MORE FROM WOOD.

EGGER

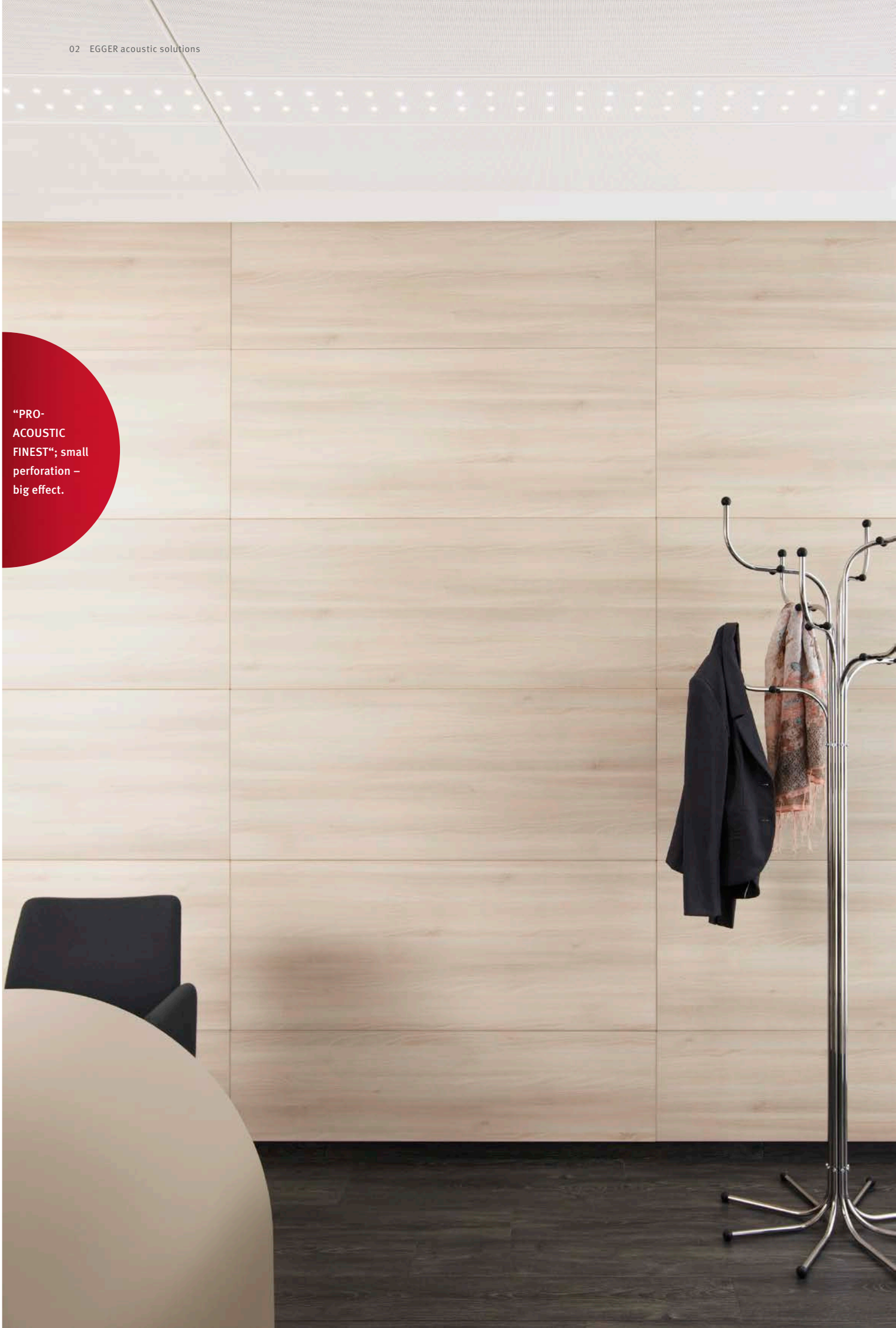
EGGER ACOUSTIC SOLUTIONS

Planning and design for straightforward room acoustics

ZOOM®
THE EVERYDAY RESOURCE

2012 – 2016

akustik+



“PRO-ACOUSTIC FINEST“; small perforation – big effect.

A WIDE RANGE OF APPLICATIONS FOR EGGER WOOD-BASED MATERIALS

Planners and architects are increasingly facing the challenge of creating SOLUTIONS FOR GOOD ACOUSTICS. When planning a room they have to bring together the need for good hearing whilst considering the demand for quiet and concentration. But in many cases, structural, physical and other design trends in modern architecture stand in the way of implementing suitable room acoustics.

SOPHISTICATED ACOUSTICS PLANNING can help improve wellbeing in today's living, learning and working environments. This applies in particular to rooms used intensively for communication, such as conference and seminar facilities, call centres, reception rooms and open-plan offices.

Absorbers made of wood-based materials are well suited for optimum acoustics thanks to their varied processing and upgrading options.

