 2
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 1.8 - 21 %

Perforation Ø	1.8 mm
Hole content	21 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rd 1.80 - 3.50
Horizontal spacing	4.96 mm →
Vertical spacing	2.48 mm ↓
Diagonal spacing	3.50 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



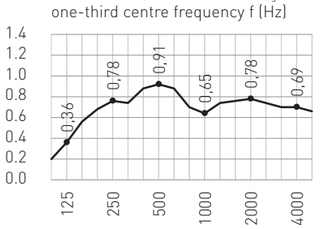
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 220/2007 Figure 2
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 2.5 - 8 %

Perforation Ø	2.5 mm
Hole content	8 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rd 2.50 - 7.80
Horizontal spacing	11.0 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



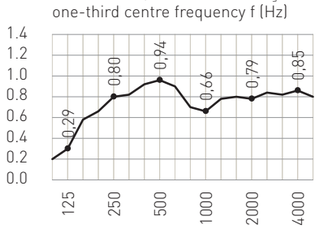
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 5
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 2.5 - 16 %

Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

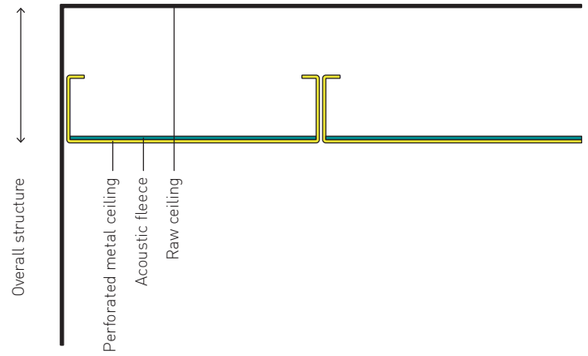
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 1
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o

METAL CEILINGS 6

Schwabenlandhalle, Fellbach

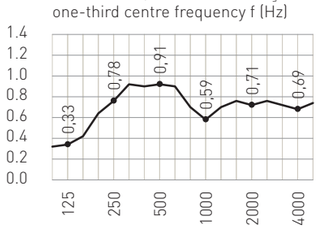


Fural
Rv 2.5 - 23 %

Perforation Ø	2.5 mm
Hole content	23 %
Max. perforation width	1,467 mm
Des. acc. to DIN 24041	Rv 2.50 - 5.00
Horizontal spacing	8.66 mm →
Vertical spacing	2.50 mm ↓
Offset spacing 60°	5.00 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



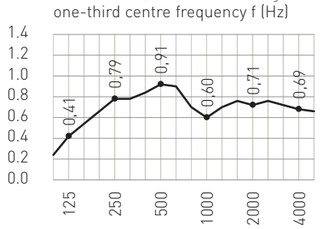
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/7
NRC	0.75
α_w	0.75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 2.8 - 20 %

Perforation Ø	2.8 mm
Hole content	20 %
Max. perforation width	627.9 mm
Des. acc. to DIN 24041	Rd 2.80 - 5.50
Horizontal spacing	7.80 mm →
Vertical spacing	3.90 mm ↓
Diagonal spacing	5.50 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



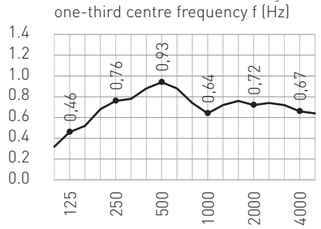
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09.06.2017 M 105629/20
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 3.0 - 12 %

Perforation Ø	3.0 mm
Hole content	12 %
Max. perforation width	877.5 mm
Des. acc. to DIN 24041	Rg 3.00 - 7.50
Horizontal spacing	7.50 mm →
Vertical spacing	7.50 mm ↓
Diagonal spacing	10.6 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



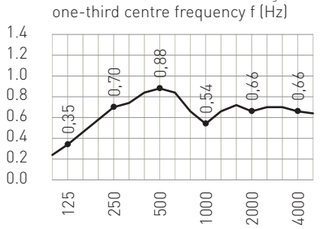
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30.09.2019 M 105629/43
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 3.0 - 24 %

Perforation Ø	3.0 mm
Hole content	24 %
Max. perforation width	877.5 mm
Des. acc. to DIN 24041	Rd 3.00 - 5.30
Horizontal spacing	7.50 mm →
Vertical spacing	3.75 mm ↓
Diagonal spacing	5.30 mm ↘
Perforation direction	→

Sound absorption

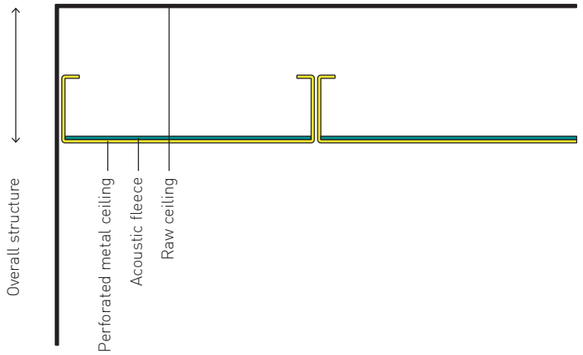
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30.09.2019 M 105629/45
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

METAL CEILINGS 7

Schuler AG, Göppingen

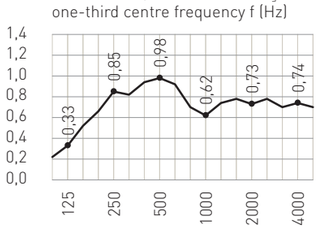


Fural
Rg 3,0 - 20 %

Perforation Ø	3,0 mm
Hole content	20 %
Max. perforation width	1.434 mm
Des. acc. to DIN 24041	Rg 3,00 - 6,00
Horizontal spacing	6,00 mm →
Vertical spacing	6,00 mm ↓
Diagonal spacing	8,48 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



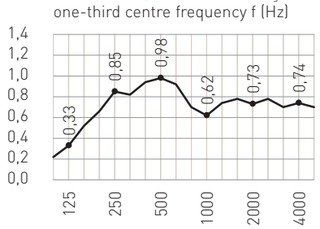
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 221/2007 Figure 2
NRC	0,80
α_w	0,75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rv 3,0 - 20 %

Perforation Ø	3,0 mm
Hole content	20 %
Max. perforation width	1.402 mm
Des. acc. to DIN 24041	Rv 3,00 - 6,35
Horizontal spacing	6,35 mm →
Vertical spacing	5,50 mm ↓
Offset spacing 60°	6,35 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



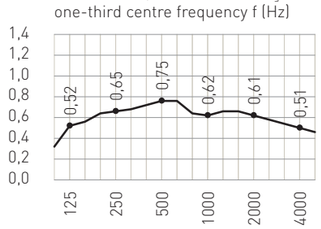
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 221/2007 Figure 2
NRC	0,80
α_w	0,75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 4,0 - 6 %

Perforation Ø	4,0 mm
Hole content	6 %
Max. perforation width	680 mm
Des. acc. to DIN 24041	Rd 4,00 - 14,14
Horizontal spacing	20,00 mm →
Vertical spacing	10,00 mm ↓
Diagonal spacing	14,14 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



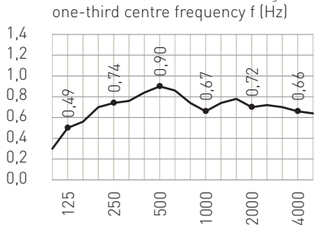
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30.09.2019 M 105629/46
NRC	0,65
α_w	0,65
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 4,0 - 12 %

Perforation Ø	4,0 mm
Hole content	12 %
Max. perforation width	680 mm
Des. acc. to DIN 24041	Rg 4,00 - 10,00
Horizontal spacing	10,00 mm →
Vertical spacing	10,00 mm ↓
Diagonal spacing	14,14 mm ↘
Perforation direction	→

Sound absorption

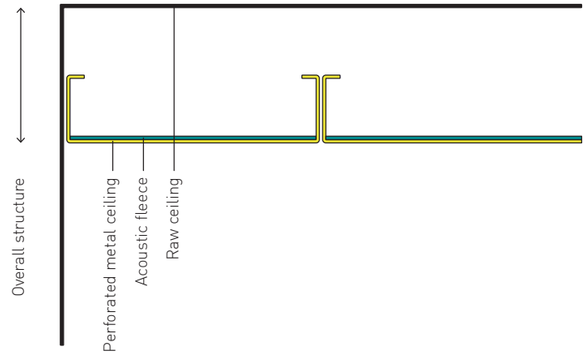
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30.09.2019 M 105629/48
NRC	0,75
α_w	0,75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

METAL CEILINGS 8

Verlagsanstalt Handwerk, Düsseldorf

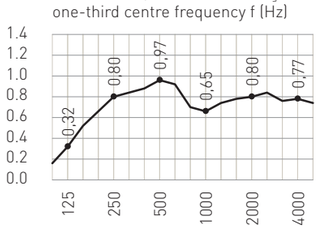


Fural
Rg 4.0 - 17 %

Perforation Ø	4.0 mm
Hole content	17 %
Max. perforation width	1,453 mm
Des. acc. to DIN 24041	Rg 4.00 - 8.60
Horizontal spacing	8.60 mm →
Vertical spacing	8.60 mm ↓
Diagonal spacing	12.1 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



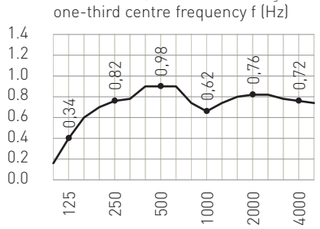
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 7
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o

Fural
Rd 4.0 - 33 %

Perforation Ø	4.0 mm
Hole content	33 %
Max. perforation width	1,450 mm
Des. acc. to DIN 24041	Rd 4.00 - 6.10
Horizontal spacing	8.60 mm →
Vertical spacing	4.30 mm ↓
Diagonal spacing	6.10 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



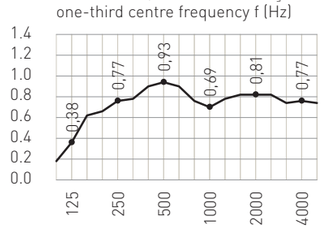
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 3
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o

Fural
Qg 4.0 - 33 %

Perforation	4.0 mm
Hole content	33 %
Max. perforation width	630 mm
Des. acc. to DIN 24041	Qg 4.00 - 7.00
Horizontal spacing	7.00 mm →
Vertical spacing	7.00 mm ↓
Diagonal spacing	9.89 mm ↘
Perforation direction	→

Sound absorption

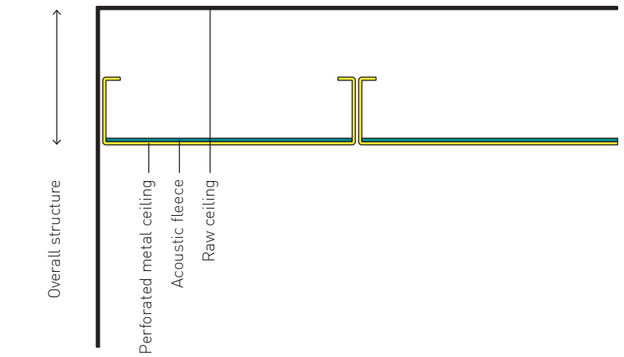
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 4
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o

METAL CEILINGS 9

Petrom City, Bucharest

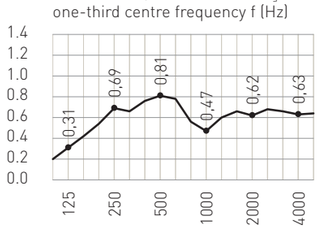


Fural
Rv 4.5 - 51 %

Perforation Ø	4.5 mm
Hole content	51 %
Max. perforation width	627 mm
Des. acc. to DIN 24041	Rv 4.50 - 6.00
Horizontal spacing	10.4 mm →
Vertical spacing	3.00 mm ↓
Offset spacing 60°	6.00 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



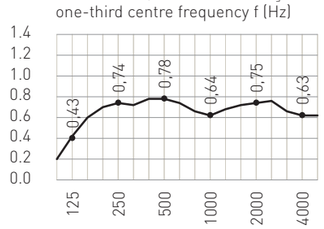
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09.06.2017 M 105629/21
NRC	0.65
α_w	0.65 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

Fural
Rg 14.0 - 23 %

Perforation Ø	14.0 mm
Hole content	23 %
Max. perforation width	598 mm
Des. acc. to DIN 24041	Rg 14.00 - 26.00
Horizontal spacing	26.0 mm →
Vertical spacing	26.0 mm ↓
Diagonal spacing	36.7 mm ↘
Perforation direction	→

Sound absorption

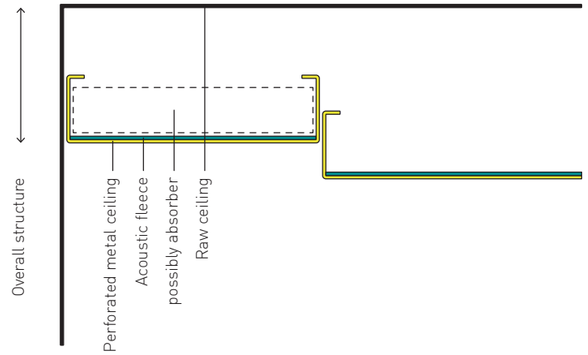
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 8
NRC	0.75
α_w	0.75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

EFFECT OF THE AIR CAVITY

SKA Rehabilitation Centre, St. Radegund



Air cavity and sound absorption coefficient

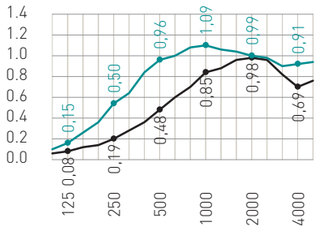
The sound absorption coefficient depends not only on the perforation used in the metal ceiling, but also and in particular on the air cavity. Here is a comparison of four different installation heights (50, 100, 200 and 400 mm).

Fural
Rg 2.5 - 16 %

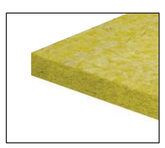
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)
w/o acoustic infill with acoustic infill



Overall structure	**50 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 20
NRC	0.65; 0.90
α_w	0.50 (MH); 0.80
Absorber class	D (DIN EN 11654), B (DIN EN 11654)
Acoustic infill	30 mm mineral wool 45 kg/m³

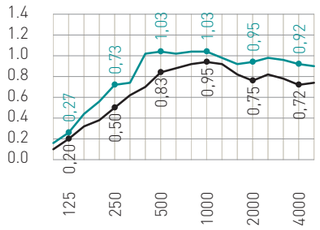


Fural
Rg 2.5 - 16 %

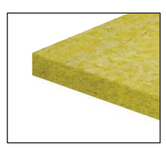
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)
w/o acoustic infill with acoustic infill



Overall structure	**100 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 21
NRC	0.75; 0.95
α_w	0.80; 0.95
Absorber class	B (DIN EN 11654), A (DIN EN 11654)
Acoustic infill	30 mm mineral wool 45 kg/m³

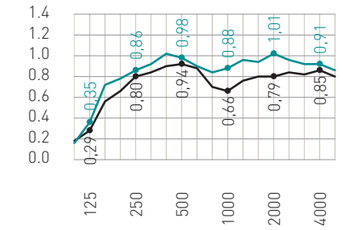


Fural
Rg 2.5 - 16 %

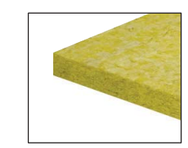
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)
w/o acoustic infill with acoustic infill



Overall structure	**200 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 1
NRC	0.80; 0.95
α_w	0.80; 0.95
Absorber class	B (DIN EN 11654), A (DIN EN 11654)
Acoustic infill	30 mm mineral wool 45 kg/m³

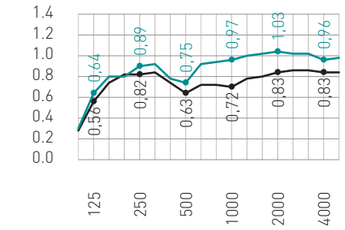


Fural
Rg 2.5 - 16 %

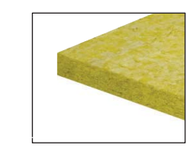
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)
w/o acoustic infill with acoustic infill

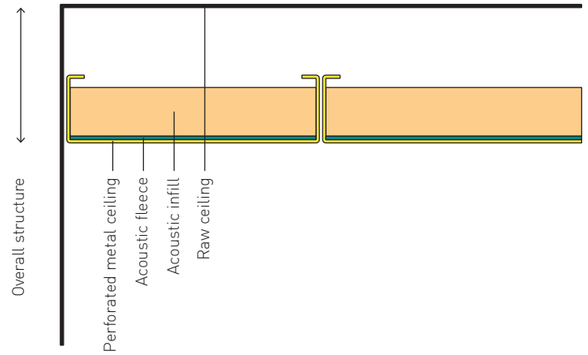


Overall structure	**400 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 22
NRC	0.75; 0.90
α_w	0.75 (L); 0.90
Absorber class	C (DIN EN 11654), A (DIN EN 11654)
Acoustic infill	30 mm mineral wool 45 kg/m³



EFFECT OF ACOUSTIC INFILLS 1

SKA Rehabilitation Centre, St. Radegund



Different acoustic infills (absorber types)

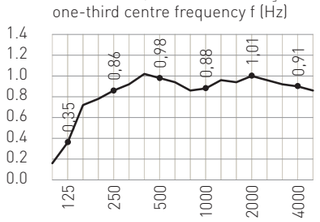
The sound absorption coefficient is greatly affected by the acoustic infills used, which can consist of mineral wool, mineral wool sealed in PE film, foam or polyester wool.

These acoustic infills are also available in different volumetric weights (kg/m³).

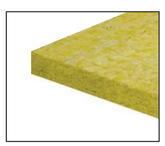
	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



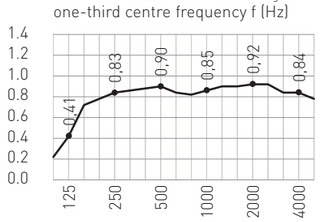
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 14
NRC	0.95
α_w	0.95
Absorber class	A (DIN EN 11654)
Acoustic infill	**30 mm mineral wool 45 kg/m³**



	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.5 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

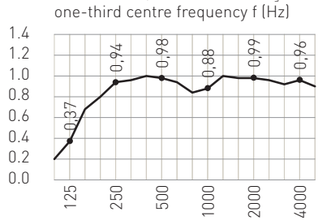


Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 17
NRC	0.85
α_w	0.90
Absorber class	A (DIN EN 11654)
Acoustic infill	**30 mm mineral wool 45 kg/m³ in PE film**

	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

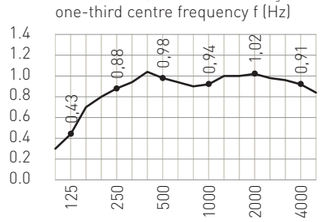


Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 18
NRC	0.95
α_w	0.95
Absorber class	A (DIN EN 11654)
Acoustic infill	**30 mm foam 9 kg/m³**

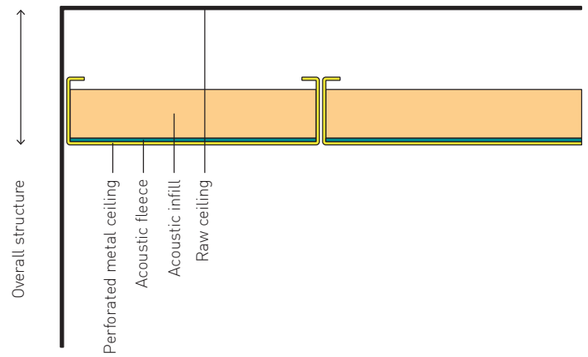
	Fural Rg 2.5 – 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 – 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 19
NRC	0.95
α_w	0.95
Absorber class	A (DIN EN 11654)
Acoustic infill	**30 mm polyester wool 48 g/m³**

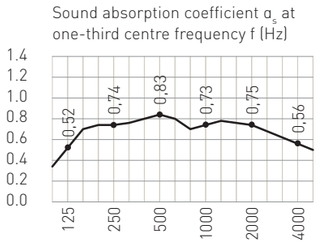


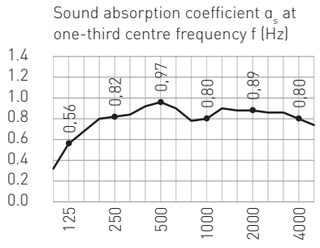
Different acoustic infills (absorber types)

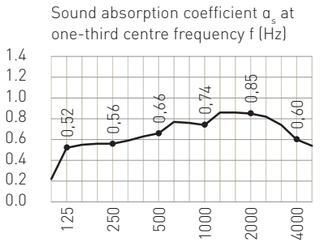
The sound absorption coefficient is greatly affected by the acoustic infills used, which can consist of mineral wool, mineral wool sealed in PE film, foam or polyester wool.

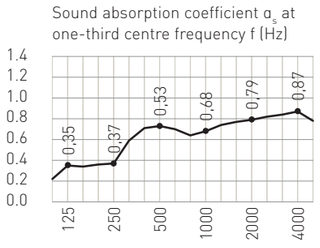
These acoustic infills are also available in different volumetric weights (kg/m³).

	Fural	**Fural**	**Fural**	**Fural**
	Rg 0.7 - 4 %	Rd 1.5 - 22 %	Rd 1.5 - 22 %	Rd 1.5 - 22 %
Perforation Ø	0.7 mm	1.5 mm	1.5 mm	1.5 mm
Hole content	4 %	22 %	22 %	22 %
Max. perforation width	1,197 mm	1,488 mm	1,488 mm	1,488 mm
Des. acc. to DIN 24041	Rg 0.70 - 3.00	Rd 1.50 - 2.83	Rd 1.50 - 2.83	Rd 1.50 - 2.83
Horizontal spacing	3.00 mm →	4.00 mm →	4.00 mm →	4.00 mm →
Vertical spacing	3.00 mm ↓	2.00 mm ↓	2.00 mm ↓	2.00 mm ↓
Diagonal spacing	4.24 mm ↘	2.83 mm ↘	2.83 mm ↘	2.83 mm ↘
Perforation direction	→	→	→	→
Sound absorption	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)
Overall structure	200 mm	200 mm	200 mm	200 mm
Fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece
Test certificate	04.07.2017 M 105629/22	05.07.2017 M 105629/26	04.12.2019 M 105629	04.12.2019 M 105629
NRC	0.75	0.85	0.70	0.60
α_w	0.75	0.90	0.70	0.60
Absorber class	C (DIN EN 11654)	A (DIN EN 11654)	C (DIN EN 11654)	C (DIN EN 11654)
Acoustic infill	**20 mm mineral wool 45 kg/m³ in PE film**	**20 mm mineral wool 45 kg/m³ in PE film**	**15 mm mineral fibreboard 300 kg/m³**	**20 mm mineral fibreboard 320 kg/m³**

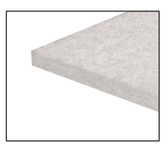




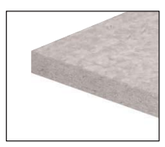




This structure can also be found analogously in the longitudinal sound insulation chapter.

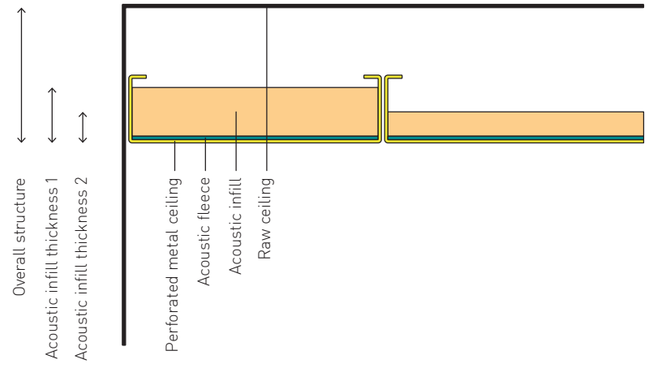


This structure can also be found analogously in the longitudinal sound insulation chapter.



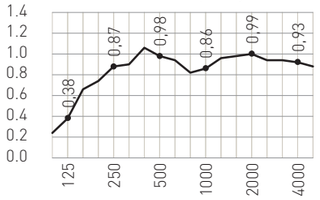
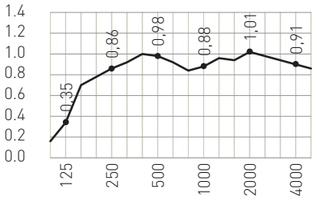
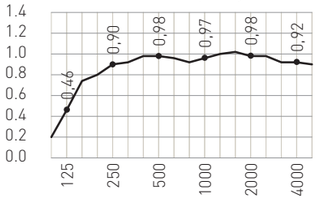
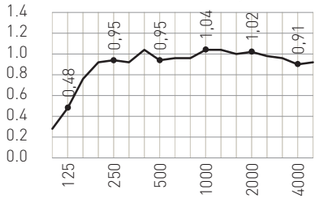
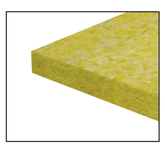
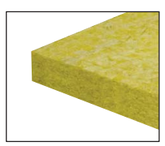
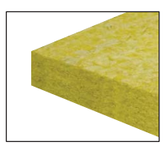
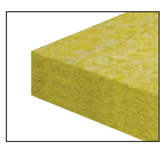
EFFECT OF THE ACOUSTIC INFILL THICKNESS

Klinikum Nord, Nuremberg



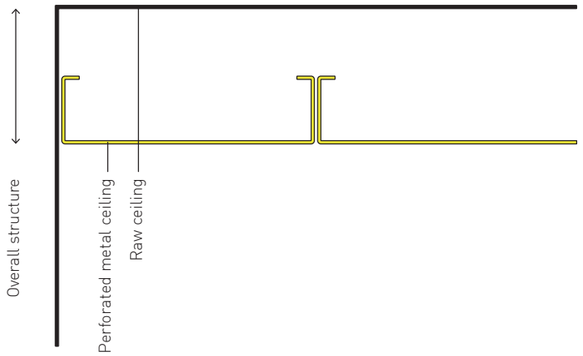
Different acoustic infill thicknesses (absorber thicknesses)

The acoustic infill thickness affects the sound absorption coefficient just as much as the acoustic infill type and the height of the air cavity. All of these 3 factors play an important role in the acoustic behaviour of the metal ceiling.

	Fural Rg 2.5 - 16 %	**Fural** Rg 2.5 - 16 %	**Fural** Rg 2.5 - 16 %	**Fural** Rg 2.5 - 16 %
Perforation Ø	2.5 mm	2.5 mm	2.5 mm	2.5 mm
Hole content	16 %	16 %	16 %	16 %
Max. perforation width	1,460 mm	1,460 mm	1,460 mm	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50	Rg 2.50 - 5.50	Rg 2.50 - 5.50	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →	5.50 mm →	5.50 mm →	5.50 mm →
Vertical spacing	5.50 mm ↓	5.50 mm ↓	5.50 mm ↓	5.50 mm ↓
Diagonal spacing	7.78 mm ↘	7.78 mm ↘	7.78 mm ↘	7.78 mm ↘
Perforation direction	→	→	→	→
Sound absorption	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)
				
	0.38 0.87 0.98 0.86 0.99 0.93	0.35 0.86 0.98 0.88 1.01 0.91	0.46 0.90 0.98 0.97 0.98 0.92	0.48 0.95 0.95 1.04 1.02 0.91
	125 250 500 1000 2000 4000	125 250 500 1000 2000 4000	125 250 500 1000 2000 4000	125 250 500 1000 2000 4000
Overall structure	200 mm	200 mm	200 mm	200 mm
Fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 13	P-BA 279/2006 Figure 14	P-BA 279/2006 Figure 15	P-BA 279/2006 Figure 16
NRC	0.95	0.95	0.95	1.00
α_w	0.95	0.95	1.00	1.00
Absorber class	A (DIN EN 11654)	A (DIN EN 11654)	A (DIN EN 11654)	A (DIN EN 11654)
Acoustic infill	**20 mm mineral wool 45 kg/m³**	**30 mm mineral wool 45 kg/m³**	**40 mm mineral wool 45 kg/m³**	**50 mm mineral wool 45 kg/m³**
				

EFFECT OF THE ACOUSTIC FLEECE

Apothekerhaus, Vienna



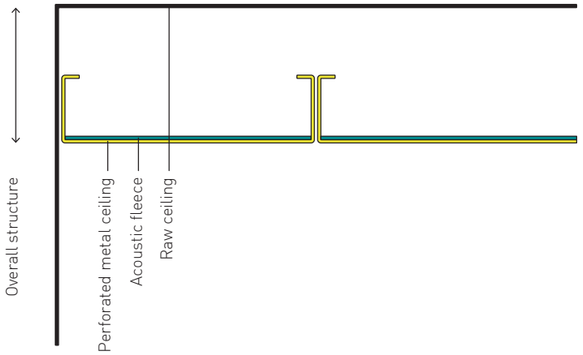
Acoustic fleece

Gluing acoustic fleece into the metal ceiling tiles improves acoustic absorption, depending on frequency range, by 40–100%.

Microperforation

In contrast to the larger perforations, microperforations with hole diameters 0.7–0.9 mm also work well without acoustic fleece.

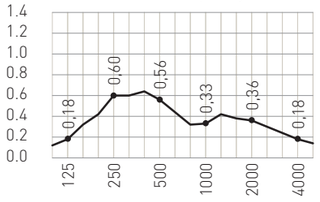
Nevertheless, adding a bonded acoustic fleece increases sound absorption, depending on frequency range, by between 25 and 100%.



	Fural Rg 0.7 - 1%
Perforation Ø	0.7 mm
Hole content	1 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 0.70 - 6.00
Horizontal spacing	6.00 mm →
Vertical spacing	6.00 mm ↓
Diagonal spacing	8.48 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

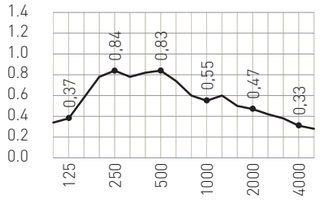


Overall structure	200 mm
Fleece	**w/o**
Test certificate	P-BA 222/2007 Figure 2
NRC	0.45
α_w	0.35 (L)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o

	Fural Rg 0.7 - 1%
Perforation Ø	0.7 mm
Hole content	1 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 0.70 - 6.00
Horizontal spacing	6.00 mm →
Vertical spacing	6.00 mm ↓
Diagonal spacing	8.48 mm ↘
Perforation direction	→

Sound absorption

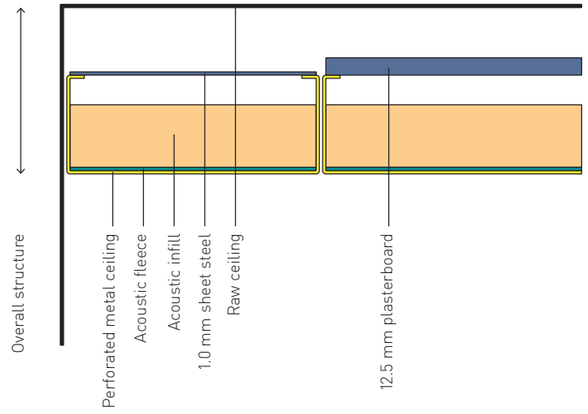
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	**Bonded acoustic fleece**
Test certificate	P-BA 231/2007 Figure 2
NRC	0.65
α_w	0.50 (LM)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o

EFFECT OF HEAVY-DUTY ACOUSTIC INFILLS 1

Military hospital, Ulm

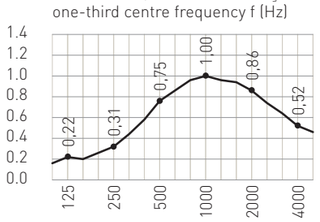
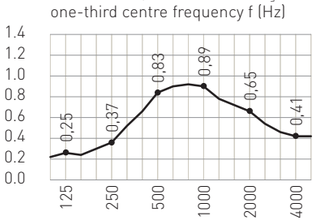
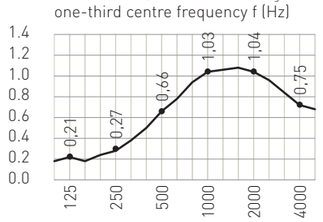
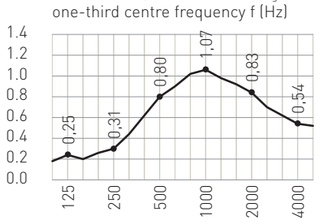


Heavy-duty acoustic infills

Using heavy-duty acoustic infills in metal ceiling systems can significantly improve the longitudinal sound insulation – the acoustic transmission between two adjacent rooms separated by walls.