In high-stress areas in particular, wood-based material absorbers demonstrate their full advantage of mechanical robustness with simultaneous design freedom.

As a full-range supplier of wood-based materials, EGGER offers comprehensive acoustic solutions that combine FUNCTIONAL SOUND ABSORPTION with TREND-CONFORMING DESIGN. Acoustically effective products made by EGGER are mainly used in four areas of application:

- Wall cladding and partition walls
- Ceilings or ceiling systems
- Furniture components
- Subsequent installations

EGGER sees itself as your experienced partner in furniture and interior design and this is why we are happy to support you in the field of acoustics.

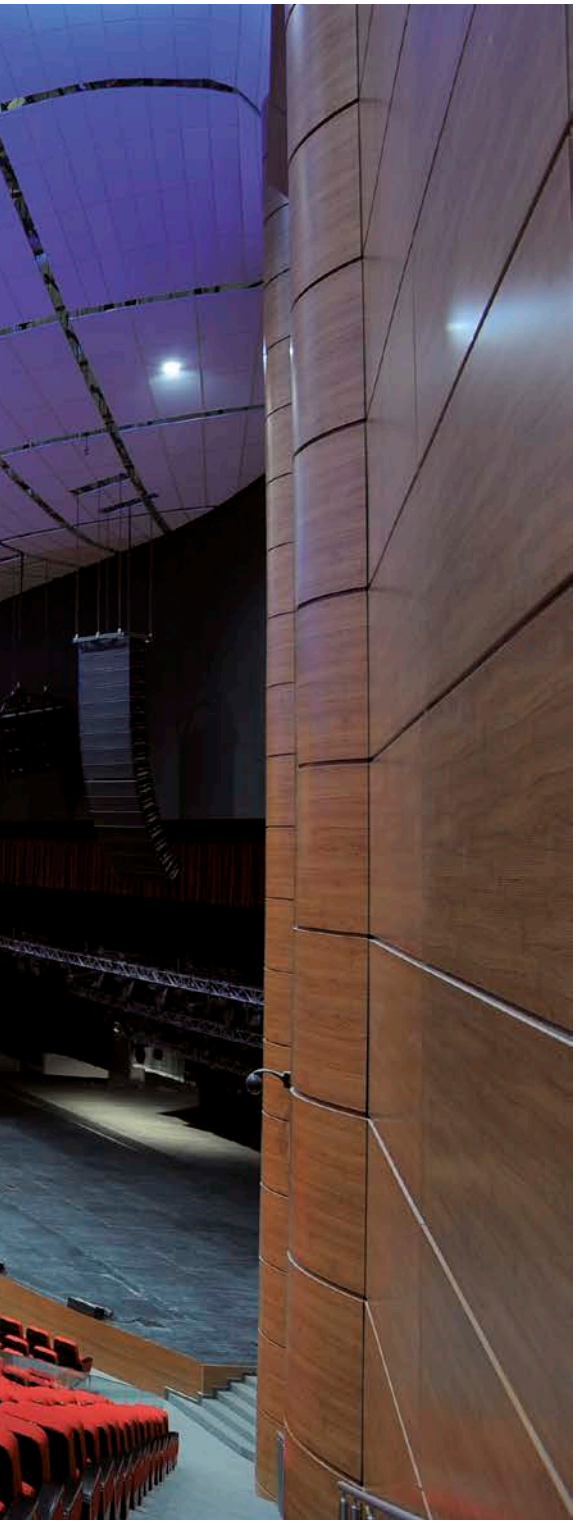
A COMPREHENSIVE ACOUSTICS ABC in section 8 of this brochure provides you with technical information on the topic of acoustics. It was compiled by physicists Dr. Catja Hilge and Dr. Christian Nocke from Akustikbüro Oldenburg.

Biomedical Centre (BMZ) of the University Hospital in Bonn. Straight and curved **ProAcoustic Classic** elements were used as wall and ceiling cladding at BMZ. The maple surface with barely noticeable microperforations meets the design standards as well as the requirements for perfect room acoustics.

CONTENTS

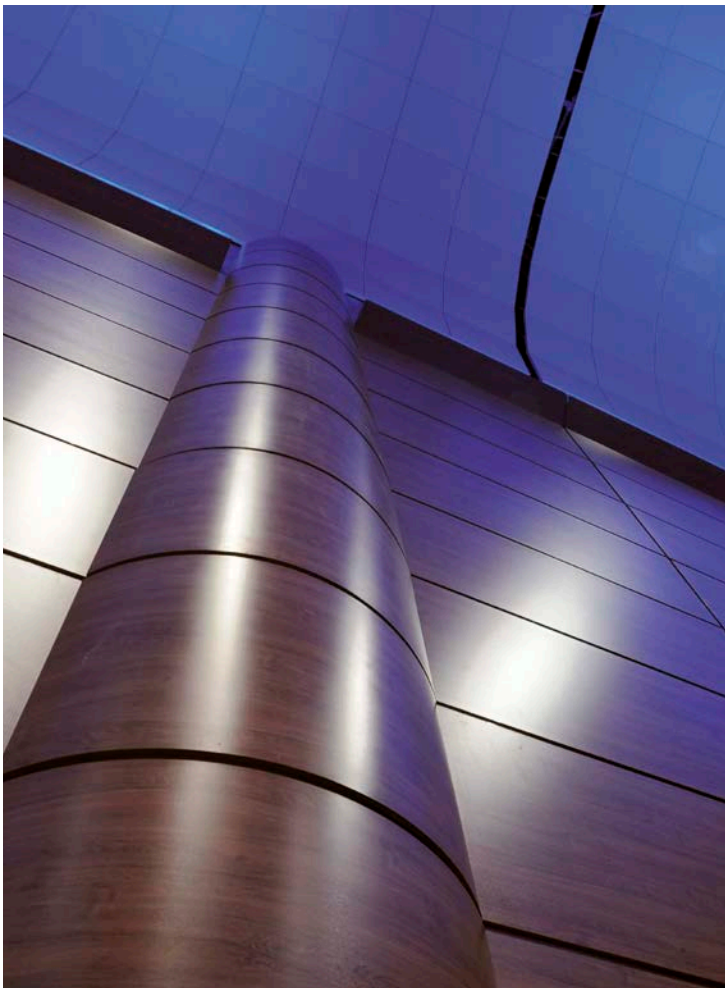
1 PLANNING AND DESIGN FOR STRAIGHTFORWARD ROOM ACOUSTICS

In the concert hall at Crocus City Hall in Moscow, Russia, more than 3.000 m² **ProAcoustic EURODEKOR®** elements in the low-flammability Flammex quality were installed – in the H3016 ST24 Jakarta Teak. Thanks to the **8/8/2.0 perforation,** the requirements for perfect room acoustics were met along with the visual design demands.



In perhaps no other case are the **STANDARDS FOR ACOUSTICS AS HIGH** as in a concert hall, where an extraordinary sound experience has to take centre stage. In public buildings, the focus is also on fire protection. ProAcoustic boards **HARMONISE** room acoustics with structural engineering requirements and an appealing design.

LOW-FLAMMABILITY AND FIRE-RESISTANT ACOUSTIC BOARDS can also be produced with Euroclass B coreboards or with Euroclass A2 coreboards.