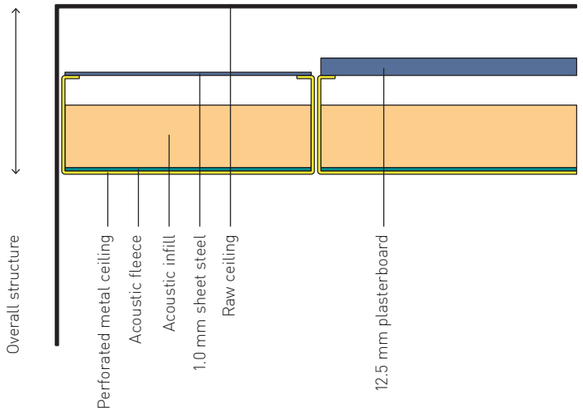
Longitudinal sound insulation

Acoustic metal ceilings with acoustic infill and heavy-duty acoustic infill are used preferentially for longitudinal sound insulation. See also pages 78–79 of this brochure.

	Fural	**Fural**	**Fural**	**Fural**
	Rg 0.7 - 4 %	Rg 0.7 - 4 %	Rd 1.5 - 22 %	Rd 1.5 - 22 %
Perforation Ø	0.7 mm	0.7 mm	1.5 mm	1.5 mm
Hole content	4 %	4 %	22 %	22 %
Max. perforation width	1,197 mm	1,197 mm	1,488 mm	1,488 mm
Des. acc. to DIN 24041	Rg 0.70 - 3.00	Rg 0.70 - 3.00	Rd 1.50 - 2.83	Rd 1.50 - 2.83
Horizontal spacing	3.00 mm →	3.00 mm →	4.00 mm →	4.00 mm →
Vertical spacing	3.00 mm ↓	3.00 mm ↓	2.00 mm ↓	2.00 mm ↓
Diagonal spacing	4.24 mm ↘	4.24 mm ↘	2.83 mm ↘	2.83 mm ↘
Perforation direction	→	→	→	→
Sound absorption	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)
				
Overall structure	200 mm	200 mm	200 mm	200 mm
Fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece
Test certificate	04.07.2017 M 105629/24	04.07.2017 M 105629/25	05.07.2017 M 105629/28	05.07.2017 M 105629/29
NRC	0.75	0.70	0.75	0.75
α_w	0.65 (M)	0.60 (M)	0.60 (MH)	0.65 (M)
Absorber class	C (DIN EN 11654)	C (DIN EN 11654)	C (DIN EN 11654)	C (DIN EN 11654)
Acoustic infill	**20 mm mineral wool 28 kg/m³ in PE film + 12.5 mm plasterboard**	**20 mm mineral wool 28 kg/m³ in PE film + cooling system + 12.5 mm plasterboard**	**20 mm mineral wool 28 kg/m³ in PE film + 12.5 mm plasterboard**	**20 mm mineral wool 28 kg/m³ in PE film + cooling system + 12.5 mm plasterboard**
				

EFFECT OF HEAVY-DUTY ACOUSTIC INFILLS 2

Sixth-Form Centre, Horw



Heavy-duty acoustic infills

Using heavy-duty acoustic infills in metal ceiling systems can significantly improve the longitudinal sound insulation – the acoustic transmission between two adjacent rooms separated by walls.

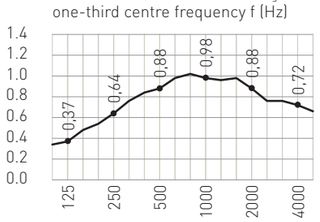
Longitudinal sound insulation

Acoustic metal ceilings with acoustic infill and heavy-duty acoustic infill are used preferentially for longitudinal sound insulation. See also pages 78–79 of this brochure.

	Fural
	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

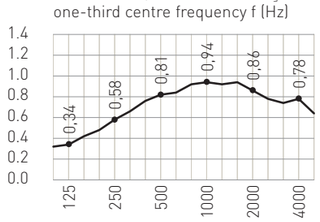


Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 229/2007 Figure 2
NRC	0.80
α_w	0.85
Absorber class	B (DIN EN 11654)
Acoustic infill	**50 mm mineral wool 28 kg/m³ in PE film + 1 mm sheet steel**

	Fural
	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 227/2007 Figure 2
NRC	0.75
α_w	0.80
Absorber class	C (DIN EN 11654)
Acoustic infill	**50 mm mineral wool 28 kg/m³ in PE film + 12.5 mm plasterboard**

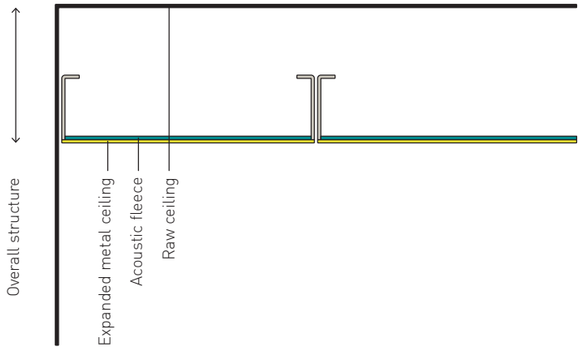
SILENCE

"One is always active with a certain amount of noise. Work takes place in silence."
(Peter Bamm, 1897–1975)

Bison Offices, Sursee
- Leuenberger Architects
- Offices
- Perforation Rd 1.5 – 22 %
- Colour RAL 9016 traffic white
- Hang-in system H28

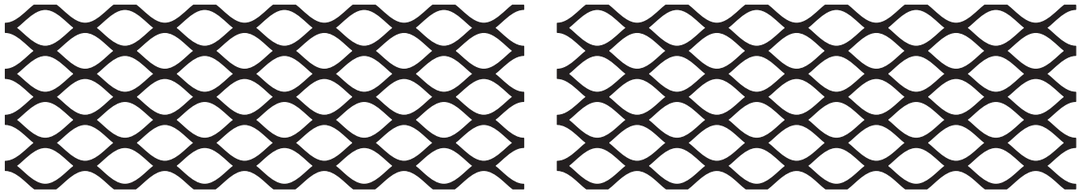
EXPANDED METAL CEILINGS

District council building, Kirchdorf



Air cavity and sound absorption coefficient

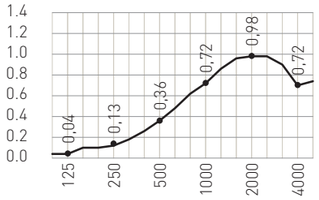
From a free cross-section > 70%, the sound absorption coefficient is hardly affected by the mesh size, but rather and in particular by the fleece, the acoustic infill and the air cavity.



	Fural
	16.0 × 8.0 × 1.5 × 1.0
Free cross-section	63 %
Overall structure	50 mm
Max. width	1,140 mm
L (diagonal 1)	16.0 mm →
W (diagonal 2)	8.0 mm ↓
B (web width)	1.5 mm
A (web thickness)	1.0 mm

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

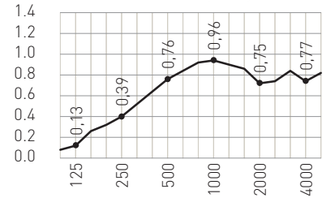


Air cavity	**50 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 246/2002 Figure 5
NRC	0.40
α_w	0.40 (MH)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o

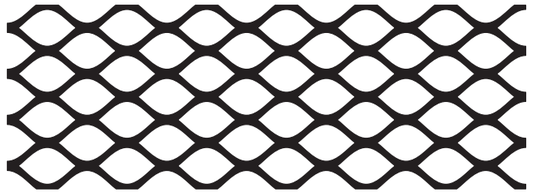
	Fural
	16.0 × 8.0 × 1.5 × 1.0
Free cross-section	63 %
Overall structure	50 mm
Max. width	1,140 mm
L (diagonal 1)	16.0 mm →
W (diagonal 2)	8.0 mm ↓
B (web width)	1.5 mm
A (web thickness)	1.0 mm

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



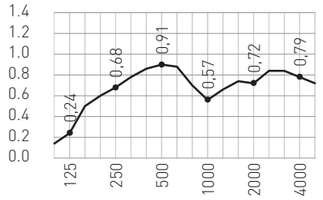
Air cavity	**100 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 246/2002 Figure 6
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



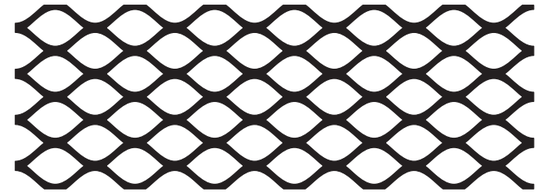
	Fural
	16.0 × 8.0 × 1.5 × 1.0
Free cross-section	63 %
Overall structure	50 mm
Max. width	1,140 mm
L (diagonal 1)	16.0 mm →
W (diagonal 2)	8.0 mm ↓
B (web width)	1.5 mm
A (web thickness)	1.0 mm

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



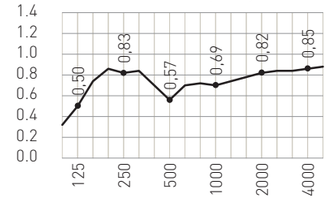
Air cavity	**200 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 246/2002 Figure 1
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



	Fural
	16.0 × 8.0 × 1.5 × 1.0
Free cross-section	63 %
Overall structure	50 mm
Max. width	1,140 mm
L (diagonal 1)	16.0 mm →
W (diagonal 2)	8.0 mm ↓
B (web width)	1.5 mm
A (web thickness)	1.0 mm

Sound absorption

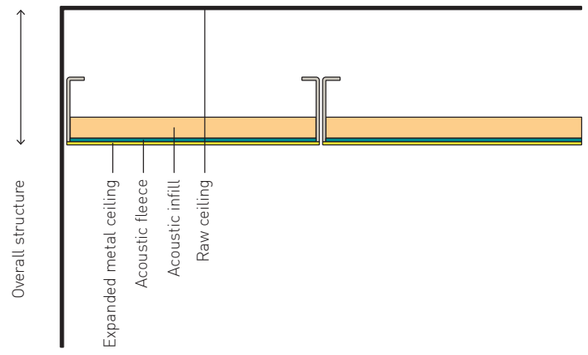
Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Air cavity	**400 mm**
Fleece	Bonded acoustic fleece
Test certificate	P-BA 246/2002 Figure 7
NRC	0.70
α_w	0.70 (LH)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

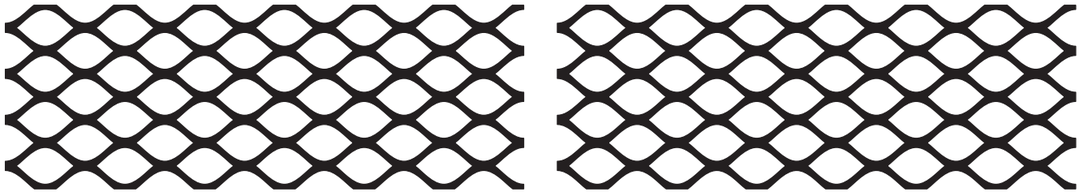
EFFECT OF ACOUSTIC INFILLS

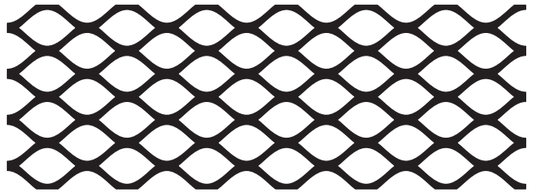
District council building, Kirchdorf

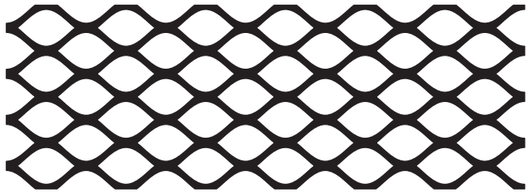


Air cavity and sound absorption coefficient

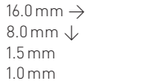
From a free cross-section > 70%, the sound absorption coefficient is hardly affected by the mesh size, but rather and in particular by the fleece, the acoustic infill and the air cavity.

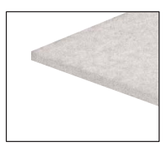


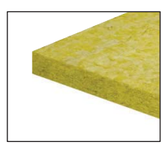




	Fural	**Fural**	**Fural**	**Fural**
	16.0 × 8.0 × 1.5 × 1.0	16.0 × 8.0 × 1.5 × 1.0	16.0 × 8.0 × 1.5 × 1.0	16.0 × 8.0 × 1.5 × 1.0
Free cross-section	63 %	63 %	63 %	63 %
Overall structure	50 mm	50 mm	50 mm	50 mm
Max. width	1,140 mm	1,140 mm	1,140 mm	1,140 mm
L (diagonal 1)	16.0 mm →	16.0 mm →	16.0 mm →	16.0 mm →
W (diagonal 2)	8.0 mm ↓	8.0 mm ↓	8.0 mm ↓	8.0 mm ↓
B (web width)	1.5 mm	1.5 mm	1.5 mm	1.5 mm
A (web thickness)	1.0 mm	1.0 mm	1.0 mm	1.0 mm
Sound absorption	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)
Air cavity	200 mm	200 mm	200 mm	200 mm
Fleece	–	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece
Test certificate	04.12.2019 M 105629	P-BA 246/2002 Figure 2	P-BA 246/2002 Figure 3	P-BA 246/2002 Figure 4
NRC	0.40	1.00	0.90	1.00
α_w	0.45 (H)	1.00 (MH)	0.90	1.00
Absorber class	D (DIN EN 11654)	A (DIN EN 11654)	A (DIN EN 11654)	A (DIN EN 11654)
Acoustic infill	**10 mm polyester wool 35 kg/m³**	**30 mm mineral wool 45 kg/m³**	**30 mm mineral wool 45 kg/m³ in PE film**	**30 mm polyester wool 48 g/m³**







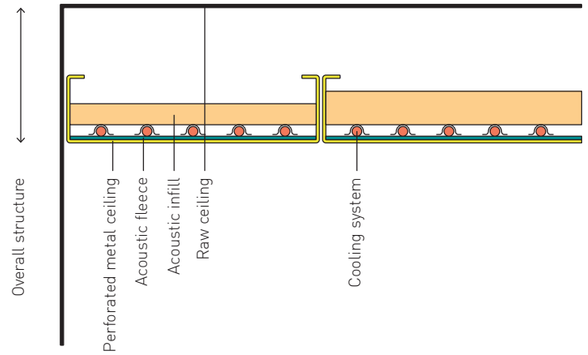
INTEGRATION

"Order is the connection of the many according to a rule."
(Immanuel Kant, 1724–1804)

Metalit Offices, Büron
- Architecture Hans Lauber
- Communal area
- Expanded metal
  Mesh 16×8×1.5×1.0 mm
- Colour RAL 7016 anthracite grey
- Floating ceiling with white
  acoustic fleece

COOLING CEILINGS 1

Federal School Centre St. Pölten



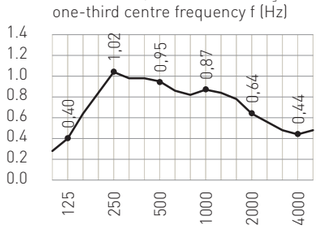
Acoustic occupancy level

Metal ceilings are particularly suitable for combination with water-bearing heat exchangers for room temperature control. Fitting the ceiling with cooling systems changes the acoustic properties of the ceiling panels, because the previously continuous holes of profiles are covered. Therefore the "acoustic occupancy level" is specified in the tables. This means the proportion of the area covered by the heat conducting profile.