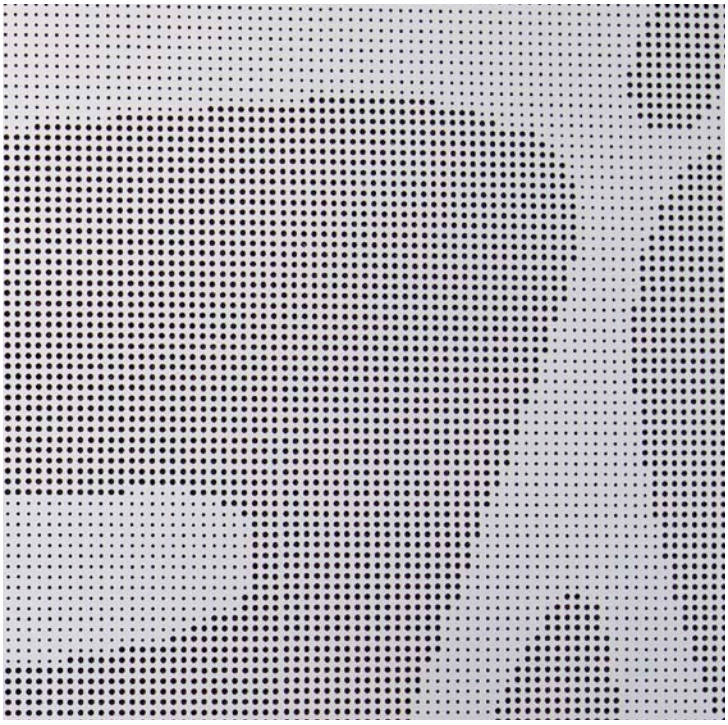


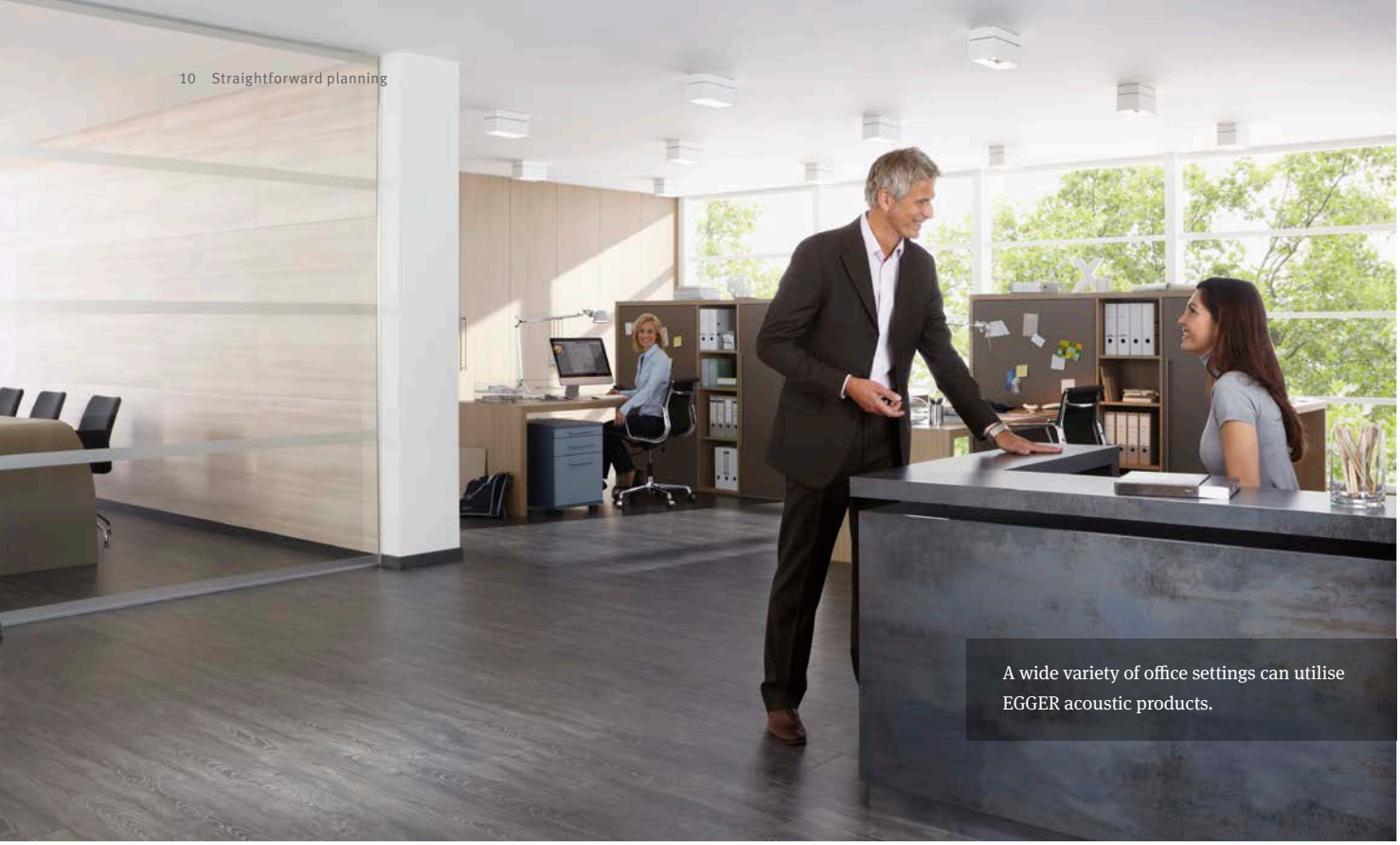
UNIQUE ACOUSTICS SOLUTIONS

120 m² of wall panelling made of **ProAcoustic EURODEKOR®** with an individual peroration pattern in the W980 ST2 Platinum White decor was installed in the BROCKENHAUS IN HANAU, Germany.

Individual design combined with acoustic effectiveness is one of our new strengths. You choose the design and bring your ideas to life with custom perforations. Linear or diagonal grids, small or large bores, with or without a frame, freely designed hole patterns all the way to your company logo – we can easily implement your ideas.

Individual perforations can be realised on the basis of your digital data in the form of CAD or image files.





A wide variety of office settings can utilise EGGER acoustic products.

Questions? Give us a call!
We offer custom, made-to-order, individually prefabricated acoustic elements and furniture components. We are happy to help.
akustik plus GmbH & Co. KG
T +49 6053 6 19 91 - 0