	Fural
	Rg 0.7 - 4 %
Perforation Ø	0.7 mm
Hole content	4 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 0.70 - 3.00
Horizontal spacing	3.0 mm →
Vertical spacing	3.0 mm ↓
Diagonal spacing	4.42 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

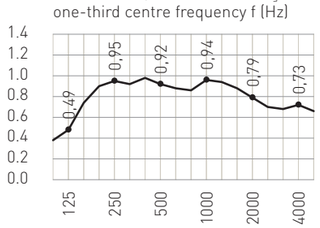


Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 225/2007
NRC	0.85
α_w	0.65 (LM)
Absorber class	C (DIN EN 11654)
Acoustic infill	**30 mm mineral wool 28 kg/m³ in PE film + cooling system**
Acoustic occ. level	**31% (cooling system + 4 heat conducting profiles)**

	Fural
	Rg 2.5 - 16%
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.5 mm →
Vertical spacing	5.5 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

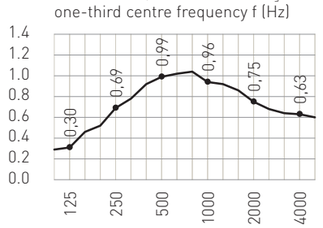


Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 223/2007
NRC	0.90
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	**30 mm mineral wool 28 kg/m³ in PE film + cooling system**
Acoustic occ. level	**31% (cooling system + 4 heat conducting profiles)**

	Fural
	Rg 2.5 - 16%
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.5 mm →
Vertical spacing	5.5 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



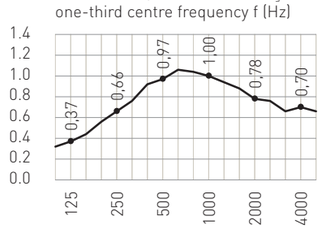
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 224/2007 Figure 2
NRC	0.85
α_w	0.85
Absorber class	B (DIN EN 11654)
Acoustic infill	**40 mm mineral wool 28 kg/m³ in PE film + cooling system + 12.5 mm plasterboard**
Acoustic occ. level	**31% (cooling system + 4 heat conducting profiles)**

see page 83
The longitudinal sound insulation factor of the same test setup

	Fural
	Rg 2.5 - 16%
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.5 mm →
Vertical spacing	5.5 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

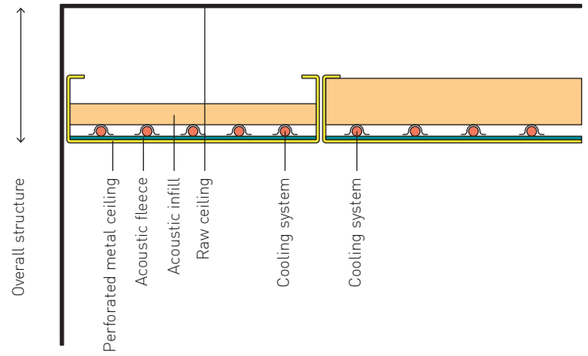


Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 228/2007 Figure 2
NRC	0.85
α_w	0.85
Absorber class	B (DIN EN 11654)
Acoustic infill	**40 mm mineral wool 28 kg/m³ in PE film + cooling system + 1.0 mm sheet steel**
Acoustic occ. level	**31% (cooling system + 4 heat conducting profiles)**

see page 83
The longitudinal sound insulation factor of the same test setup

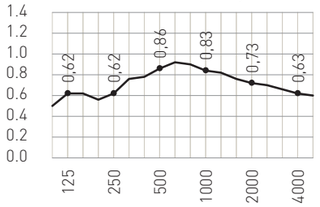
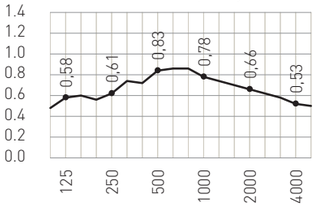
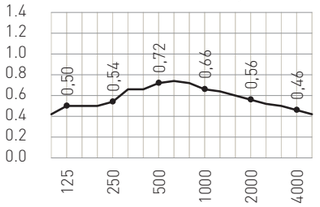
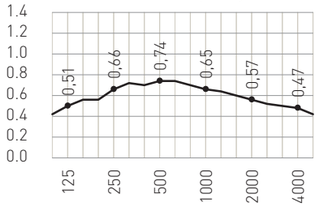
COOLING CEILINGS 2

Schunk Carbon Technology GmbH, Bad Goisern



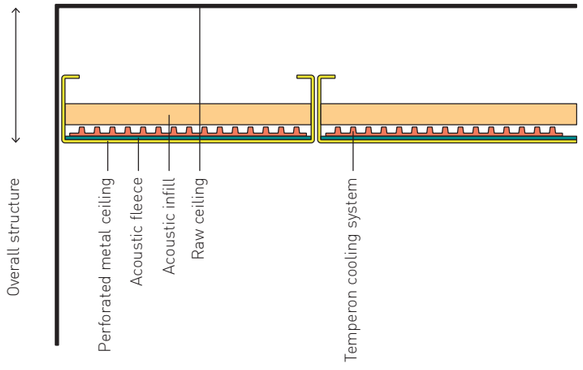
Acoustic occupancy level

Metal ceilings are particularly suitable for combination with water-bearing heat exchangers for room temperature control. Fitting the ceiling with cooling systems changes the acoustic properties of the ceiling panels, because the previously continuous holes of profiles are covered. Therefore the "acoustic occupancy level" is specified in the tables. This means the proportion of the area covered by the heat conducting profile.

	Fural	**Fural**	**Fural**	**Fural**
	Rg 1.5 - 11 %	Rg 1.5 - 11 %	Rg 1.5 - 11 %	Rg 1.5 - 11 %
Perforation Ø	1.5 mm	1.5 mm	1.5 mm	1.5 mm
Hole content	11 %	11 %	11 %	11 %
Max. perforation width	1,488 mm	1,488 mm	1,488 mm	1,488 mm
Des. acc. to DIN 24041	Rg 1.50 - 4.00	Rg 1.50 - 4.00	Rg 1.50 - 4.00	Rg 1.50 - 4.00
Horizontal spacing	4.00 mm →	4.00 mm →	4.00 mm →	4.00 mm →
Vertical spacing	4.00 mm ↓	4.00 mm ↓	4.00 mm ↓	4.00 mm ↓
Diagonal spacing	5.65 mm ↘	5.65 mm ↘	5.65 mm ↘	5.65 mm ↘
Perforation direction	→	→	→	→
Sound absorption	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)	Sound absorption coefficient α_s at one-third centre frequency f (Hz)
				
	0.62 0.62 0.86 0.83 0.73 0.63	0.58 0.61 0.83 0.78 0.66 0.53	0.50 0.54 0.72 0.66 0.56 0.46	0.51 0.66 0.74 0.65 0.57 0.47
	125 250 500 1000 2000 4000	125 250 500 1000 2000 4000	125 250 500 1000 2000 4000	125 250 500 1000 2000 4000
Overall structure	750 mm	750 mm	750 mm	750 mm
Fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece
Test certificate	26.06.2014 M 105629/10	26.06.2014 M 105629/11	28.04.2014 M 105629/8	28.04.2014 M 105629/9
NRC	0.75	0.70	0.60	0.65
α_w	0.80	0.70	0.60	0.60
Absorber class	B (DIN EN 11654)	C (DIN EN 11654)	C (DIN EN 11654)	C (DIN EN 11654)
Acoustic infill	**30 mm mineral wool 45 kg/m³ in PE film + cooling system**	**30 mm mineral wool 45 kg/m³ in PE film + cooling system**	**30 mm mineral wool 45 kg/m³ in PE film + cooling system**	**80 mm mineral wool 30 kg/m³ in PE film + cooling system**
Acoustic occ. level	**47 % (cooling system + 4 heat conducting profiles)**	**59 % (cooling system + 5 heat conducting profiles)**	**71 % (cooling system + 6 heat conducting profiles)**	**71 % (cooling system + 6 heat conducting profiles)**
				

COOLING CEILINGS 3

Palazzo Regione Lombardia, Milan



Acoustic occupancy level

Metal ceilings are particularly suitable for combination with water-bearing heat exchangers for room temperature control. Fitting the ceiling with cooling systems changes the acoustic properties of the ceiling panels, because the previously continuous holes of profiles are covered. Therefore the "acoustic occupancy level" is specified in the tables. This means the proportion of the area covered by the heat conducting profile.

	Fural Rg 0.7 - 4 %	**Fural** Rv 1.6 - 20 %	**Fural** Rd 1.8 - 21 %	**Fural** Rg 2.5 - 16 %
Perforation Ø	0.7 mm	1.6 mm	1.8 mm	2.5 mm
Hole content	4 %	20 %	21 %	16 %
Max. perforation width	1,140 mm	1,450 mm	1,400 mm	1,140 mm
Des. acc. to DIN 24041	Rg 0.70 - 3.00	Rv 1.60 - 3.50	Rd 1.80 - 3.50	Rg 2.50 - 5.50
Horizontal spacing	3.00 mm →	3.50 mm →	4.96 mm →	5.50 mm →
Vertical spacing	3.00 mm ↓	3.03 mm ↓	2.48 mm ↓	5.50 mm ↓
Diagonal spacing	4.42 mm ↘	3.50 mm ↘	3.50 mm ↘	7.78 mm ↘
Perforation direction	→	→	→	→
Sound absorption	Sound absorption coefficient α_s at one-third centre frequency f (Hz), **Fleece and cooling system plus mineral wool in PE**	**Sound absorption** Sound absorption coefficient α_s at one-third centre frequency f (Hz), **Fleece and cooling system plus mineral wool in PE**	**Sound absorption** Sound absorption coefficient α_s at one-third centre frequency f (Hz), **Fleece and cooling system plus mineral wool in PE**	**Sound absorption** Sound absorption coefficient α_s at one-third centre frequency f (Hz), **Fleece and cooling system plus mineral wool in PE**
Overall structure	200 mm	200 mm	200 mm	200 mm
Fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M61 840/10 + M61 840/8	07.12.2010 M61 840/9 + M61 840/13	07.12.2010 M61 840/12 + M61 840/15	07.12.2010 M61 840/14 + M61 840/11
NRC	0.75; 0.90	0.70; 0.95	0.70; 0.95	0.75; 0.95
α_w	0.65 (LM); 0.80 (L)	0.65; 0.95	0.65; 0.95	0.70 (L); 0.90 (L)
Absorber class	C (DIN EN 11654), B (DIN EN 11654)	C (DIN EN 11654), A (DIN EN 11654)	C (DIN EN 11654), A DIN EN 11654)	C (DIN EN 11654), A (DIN EN 11654)
Acoustic infill	**40 mm mineral wool 45 kg/m³ in PE film + Temperon cooling system**	**40 mm mineral wool 45 kg/m³ in PE film + Temperon cooling system**	**40 mm mineral wool 45 kg/m³ in PE film + Temperon cooling system**	**40 mm mineral wool 45 kg/m³ in PE film + Temperon cooling system**
Acoustic occ. level	**29% (cooling system)**	**29% (cooling system)**	**29% (cooling system)**	**29% (cooling system)**

PRECISION

"The place to improve the world is first in one's own heart and head and hands, and then work outward from there."
(Robert M. Pirsig, 1924-2017)

Image on left:
Bison Offices, Sursee
- Leuenberger Architects
- Atrium
- Perforation Rd 1.5 – 22 %
- Colour RAL 9016 traffic white
- Hang-in system H28

Image on right:
Hotel "Birdland", Sempach
- Architect: Markus Schumacher
- Conference room
- Perforation Rv 1.6 – 20 %
- Colour RAL 9007 grey aluminium
- Hang-in system wall cladding

FLOATING CEILINGS

Special acoustic features of floating ceilings

In contrast to closed ceiling systems, it is not appropriate to specify sound absorption values for individual absorbers. Thanks to the additional absorbent rear side of floating ceilings, excellent acoustic results are achievable on paper (e.g. α_w=1.6), which cannot be accounted for meaningfully. Furthermore, the edge diffraction and the ratio of perimeter to area of a floating ceiling have a certain influence that cannot be determined directly. These effects mean that floating ceilings have **better sound absorption** than closed ceilings.

Therefore the **equivalent sound absorption area** is specified for individual absorbers, rather than the sound absorption coefficient:

The following example shows how much flat ceiling a floating ceiling can replace in order to achieve the same acoustic effect.

Schuler, Göppingen
- Architect: Holzbauer & Partner
- Offices
- Perforation Rg 2.5 - 16 %
- Colour RAL 9016 traffic white
- Multi-floating ceiling system with hang-in tiles

Example
- Room situation with dimensions l = 10 m, w = 10 m, h = 3 m
- Floor space: 100 m²
- Room volume V: 300 m³
- Carpet (100 m²): α = 0.06
- Plastered ceiling and wall (190 m²): α = 0.03
- Glass window front (30 m²): α = 0.01
- Unfurnished

Formulae
- Equivalent sound absorption area A (α = degree of absorption, S = area): $A = \alpha \times S$
- Reverberation time T (V = volume): $T = 0.163 \times V/A$ (Sabine formula)

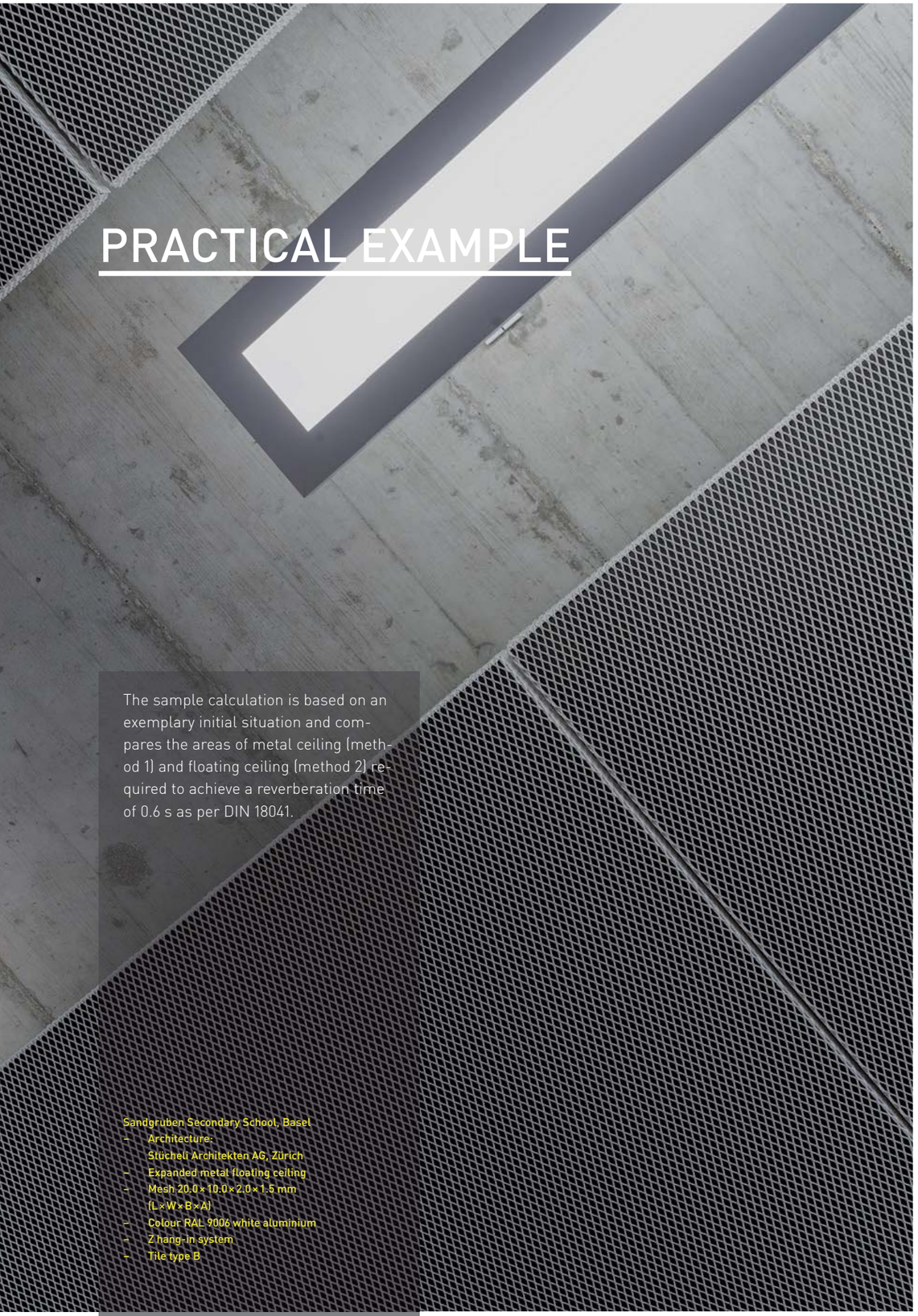
	Recommended reverberation time T ~ 0.6 s (DIN 18041)	Initial situation of a plastered, reverberant ceiling	All-over metal ceiling Fural Rg 2.5 – 16 % with 30 mm mineral wool 45 kg/m³ in PE film	Floating ceilings Fural Rg 2.5 – 16 % with 50 mm mineral wool 100 kg/m³ in PE film
T	Calculated reverberation time	3.0 s	0.6 s	0.6 s
S	Area of metal ceiling	–	75.0 m²	49.0 m² ~ 17x
A	Equivalent sound absorption area of the whole room	16.0 m²	81.8 m²	82.3 m²

(The individual calculations can be found on the next page.)

Conclusion

In order to achieve the same acoustic effect in a room, a much smaller area is required if floating ceilings are used. The additional physical dampening effects can yield a **material saving of up to 30%**.

The benefits of floating ceilings
- Additionally absorbent rear side
- Saving of ~ 30% material area compared to a metal ceiling
- More flexible in terms of layout
- Existing lighting may continue to be used
- Straightforward retrofitting
- Can be used or retrofitted during building core activation
- Simple subsequent air conditioning



PRACTICAL EXAMPLE

The sample calculation is based on an exemplary initial situation and compares the areas of metal ceiling (method 1) and floating ceiling (method 2) required to achieve a reverberation time of 0.6 s as per DIN 18041.