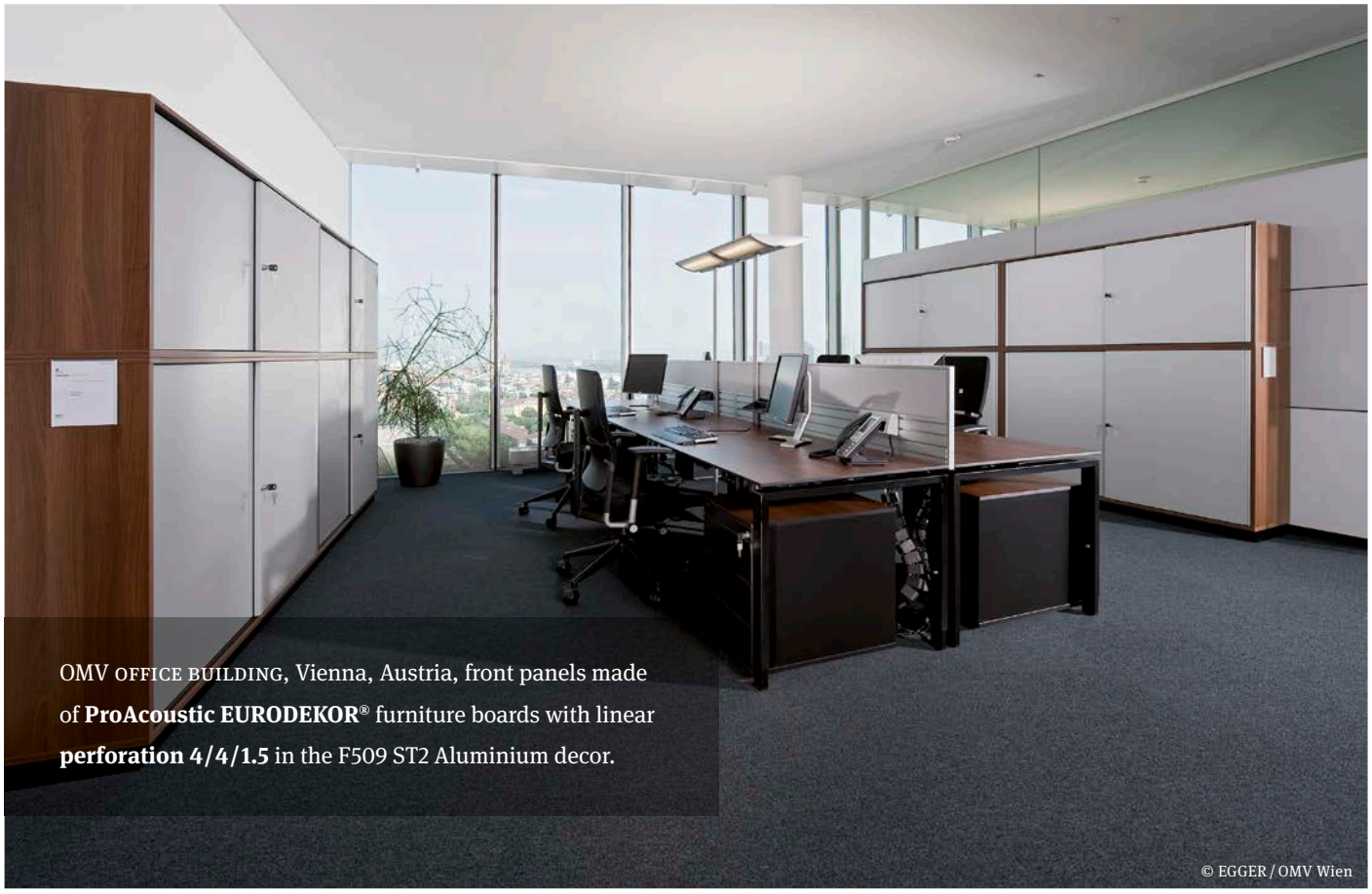
© EGGER / OMV Wien

COMBINING FUNCTIONALITY AND DESIGN

An architect can be challenged creatively where room acoustics are concerned, they will often conflict with the structural or physical demands of the building. For example, when a room is defined by a large glass façade or thermally active components such as a concrete ceiling, plans should incorporate sufficient sound-absorbing surfaces to compensate.

This increases the importance of acoustically effective surfaces in furniture construction. In decor and material combinations, ACOUSTICALLY EFFECTIVE FRONT OR REAR PANELS can be executed in matching colours. For example, it is possible to replace existing sound reflecting hinged doors with acoustically effective doors with relatively little effort.

Select A5 ACOUSTIC PRODUCT SAMPLES are available around the clock from our samples shop: www.egger.com/shop



OMV OFFICE BUILDING, Vienna, Austria, front panels made of **ProAcoustic EURODEKOR®** furniture boards with linear **perforation 4/4/1.5** in the F509 ST2 Aluminium decor.

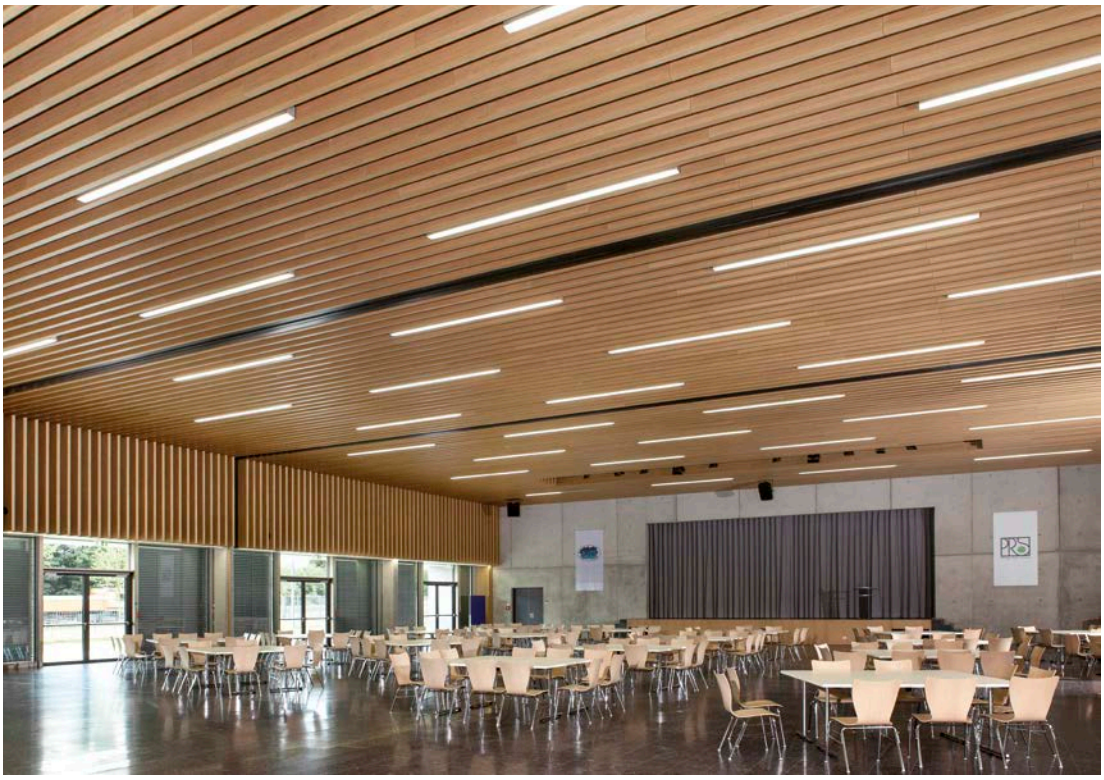
© EGGER / OMV Wien

For the Philipp-Reis School in Friedrichsdorf, Germany, over 1,000 m² of **ProAcoustic Linear Deluxe 16/2.0** wall panelling was veneered with genuine oak and **ProAcoustic Linear Deluxe 16/2.0** processed in the H1334 ST9 Ferrara Oak Natural decor. 135 individually fabricated ceiling elements with an acoustically effective area of 2,700 m² were installed in the assembly hall.

GOOD ACOUSTICS SET STANDARDS

Good room acoustics are essential for the learning environments of teachers and students. A high noise level is stressful, the speaker has to talk louder and the listeners have a harder time concentrating. This is why VISIONARY ACOUSTICS PLANNING is required for good speaking and listening comfort, especially in schools and universities. Next to ceiling solutions, EGGER also offers acoustically effective WALL PANELLING AND FURNITURE COMPONENTS in decor and material combinations.

USE THE FULL PRODUCT RANGE for your projects! You have access to the comprehensive programme of the EGGER ZOOM® collection for the selection of decors. Coatings in RAL colours or according to NCS values as well as genuine wood veneers round out the selection.