Sandgruben Secondary School, Basel
- Architecture:
  Stücheli Architekten AG, Zürich
- Expanded metal floating ceiling
- Mesh 20.0 × 10.0 × 2.0 × 1.5 mm
  (L × W × B × A)
- Colour RAL 9006 white aluminium
- Z hang-in system
- Tile type B

Calculations

Initial situation

Walls, ceilings	S = 190 m² α = 0.03 (at 500 Hz as per DIN 18041)
Window front	S = 30 m² α = 0.11 (at 500 Hz as per DIN 18041)
Carpet, short	S = 100 m² α = 0.07 (at 500 Hz as per DIN 18041)
Equivalent sound absorption area A [500 Hz]	Walls + raw ceiling 190 m² × 0.03 = 5.7 m² Window front 30 m² × 0.11 = 3.3 m² Carpet100 m² × 0.07 = 7.0 m² Total 16.0 m²
Reverberation time	T = 0.163 × 300/16 = 3.0 s >> 0.6 s (requirement as per DIN 18041)

Method 1

Install a metal ceiling, all-over
(75 m² in perforated version, 25 m² plain)

Perforated metal ceiling	S = 75 m² α = 0.90 (at 500 Hz acc. to test report P-BA 279/2006 Figure 17; see page 34)
Plain metal ceiling	S = 25 m² α = 0.05 (at 500 Hz acc. to test report P-BA 279/2006 Figure 31; on request)
Equivalent sound absorption area A [500 Hz]	Walls 90 m² × 0.03 = 2.7 m² Window front 30 m² × 0.11 = 3.3 m² Carpet 100 m² × 0.07 = 7.0 m² Perf. metal ceiling 75 m² × 0.90 = 67.5 m² Plain metal ceiling 25 m² × 0.05 = 1.25 m² Total 81.8 m²
Reverberation time	T = 0.163 × 300/81.8 = 0.6 s

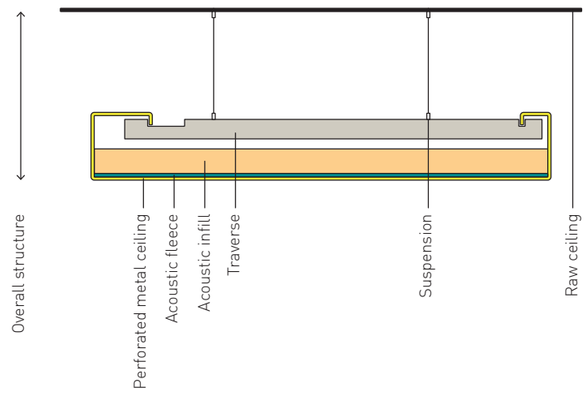
Method 2

Install 17x floating ceilings @ 2.88 m²
(total area 48.96 m²)

Floating ceiling	A = 3.9 m² each (at 500 Hz acc. to test report 07/12/2010 M 61840/20; see page 65)
Equivalent sound absorption area A [500 Hz]	Walls and raw ceiling 190 m² × 0.03 = 5.7 m² Carpet100 m² × 0.07 = 7.0 m² Window front 30 m² × 0.11 = 3.3 m² Floating ceiling 3.9 m² each × 17 = 66.3 m² Total 82.3 m²
Reverberation time	T = 0.163 × 300/82 3 = 0.6 s

FLOATING CEILINGS

Schuler AG, Göppingen



Floating ceilings

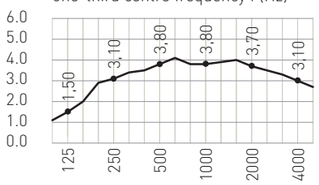
Floating ceilings can be used both as individual elements and as multi-part, combined units.

Fural
Rv 1.6 - 20 %

Perforation Ø	1.6 mm
Hole content	20 %
Max. perforation width	1,450 mm
Des. acc. to DIN 24041	Rv 1.60 - 3.50
Horizontal spacing	3.50 mm →
Vertical spacing	3.03 mm ↓
Offset spacing 60°	3.50 mm ↘
Perforation direction	→

Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)



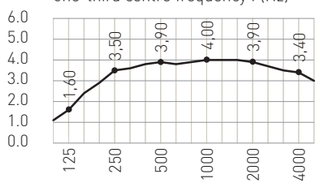
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/21
Equiv. sound absorp.	(500 Hz) 3.8 m²
Visible surface area	2.88 m²
Acoustic infill	50 mm mineral wool **100 kg/m³** in PE film

Fural
Rv 1.6 - 20 %

Perforation Ø	1.6 mm
Hole content	20 %
Max. perforation width	1,450 mm
Des. acc. to DIN 24041	Rv 1.60 - 3.50
Horizontal spacing	3.50 mm →
Vertical spacing	3.03 mm ↓
Offset spacing 60°	3.50 mm ↘
Perforation direction	→

Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)



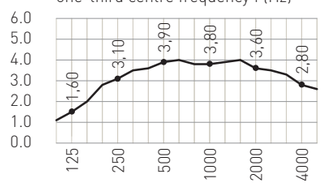
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/18
Equiv. sound absorp.	(500 Hz) 3.9 m²
Visible surface area	2.88 m²
Acoustic infill	50 mm mineral wool **150 kg/m³** in PE film

Fural
Rg 2.5 - 16 %

Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)



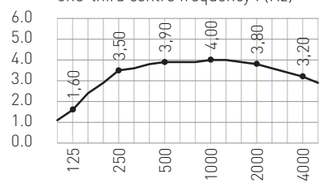
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/20
Equiv. sound absorp.	(500 Hz) 3.9 m²
Visible surface area	2.88 m²
Acoustic infill	50 mm mineral wool **100 kg/m³** in PE film

Fural
Rg 2.5 - 16 %

Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)



Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/17
Equiv. sound absorp.	(500 Hz) 3.9 m²
Visible surface area	2.88 m²
Acoustic infill	50 mm mineral wool **150 kg/m³** in PE film

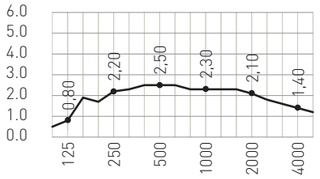
European Investment Bank, Luxembourg

COOLING FLOATING CEILINGS 1

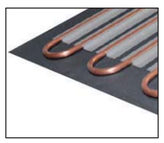
	Fural
	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)



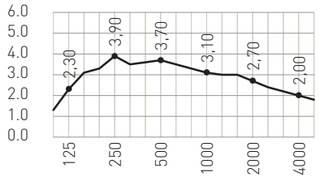
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	28.06.2019 M 105629/37
Equiv. sound absorp.	(500 Hz) 2.50 m²
Visible surface area	3.45 m²
Acoustic infill	**Cooling system**
Acoustic occ. level	73 % (cooling system with 12 heat conducting profiles)



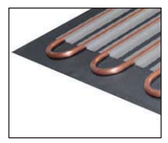
	Fural
	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

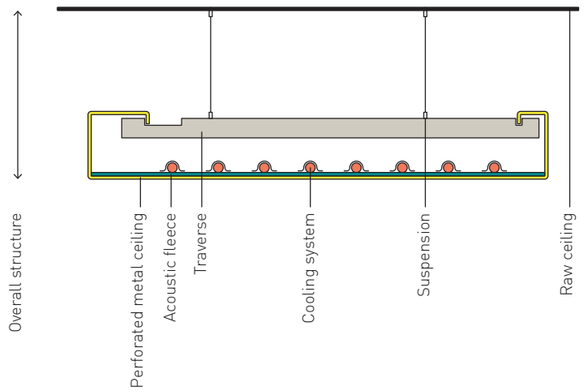
Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)



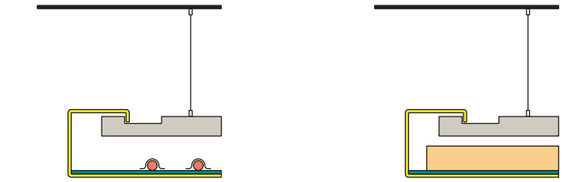
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	28.06.2019 M 105629/38
Equiv. sound absorp.	(500 Hz) 3.70 m²
Visible surface area	3.45 m²
Acoustic infill	**50 mm mineral wool 100 kg/m³ in PE film + cooling system**
Acoustic occ. level	73 % (cooling system with 12 heat conducting profiles)





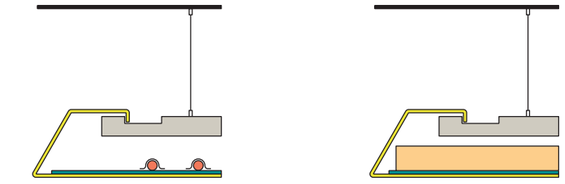
Room temperature control by floating ceiling

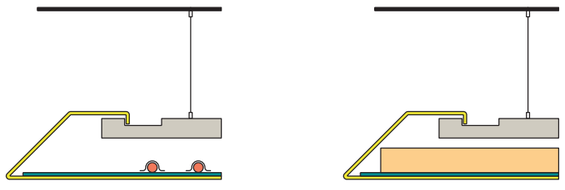
Floating ceilings are particularly suitable for combination with water-bearing heat exchangers for room temperature control. Fitting with cooling systems changes the acoustic properties of the floating ceilings, because the previously continuous holes of profiles are covered. Therefore the "acoustic occupancy level" is specified in the tables. This means the proportion of the area covered by the heat conducting profile.



Edge formation of floating ceilings

The edge formation of floating ceilings can be implemented with internal angles of 90°, 60° or 45°. While internal angles of 90° create a voluminous impression, the versions with internal angles of 60° and 45° have a more two-dimensional effect.





COOLING FLOATING CEILINGS 2

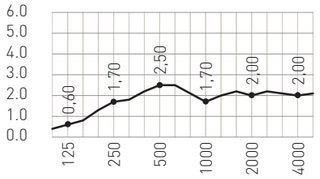
Gotech, Weissach

Fural
Rv 1.6 - 20 %

Perforation Ø	1.6 mm
Hole content	20 %
Max. perforation width	1,450 mm
Des. acc. to DIN 24041	Rv 1.60 - 3.50
Horizontal spacing	3.50 mm →
Vertical spacing	3.03 mm ↓
Offset spacing 60°	3.50 mm ↘
Perforation direction	→

Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)



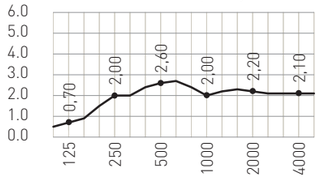
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/16
Equiv. sound absorp.	(500 Hz) 2.5 m²
Visible surface area	2.88 m²
Acoustic infill	**Temperon cooling system**
Acoustic occ. level	30 %

Fural
Rg 2.5 - 16 %

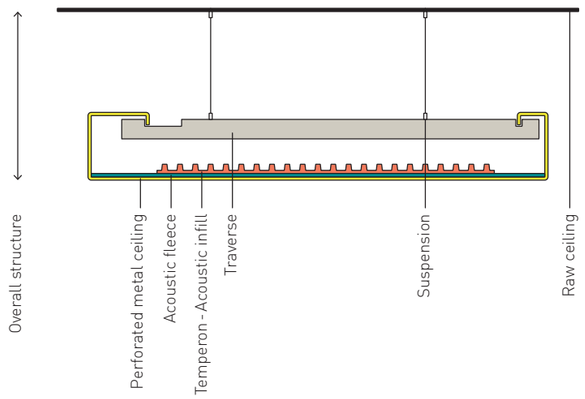
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Absorption area A_{Obj}/m² at one-third centre frequency f (Hz)

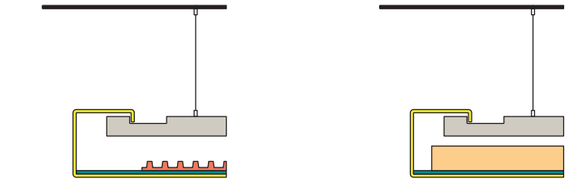


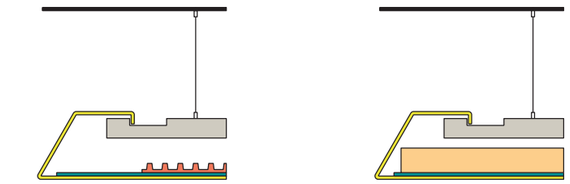
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61 840/19
Equiv. sound absorp.	(500 Hz) 2.6 m²
Visible surface area	2.88 m²
Acoustic infill	**Temperon cooling system**
Acoustic occ. level	30 %

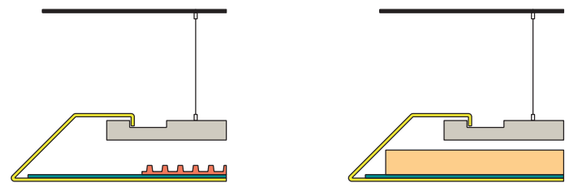


Room temperature control by floating ceiling

Floating ceilings are particularly suitable for combination with water-bearing heat exchangers for room temperature control. Fitting with cooling systems changes the acoustic properties of the floating ceilings, because the previously continuous holes of profiles are covered. Therefore the "acoustic occupancy level" is specified in the tables. This means the proportion of the area covered by the heat conducting profile.





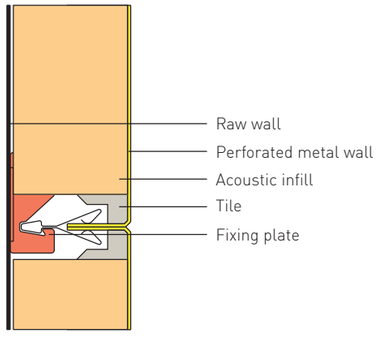


Edge formation of floating ceilings

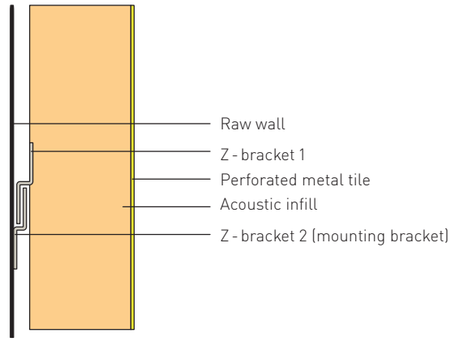
The edge formation of floating ceilings can be implemented with internal angles of 90°, 60° or 45°. While internal angles of 90° create a voluminous impression, the versions with internal angles of 60° and 45° have a more two-dimensional effect.