2 PLANNING EXAMPLES

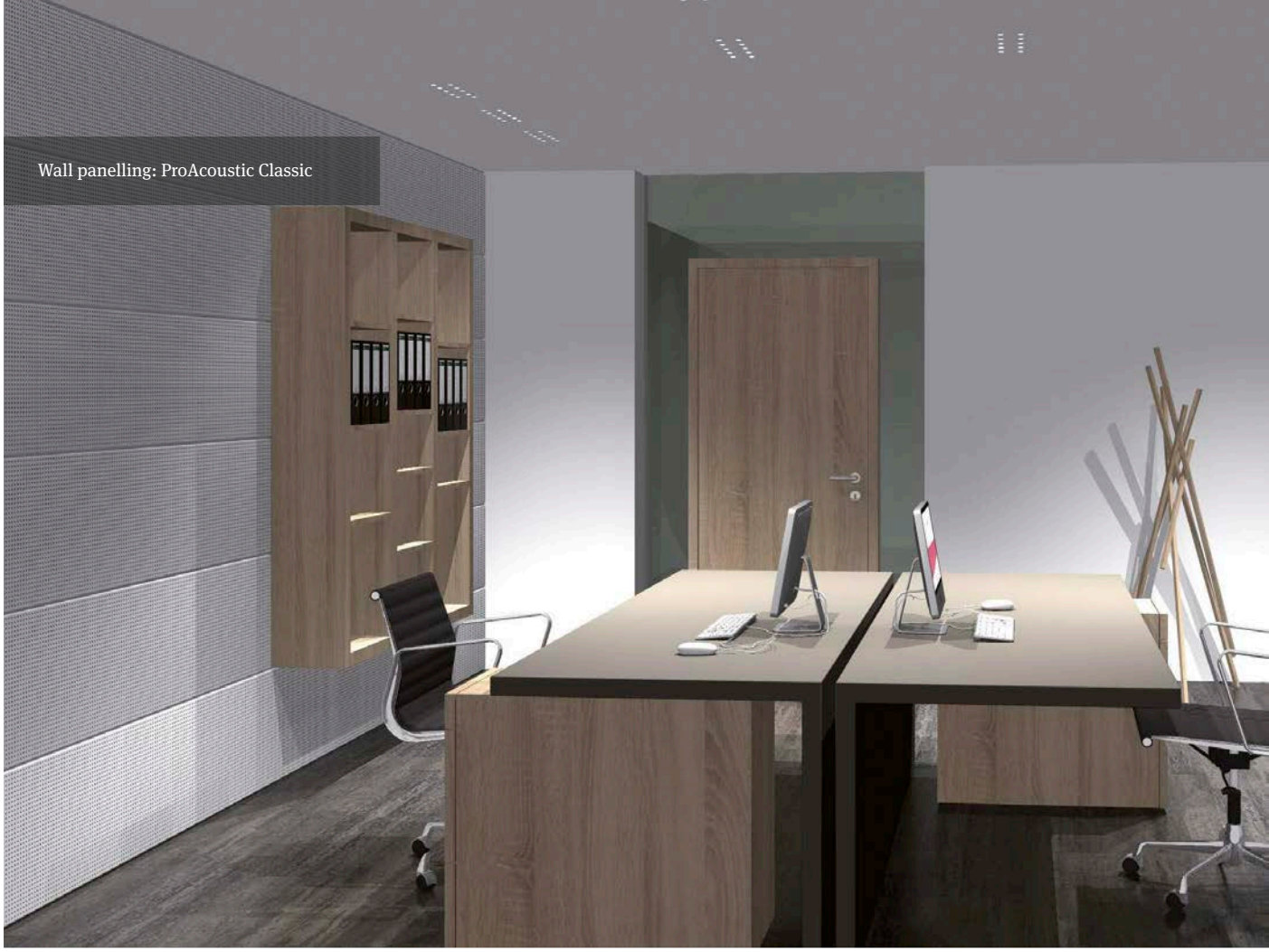
Planning, measuring, designing and implementing

The work of architects can largely be based on the required acoustic performance of the rooms they are working with. THE PURPOSE OF THE ROOM will be determined by aspects of daily life e.g. the course of meetings, performance at work stations, the ability of students to learn in the classroom and the comprehension of speech in auditoriums.

The requirements for PLANNING the acoustics of a room are defined in the DIN 18041 standard where reverberation time plays an important role. Since the reverberation time can be measured objectively, rooms can be compared and evaluated based on the quality of their acoustics.

The REVERBERATION TIME mainly depends on three factors: the volume of the room, the surfaces, and the furnishings present in the room.

The DIN 18041 standard differentiates between three categories with regards to the optimum reverberation time, these being music, speech and education. Planning therefore takes the three factors mentioned above into account along with the use of the room. For further details, please consult the ABC's of acoustics found in section 8 of this brochure. The interplay between PLANNING, MEASURING, DESIGNING AND IMPLEMENTING is illustrated by the following three planning examples for the office, conference room and restaurant.



Wall panelling: ProAcoustic Classic

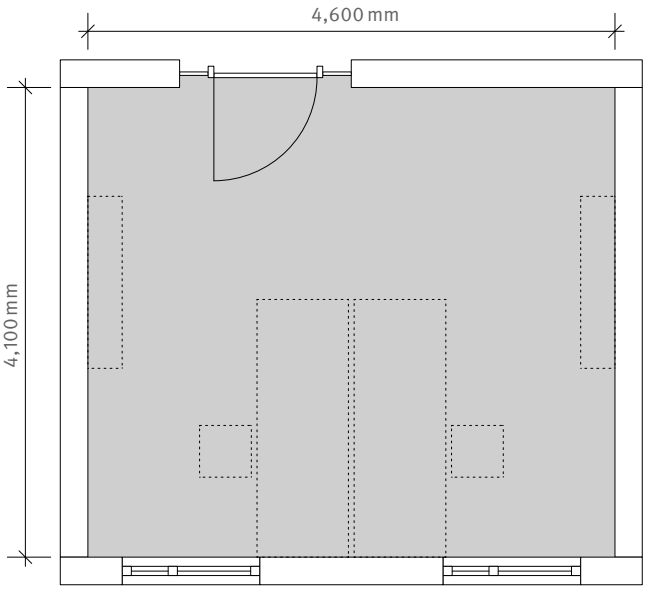
2.1 OFFICE

Planning and measuring

According to the DIN 18041 standard, rooms used intensively for communication such as meeting rooms, conference rooms or rooms for several persons should be treated according to the “education” category. For the purpose of planning room acoustics, the acoustician requires a layout of the room as well as information about the type of use, the surfaces that delimit the room (windows, doors, air-handling ceilings etc.), furnishings and the average number of persons in the room. In this example, we are planning a DOUBLE OFFICE with dimensions of 4.6 × 4.1 m and a height of 2.6 m.