ACOUSTIC WALLS 1

Clip-in system



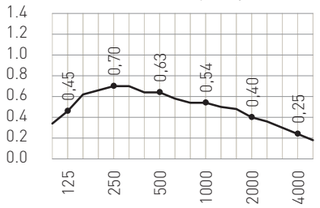
Hang-in system



	Fural Rg 0.7 - 1 %	**Fural** Rg 0.7 - 4 %	**Fural** Rv 1.6 - 20 %	**Fural** Rd 1.8 - 21 %
Perforation Ø	0.7 mm	0.7 mm	1.6 mm	1.8 mm
Hole content	1 %	4 %	20 %	21 %
Max. perforation width	1,140 mm	1,140 mm	1,450 mm	1,400 mm
Des. acc. to DIN 24041	Rg 0.70 - 6.00	Rg 0.70 - 3.00	Rv 1.60 - 3.50	Rd 1.80 - 3.50
Horizontal spacing	6.00 mm →	3.00 mm →	3.50 mm →	4.96 mm →
Vertical spacing	6.00 mm ↓	3.00 mm ↓	3.03 mm ↓	2.48 mm ↓
Diagonal spacing	8.48 mm ↘	4.24 mm ↘	3.50 mm ↘	3.50 mm ↘
Offset spacing 60°				
Perforation direction	→	→	→	→

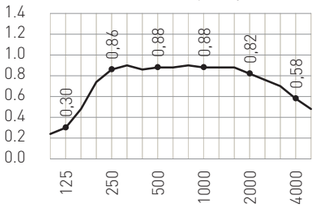
Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



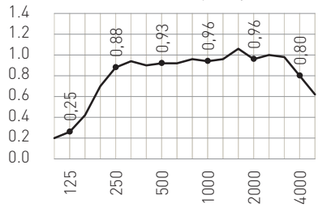
Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



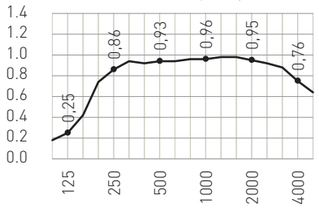
Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Sound absorption

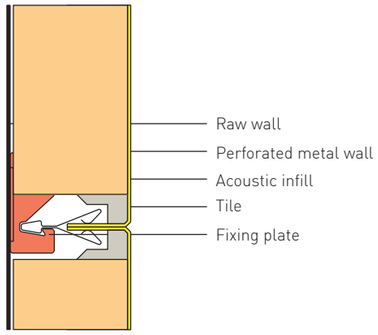
Sound absorption coefficient α_s at one-third centre frequency f (Hz)

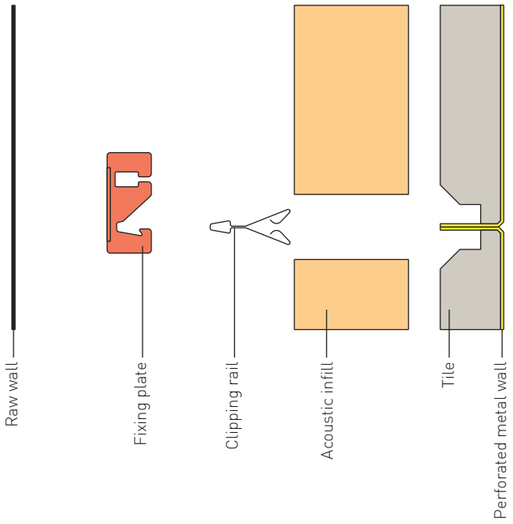


Overall structure	50 mm	50 mm	50 mm	50 mm
Fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/27	07.12.2010 M 61840/26	07.12.2010 M 61840/22	07.12.2010 M 61840/25
NRC	0.55	0.85	0.95	0.95
α_w	0.40 (L)	0.80 (L)	0.95	0.95
Absorber class	D (DIN EN 11654)	B (DIN EN 11654)	A (DIN EN 11654)	A (DIN EN 11654)
Acoustic infill	**50 mm mineral wool 100 kg/m³ in PE film**	**50 mm mineral wool 100 kg/m³ in PE film**	**50 mm mineral wool 100 kg/m³ in PE film**	**50 mm mineral wool 100 kg/m³ in PE film**

ACOUSTIC WALLS 2

Tyrol Control Centre, Innsbruck





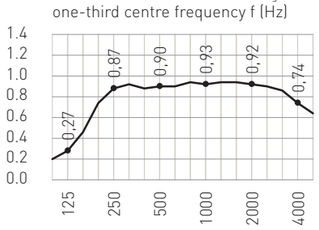
Substructure of acoustic walls

Acoustic walls can be installed using the same grid and clamping profiles that are used for metal ceilings.

	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)

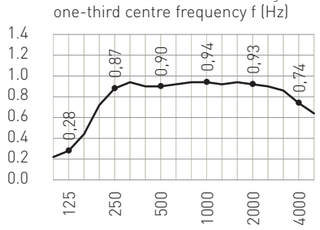


Overall structure	50 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/23
NRC	0.90
α_w	0.90
Absorber class	A (DIN EN 11654)
Acoustic infill	**50 mm mineral wool 100 kg/m³ in PE film**

	Fural Rv 3.0 - 20 %
Perforation Ø	3.0 mm
Hole content	20 %
Max. perforation width	1,447 mm
Des. acc. to DIN 24041	Rv 3.00 - 6.35
Horizontal spacing	3.25 mm →
Vertical spacing	5.50 mm ↓
Offset spacing 60°	6.35 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	50 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/24
NRC	0.90
α_w	0.90
Absorber class	A (DIN EN 11654)
Acoustic infill	**50 mm mineral wool 100 kg/m³ in PE film**

L-ABSORBERS

Rudolf Diesel Municipal Secondary School, Munich

Product description

The L-shaped absorber element consists of metal components arranged at right angles to each other in the room border between wall and ceiling. The absorber elements are only attached to the wall, in order not to load the ceiling statically. The one-piece design results in a precise joint pattern and quick installation. The distance between metal elements and ceiling is variable. The metal elements are coated with acoustic fleece on the back. 60 mm-thick acoustic inlays are employed as cavity soundproofing.

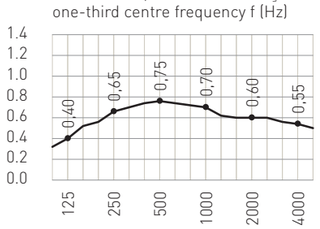
Acoustic

L-absorbers impress with their high acoustic effectiveness and high-quality appearance. One of the most important criteria for the quality of a room is optimum room acoustics.

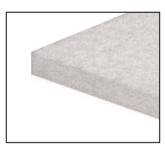
Fural	Rg 0.7 - 4 %
Perforation Ø	0.7 mm
Hole content	4 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 0.70 - 3.00
Horizontal spacing	3.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.42 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



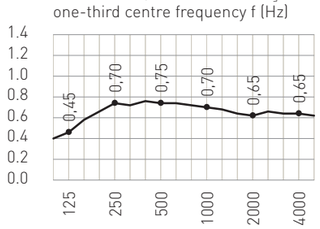
Overall structure	**100 mm**
Length	1,000 mm
Fleece	Bonded acoustic fleece
Test certificate	22.12.2017 M105629/33
NRC	0.70
α_w	0.65
Absorber class	C (DIN EN 11654)
Acoustic infill	60 mm sheep's wool 20 kg/m³



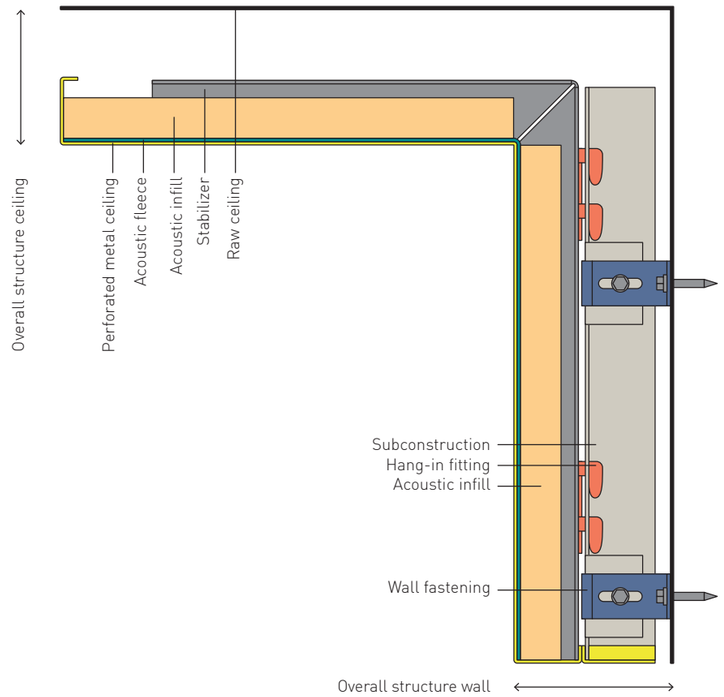
Fural	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Sound absorption coefficient α_s at one-third centre frequency f (Hz)



Overall structure	**100 mm**
Length	1,000 mm
Fleece	Bonded acoustic fleece
Test certificate	22.12.2017 M105629/33
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	60 mm sheep's wool 20 kg/m³



LONGITUDINAL SOUNDPROOFING

Principles

A major criterion for the acoustic quality of a building is the sound transmission from room to room and from floor to floor. The better the building materials employed absorb the longitudinal sound, the smaller the disturbing influences.
As so often, the law of the weakest link applies here as well. If a component has a sound insulation factor of e.g. 20 dB, the resulting sound insulation factor of the whole system will never be better than 20 dB, no matter how good the remaining components are. For this reason, not only the degree of absorption but also the longitudinal sound insulation factor must be taken into consideration when selecting the products used.

Gemeentehuis, Westland
- Architecture: Cepezed
- Corridor area
- Perforation Rd 2.5 – 16 %
- Colour RAL 9016 traffic white
- Strip grid system

Longitudinal sound insulation in drywall construction

Particularly with dry walls, the longitudinal sound insulation of the ceiling is a major factor in the acoustic function of a room. The sound penetrates through the ceiling into the ceiling void and is transmitted to the adjoining room. There the sound waves pass through the ceiling again and can be heard in the room as residual noise. The difference between the transmitted noise level and the received noise level is referred to as normalised flanking level difference and can be tested in the laboratory.

Outstanding insulation values

In the tests conducted according to DIN EN ISO 10848-2, Fural achieved outstanding results. Strip-grid and clip-in strip grid systems with the following structure were tested:

- Perforated Fural metal ceiling
- Mineral wool inlay sealed in PE film
- Plasterboard or steel cover

The systems enable quick and flexible adaptation of the rooms for the developer or tenant in the event of changes in use. Thanks to the excellent insulation values, components such as plasterboard partitions can be omitted, which results in significant potential savings.

Even in the case of ceiling panels that have been fitted additionally with cooling and heating coils, this has no further effect on the longitudinal sound insulation factor. The specified values are also achieved in this setup.

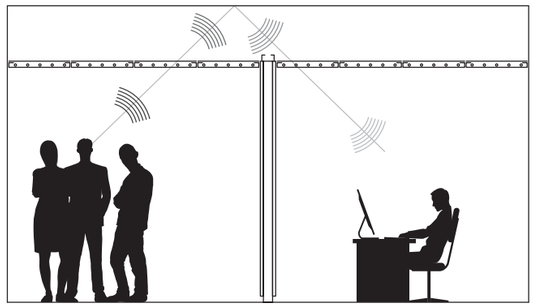
Values achieved

Ceiling tile with plasterboard cover: up to 56 dB; ceiling tile with steel cover: up to 52 dB.

Measurement and evaluation

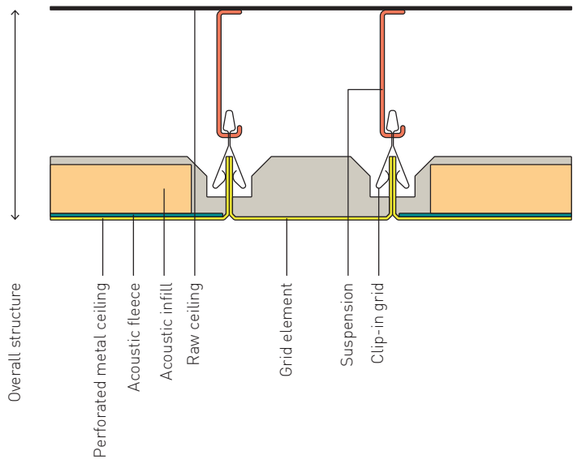
The normalised flanking level difference is tested as per DIN EN ISO 10848-2. In this test, a suspended ceiling that extends over two adjoining rooms is installed above a standard partition wall in the test laboratory. A transmitter (loudspeaker) is installed in one room and a receiver (microphone) in the other. The transmitted, defined noise is measured as incoming noise in the receiving room. The resulting measurement curve is evaluated as per ISO 717-1 in a frequency range from 100 Hz to 5000 Hz.

The higher the weighted normalised flanking sound level difference, $D_{n,f,w}$, the better the sound insulating properties that the component possesses. The C and C_{tr} values provide additional information about a component's properties. C provides information about the insulating properties against balanced frequency spectra, such as office, residential and traffic noises. The C_{tr} value can be used for assessing noises with a large low-frequency content (aircraft noise, traffic noise).



CLIP-IN STRIP-GRID CEILINGS

Bügelbauten, Berlin Central Station



Clip-in strip-grid systems

Clip-in strip-grid ceilings impress with their outstanding appearance. The high-precision double clip-in studs allow the tiles to be fitted without stress and without any height differences viewed from below.

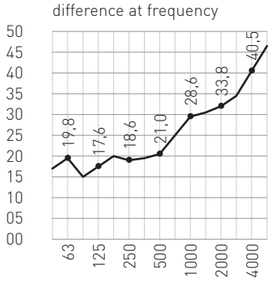
The advantage of the clip-in strip-grid system is that the strip grids can be removed from the ceiling assembly at any time, without adjoining fields having to be removed. This is possible because the support frame takes on the essential load-bearing function.

Fural

	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

Normalised flanking sound level difference at frequency



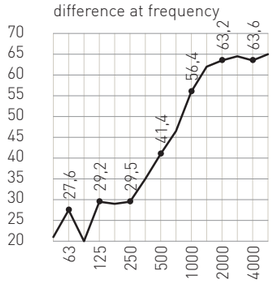
Overall structure	720 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/32
Weighted normalised flanking sound level difference $D_{n,tw}(C;C_{tr})$	27 (-1; -3) dB
Acoustic infill	**30 mm mineral wool 45 kg/m³ in PE film**

Fural

	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→

Sound absorption

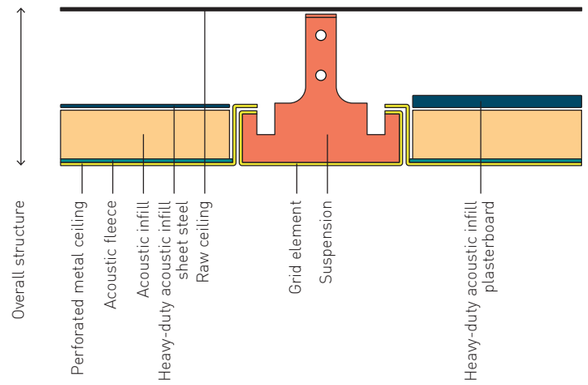
Normalised flanking sound level difference at frequency



Overall structure	720 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/33[a]
Weighted normalised flanking sound level difference $D_{n,tw}(C;C_{tr})$	44 (-1; -6) dB
Acoustic infill	**30 mm mineral wool 45 kg/m³ in PE film + 12.5 mm plasterboard**

STRIP-GRID CEILINGS

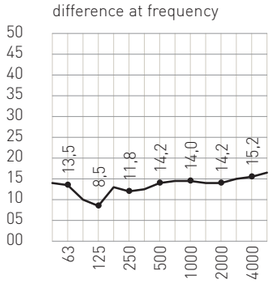
CJIB, Leeuwarden



Strip-grid systems

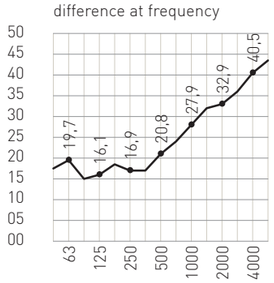
Strip grids offer designers greater flexibility: The ceiling pattern can be adapted on the construction grid, dividing walls can be incorporated in the system and the ceiling can meet stringent longitudinal sound insulation requirements.

	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→
Sound absorption	Normalised flanking sound level difference at frequency



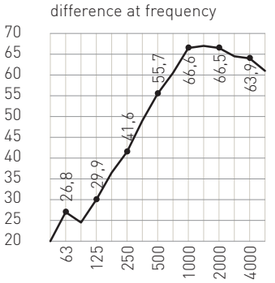
Overall structure	720 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/28
Weighted normalised flanking sound level difference $D_{n,tw}(C;C_{tr})$	14 (0; 0) dB
Acoustic infill	**w/o**

	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→
Sound absorption	Normalised flanking sound level difference at frequency



Overall structure	720 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/29
Weighted normalised flanking sound level difference $D_{n,tw}(C;C_{tr})$	26 (-1; -3) dB
Acoustic infill	**30 mm mineral wool 45 kg/m³ in PE film**

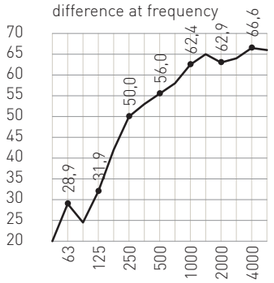
	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→
Sound absorption	Normalised flanking sound level difference at frequency



Overall structure	720 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/30
Weighted normalised flanking sound level difference $D_{n,tw}(C;C_{tr})$	52 (-2; -9) dB
Acoustic infill	**30 mm mineral wool 45 kg/m³ in PE film + 1.0 mm sheet steel cover**

see page 55 for the sound absorption of the same test setup

	Fural Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→
Sound absorption	Normalised flanking sound level difference at frequency

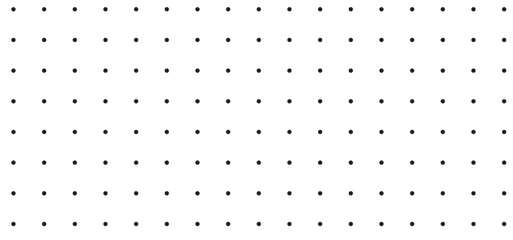


Overall structure	720 mm
Fleece	Bonded acoustic fleece
Test certificate	07.12.2010 M 61840/31
Weighted normalised flanking sound level difference $D_{n,tw}(C;C_{tr})$	56 (-4; -11) dB
Acoustic infill	**30 mm mineral wool 45 kg/m³ in PE film + 12.5 mm plasterboard**

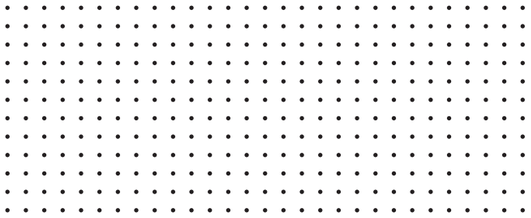
see page 55 for the sound absorption of the same test setup

TESTED PERFORATIONS 1

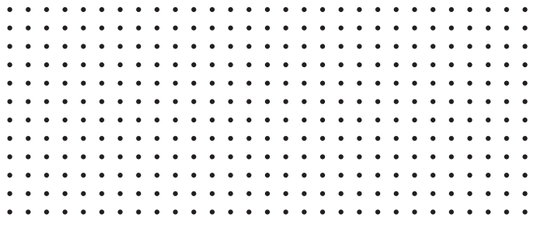
	Fural
	Rg 0.7 - 1 %
Perforation Ø	0.7 mm
Hole content	1 %
Max. perforation width	1,197 mm
Des. acc. to DIN 24041	Rg 0.70 - 6.00
Horizontal spacing	6.00 mm →
Vertical spacing	6.00 mm ↓
Diagonal spacing	8.48 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	31/08/2007 P-BA 231/2007
NRC	0.65
α_w	0.50 (LM)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o



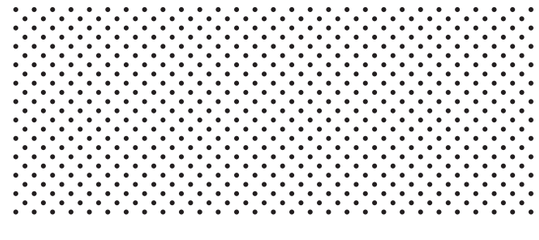
	Fural
	Rg 0.7 - 1.5 %
Perforation Ø	0.7 mm
Hole content	1.5 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rg 0.70 - 5.00
Horizontal spacing	5.00 mm →
Vertical spacing	5.00 mm ↓
Diagonal spacing	7.07 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	04/12/2019 M 105629
NRC	0.60
α_w	0.50 (L)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o



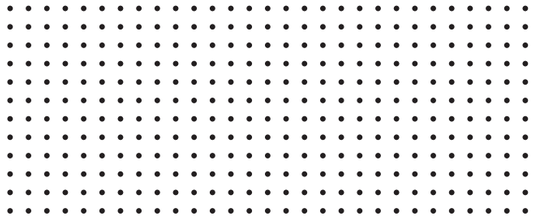
	Fural
	Rg 0.7 - 4 %
Perforation Ø	0.7 mm
Hole content	4 %
Max. perforation width	1,197 mm
Des. acc. to DIN 24041	Rg 0.70 - 3.00
Horizontal spacing	3.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.24 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	31/08/2007 P-BA 219/2007
NRC	0.80
α_w	0.75 (LM)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



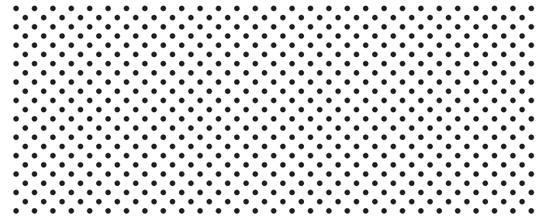
	Fural
	Rg 0.8 - 6 %
Perforation Ø	0.8 mm
Hole content	6 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rg 0.80 - 3.00
Horizontal spacing	3.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.24 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09/06/2017 M 105629/17
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



	Fural
	Rd 0.8 - 11 %
Perforation Ø	0.8 mm
Hole content	11 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rd 0.80 - 2.12
Horizontal spacing	3.00 mm →
Vertical spacing	1.50 mm ↓
Diagonal spacing	2.12 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09/06/2017 M 105629/18
NRC	0.75
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

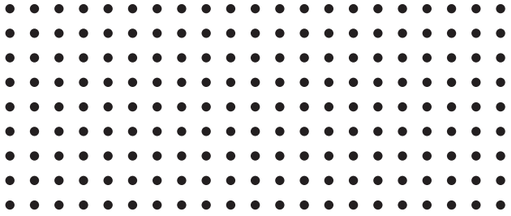


	Fural
	Rg 0.9 - 7 %
Perforation Ø	0.9 mm
Hole content	7 %
Max. perforation width	1,022 mm
Des. acc. to DIN 24041	Rg 0.90 - 3.00
Horizontal spacing	3.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.24 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30/09/2019 M 105629/44
NRC	0.75
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

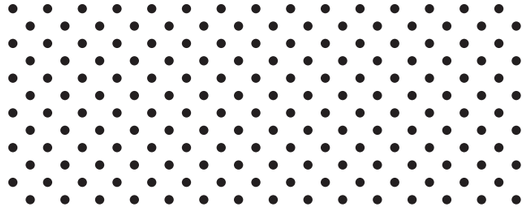


	Fural
	Rd 0.9 - 14 %
Perforation Ø	0.9 mm
Hole content	14 %
Max. perforation width	1,022 mm
Des. acc. to DIN 24041	Rd 0.90 - 2.12
Horizontal spacing	3.00 mm →
Vertical spacing	1.50 mm ↓
Diagonal spacing	2.12 mm ↘
Perforation direction	→
Overall structure	400 mm
Fleece	Bonded acoustic fleece
Test certificate	17/11/2012 7178-12-2
NRC	0.55
α_w	0.55 (LH)
Absorber class	D (DIN EN 11654)
Acoustic infill	w/o

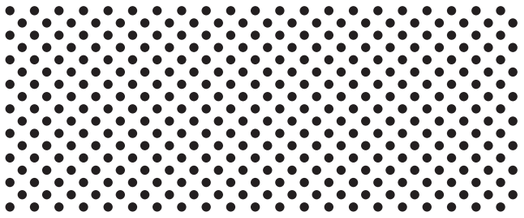
TESTED PERFORATIONS 2



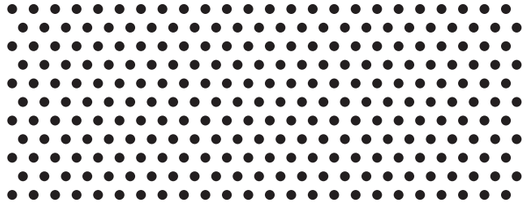
	Fural
	Rg 1.5 - 11 %
Perforation Ø	1.5 mm
Hole content	11 %
Max. perforation width	1,488 mm
Des. acc. to DIN 24041	Rg 1.50 - 4.00
Horizontal spacing	4.00 mm →
Vertical spacing	4.00 mm ↓
Diagonal spacing	5.65 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07/12/2010 M 61840/6
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



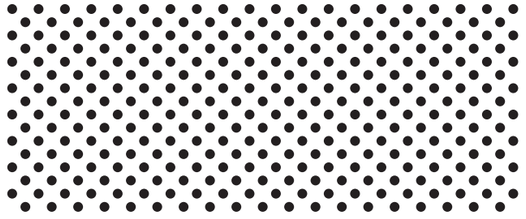
	Fural
	Rd 1.5 - 11 %
Perforation Ø	1.5 mm
Hole content	11 %
Max. perforation width	1,470 mm
Des. acc. to DIN 24041	Rd 1.50 - 4.00
Horizontal spacing	5.66 mm →
Vertical spacing	2.83 mm ↓
Diagonal spacing	4.00 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07/12/2010 M 61 840/6
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



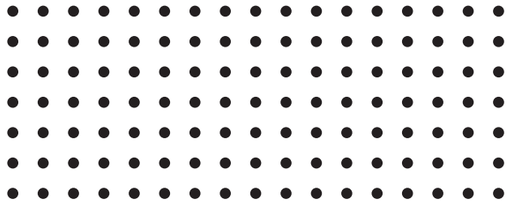
	Fural
	Rd 1.5 - 22 %
Perforation Ø	1.5 mm
Hole content	22 %
Max. perforation width	1,488 mm
Des. acc. to DIN 24041	Rd 1.50 - 2.83
Horizontal spacing	4.00 mm →
Vertical spacing	2.00 mm ↓
Diagonal spacing	2.83 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07/12/2010 M 61840/5
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



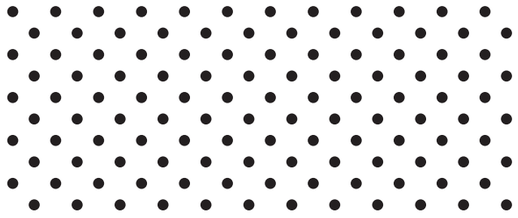
	Fural
	Rv 1.6 - 20 %
Perforation Ø	1.6 mm
Hole content	20 %
Max. perforation width	1,450 mm
Des. acc. to DIN 24041	Rv 1.60 - 3.50
Horizontal spacing	3.50 mm →
Vertical spacing	3.03 mm ↓
Offset spacing 60°	3.50 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	14/12/2006 P-BA 279/2006
NRC	0.74
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o



	Fural
	Rd 1.6 - 22 %
Perforation Ø	1.6 mm
Hole content	22 %
Max. perforation width	636.4 mm
Des. acc. to DIN 24041	Rd 1.60 - 3.00
Horizontal spacing	4.30 mm →
Vertical spacing	2.15 mm ↓
Diagonal spacing	3.00 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09/06/2017 M 105629/19
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

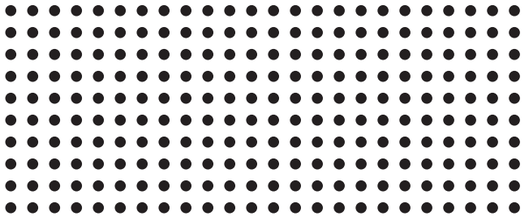


	Fural
	Rg 1.8 - 10 %
Perforation Ø	1.8 mm
Hole content	10 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rg 1.80 - 4.95
Horizontal spacing	4.95 mm →
Vertical spacing	4.95 mm ↓
Diagonal spacing	7.00 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07/12/2010 M 61840/4
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

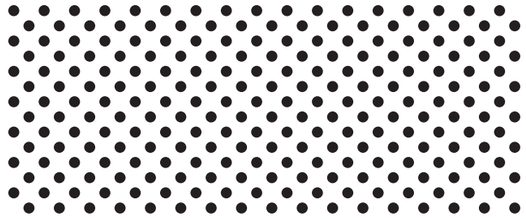


	Fural
	Rd 1.8 - 10 %
Perforation Ø	1.8 mm
Hole content	10 %
Max. perforation width	728 mm
Des. acc. to DIN 24041	Rd 1.80 - 4.95
Horizontal spacing	7.00 mm →
Vertical spacing	3.50 mm ↓
Diagonal spacing	4.95 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07/12/2010 M 61840/4
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

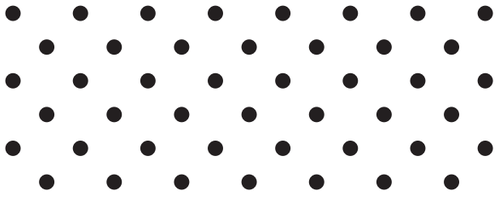
TESTED PERFORATIONS 3



	Fural
	Rg 1.8 - 20 %
Perforation Ø	1.8 mm
Hole content	20 %
Max. perforation width	632 mm
Des. acc. to DIN 24041	Rg 1.80 - 3.57
Horizontal spacing	3.57 mm →
Vertical spacing	3.57 mm ↓
Diagonal spacing	5.04 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 220/2007 Figure 2
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

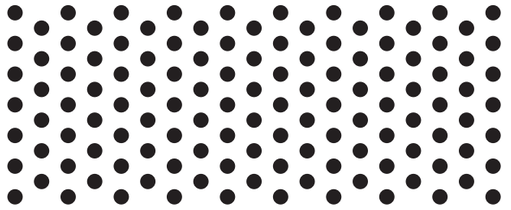


	Fural
	Rd 1.8 - 21 %
Perforation Ø	1.8 mm
Hole content	21 %
Max. perforation width	1,400 mm
Des. acc. to DIN 24041	Rd 1.80 - 3.50
Horizontal spacing	4.96 mm →
Vertical spacing	2.48 mm ↓
Diagonal spacing	3.50 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	31/08/2007 P-BA 220/2007 Figure 2
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

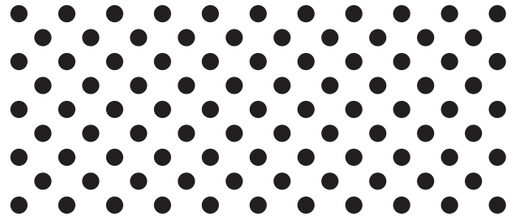


	Fural
	Rd 2.5 - 8 %
Perforation Ø	2.5 mm
Hole content	8 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rd 2.50 - 7.80
Horizontal spacing	11.0 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	14/12/2006 P-BA 279/2006 Figure 5
NRC	0.80
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

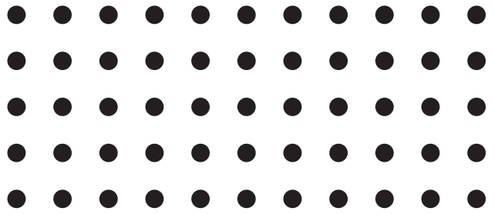
	Fural
	Rg 2.5 - 16 %
Perforation Ø	2.5 mm
Hole content	16 %
Max. perforation width	1,460 mm
Des. acc. to DIN 24041	Rg 2.50 - 5.50
Horizontal spacing	5.50 mm →
Vertical spacing	5.50 mm ↓
Diagonal spacing	7.78 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	14/12/2006 P-BA 279/2006 Figure 1
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o



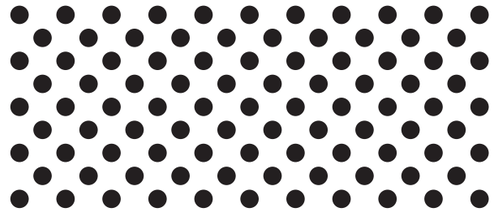
	Fural
	Rv 2.5 - 23 %
Perforation Ø	2.5 mm
Hole content	23 %
Max. perforation width	1,467 mm
Des. acc. to DIN 24041	Rv 2.50 - 5.00
Horizontal spacing	8.66 mm →
Vertical spacing	2.50 mm ↓
Offset spacing 60°	5.00 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	07/12/2010 M 61 840/7
NRC	0.75
α_w	0.75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



	Fural
	Rd 2.8 - 20 %
Perforation Ø	2.8 mm
Hole content	20 %
Max. perforation width	627.9 mm
Des. acc. to DIN 24041	Rd 2.80 - 5.50
Horizontal spacing	7.80 mm →
Vertical spacing	3.90 mm ↓
Diagonal spacing	5.50 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09/06/2017 M 105629/20
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



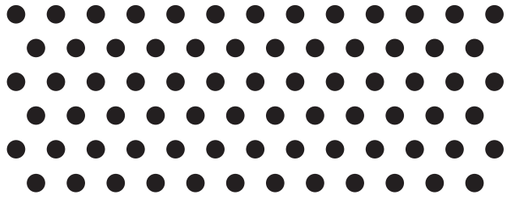
	Fural
	Rg 3.0 - 12 %
Perforation Ø	3.0 mm
Hole content	12 %
Max. perforation width	877.5 mm
Des. acc. to DIN 24041	Rg 3.00 - 7.50
Horizontal spacing	7.50 mm →
Vertical spacing	7.50 mm ↓
Diagonal spacing	10.6 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30/09/2019 M 105629/43
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



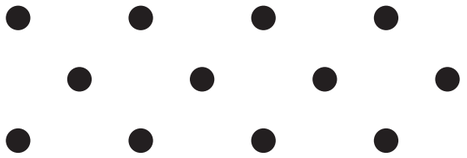
	Fural
	Rd 3.0 - 24 %
Perforation Ø	3.0 mm
Hole content	24 %
Max. perforation width	877.5 mm
Des. acc. to DIN 24041	Rd 3.00 - 5.30
Horizontal spacing	7.50 mm →
Vertical spacing	3.75 mm ↓
Diagonal spacing	5.30 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30/09/2019 M 105629/45
NRC	0.70
α_w	0.70
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

TESTED PERFORATIONS 4

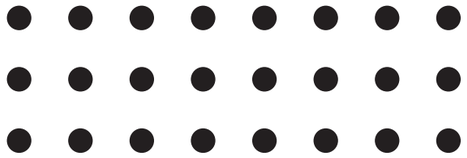
	Fural
	Rg 3.0 - 20 %
Perforation Ø	3.0 mm
Hole content	20 %
Max. perforation width	1,434 mm
Des. acc. to DIN 24041	Rg 3.00 - 6.00
Horizontal spacing	6.0 mm →
Vertical spacing	6.0 mm ↓
Diagonal spacing	8.48 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 221/2007 Figure 2
NRC	0.80
α_w	0.75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



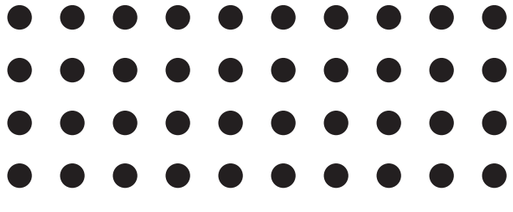
	Fural
	Rv 3.0 - 20 %
Perforation Ø	3.0 mm
Hole content	20 %
Max. perforation width	1,402 mm
Des. acc. to DIN 24041	Rv 3.00 – 6.35
Horizontal spacing	6.35 mm →
Vertical spacing	5.50 mm ↓
Offset spacing 60°	6.35 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 221/2007 Figure 2
NRC	0.80
α_w	0.75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



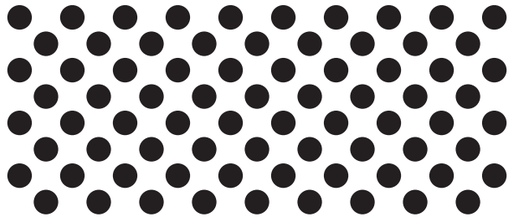
	Fural
	Rd 4.0 - 6 %
Perforation Ø	4.0 mm
Hole content	6 %
Max. perforation width	680 mm
Des. acc. to DIN 24041	Rd 4.00 - 14.14
Horizontal spacing	20.00 mm →
Vertical spacing	10.00 mm ↓
Diagonal spacing	14.14 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30/09/2019 M 105629/46
NRC	0.65
α_w	0.65
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



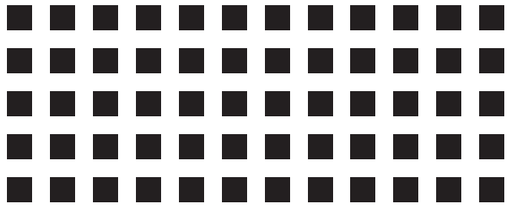
	Fural
	Rg 4.0 - 12 %
Perforation Ø	4.0 mm
Hole content	12 %
Max. perforation width	680 mm
Des. acc. to DIN 24041	Rg 4.00 - 10.00
Horizontal spacing	10.00 mm →
Vertical spacing	10.00 mm ↓
Diagonal spacing	14.14 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	30/09/2019 M 105629/48
NRC	0.75
α_w	0.75
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o



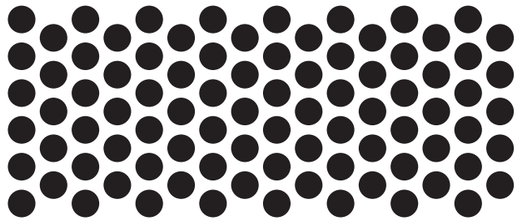
	Fural
	Rg 4.0 - 17 %
Perforation Ø	4.0 mm
Hole content	17 %
Max. perforation width	1,453 mm
Des. acc. to DIN 24041	Rg 4.00 - 8.60
Horizontal spacing	8.60 mm →
Vertical spacing	8.60 mm ↓
Diagonal spacing	12.1 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 7
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o



	Fural
	Rd 4.0 - 33 %
Perforation Ø	4.0 mm
Hole content	33 %
Max. perforation width	1,450 mm
Des. acc. to DIN 24041	Rd 4.00 - 6.10
Horizontal spacing	8.60 mm →
Vertical spacing	4.30 mm ↓
Diagonal spacing	6.10 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 3
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o

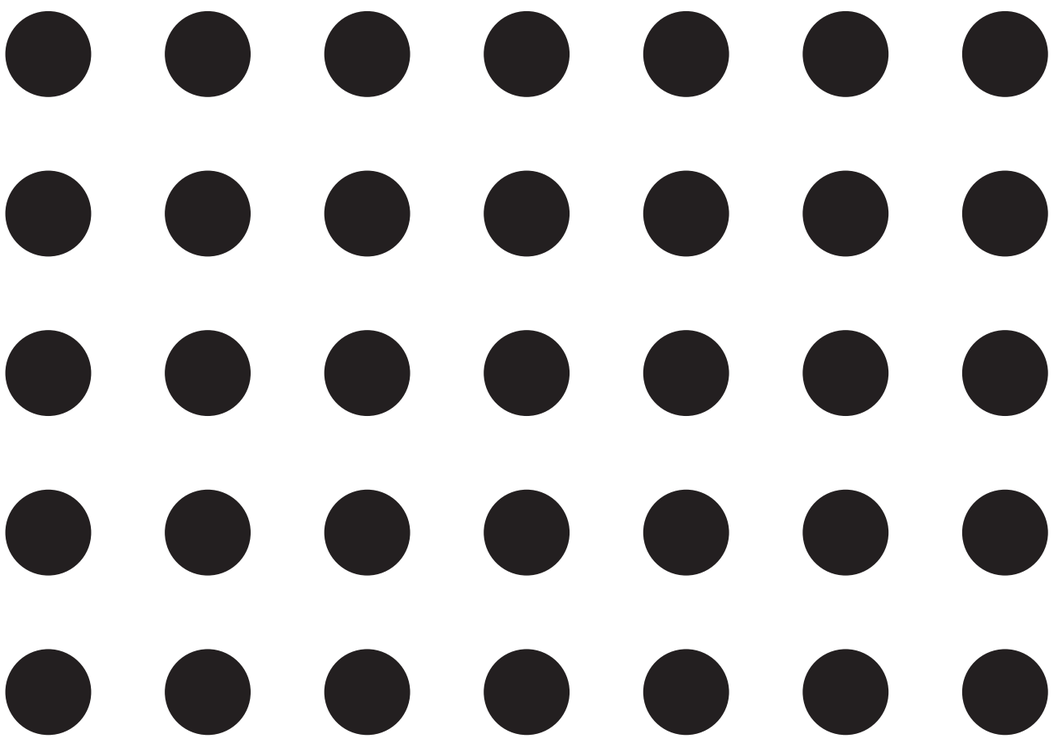


	Fural
	Qg 4.0 - 33 %
Perforation	4.0 mm
Hole content	33 %
Max. perforation width	630 mm
Des. acc. to DIN 24041	Qg 4.00 - 7.00
Horizontal spacing	7.00 mm →
Vertical spacing	7.00 mm ↓
Diagonal spacing	9.89 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 4
NRC	0.80
α_w	0.80
Absorber class	B (DIN EN 11654)
Acoustic infill	w/o



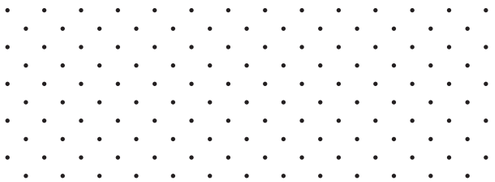
	Fural
	Rv 4.5 - 51 %
Perforation Ø	4.5 mm
Hole content	51 %
Max. perforation width	627 mm
Des. acc. to DIN 24041	Rv 4.50 - 6.00
Horizontal spacing	10.4 mm →
Vertical spacing	3.00 mm ↓
Offset spacing 60°	6.00 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	09/06/2017 M 105629/21
NRC	0.65
α_w	0.65 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

TESTED PERFORATIONS 5

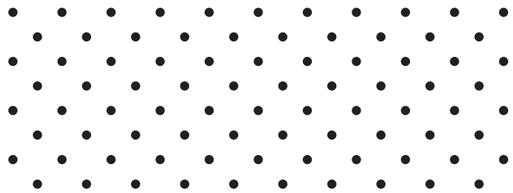


	Fural
	Rg 14.0 - 23 %
Perforation Ø	14.0 mm
Hole content	23 %
Max. perforation width	598 mm
Des. acc. to DIN 24041	Rg 14.00 - 26.00
Horizontal spacing	26.00 mm →
Vertical spacing	26.00 mm ↓
Diagonal spacing	36.76 mm ↘
Perforation direction	→
Overall structure	200 mm
Fleece	Bonded acoustic fleece
Test certificate	P-BA 279/2006 Figure 8
NRC	0.75
α_w	0.75 (L)
Absorber class	C (DIN EN 11654)
Acoustic infill	w/o

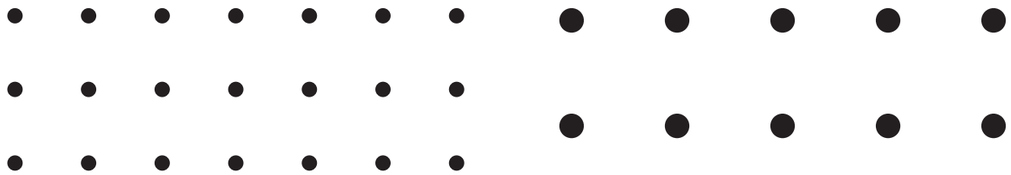
UNTESTED PERFORATIONS



	Fural
	Rd 0.7 - 2 %
Perforation Ø	0.7 mm
Hole content	2 %
Max. perforation width	1,140 mm
Des. acc. to DIN 24041	Rd 0.70 - 6.00
Horizontal spacing	6.00 mm →
Vertical spacing	3.00 mm ↓
Diagonal spacing	4.24 mm ↘
Perforation direction	→



	Fural
	Rd 1.5 - 6 %
Perforation Ø	1.5 mm
Hole content	6 %
Max. perforation width	1,486 mm
Des. acc. to DIN 24041	Rd 1.50 - 8.00
Horizontal spacing	8.00 mm →
Vertical spacing	4.00 mm ↓
Diagonal spacing	5.65 mm ↘
Perforation direction	→

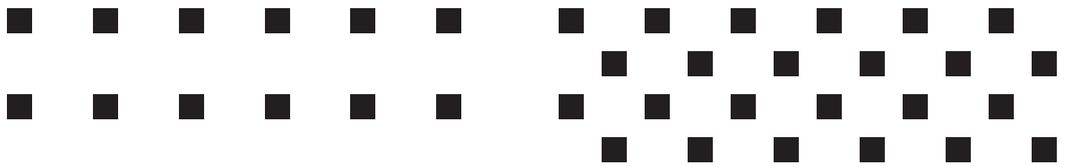


	Fural
	Rg 2.5 - 4 %
Perforation Ø	2.5 mm
Hole content	4 %
Max. perforation width	1,430 mm
Des. acc. to DIN 24041	Rg 2.50 - 12.00
Horizontal spacing	12.00 mm →
Vertical spacing	12.00 mm ↓
Diagonal spacing	16.97 mm ↘
Perforation direction	→

	Fural
	Rg 4.0 - 4 %
Perforation Ø	4.0 mm
Hole content	4 %
Max. perforation width	606 mm
Des. acc. to DIN 24041	Rg 4.00 - 17.20
Horizontal spacing	17.20 mm →
Vertical spacing	17.20 mm ↓
Diagonal spacing	24.32 mm ↘
Perforation direction	→

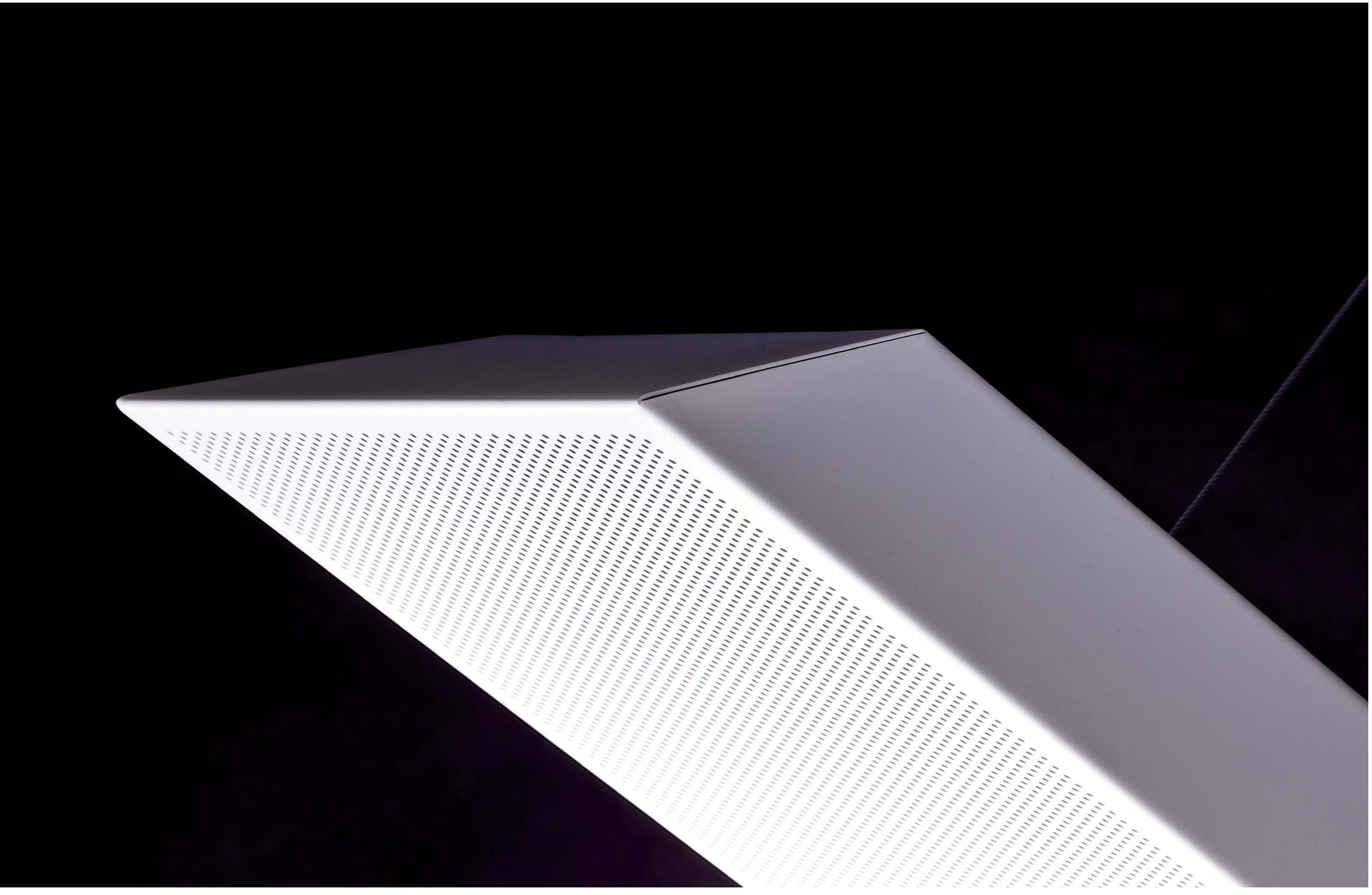
	Fural
	Rg 1.8 - 2 %
Perforation Ø	1.8 mm
Hole content	2 %
Max. perforation width	1,413 mm
Des. acc. to DIN 24041	Rg 1.80 - 9.90
Horizontal spacing	9.90 mm →
Vertical spacing	9.90 mm ↓
Diagonal spacing	14.0 mm ↘
Perforation direction	→

	Fural
	Rd 1.8 - 5 %
Perforation Ø	1.8 mm
Hole content	5 %
Max. perforation width	1,413 mm
Des. acc. to DIN 24041	Rd 1.80 - 7.00
Horizontal spacing	9.90 mm →
Vertical spacing	4.95 mm ↓
Diagonal spacing	7.00 mm ↘
Perforation direction	→



	Fural
	Qg 4.0 - 8 %
Perforation edge	4.0 mm
Hole content	8 %
Max. perforation width	630 mm
Des. acc. to DIN 24041	Qg 4.00 - 14.00
Horizontal spacing	14.00 mm →
Vertical spacing	14.00 mm ↓
Diagonal spacing	19.79 mm ↘
Perforation direction	→

	Fural
	Qd 4.0 - 17 %
Perforation edge	4.0 mm
Hole content	17 %
Max. perforation width	630 mm
Des. acc. to DIN 24041	Qd 4.00 - 7.00
Horizontal spacing	14.00 mm →
Vertical spacing	7.00 mm ↓
Diagonal spacing	9.89 mm ↘
Perforation direction	→



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