The room volume is 49m³ and the reverberation time requirement according to the DIN 18041 standard is 0.4 seconds. Without acoustic measures, the reverberation time in this double office would be 1.5 seconds which would limit the ability to concentrate on work. This means the architect and acoustician should consult at this planning stage, since the required acoustics calculations by the acoustician require the definition of products by the architect. Based on the “room data”, the acoustician calculates the required absorber surface area based on the sound absorption values of the desired acoustic products and makes recommendations for their positioning.

In this example, the required reverberation time of 0.4 seconds was achieved by installing 20 m² of ProAcoustic Classic in the form of wall panelling. ProAcoustic Classic has a linear perforation in a 3 mm grid with a hole diameter of 1mm, i.e. this microperforation product has 111,111 holes per square metre.

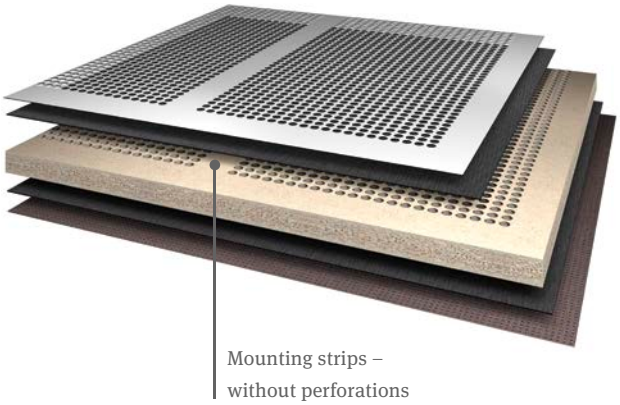


Double office layout

The installation of 20 m² ProAcoustic Classic reduces the reverberation time from 1.5 seconds to 0.4 seconds as required by the DIN 18041 standard.

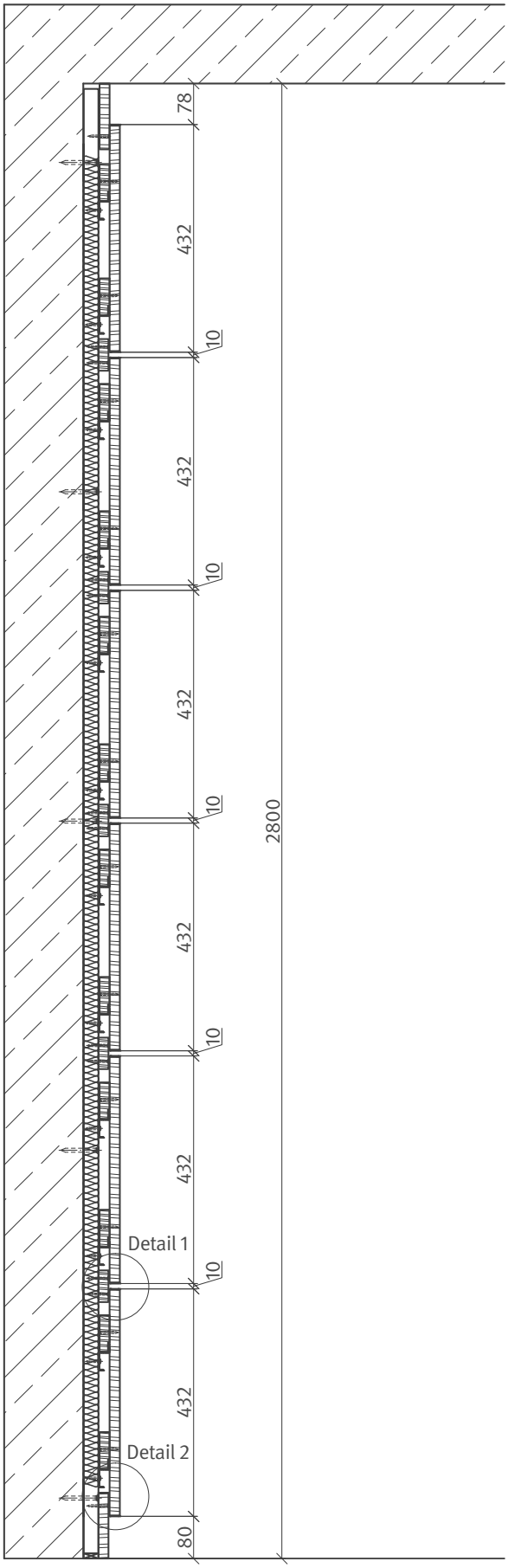
Design and implementation

Mounting strips integrated into the board structure, which are clearly visible on the reverse side of the board (see illustration) and facilitate straightforward processing by the fabricator are helpful for wall installation.

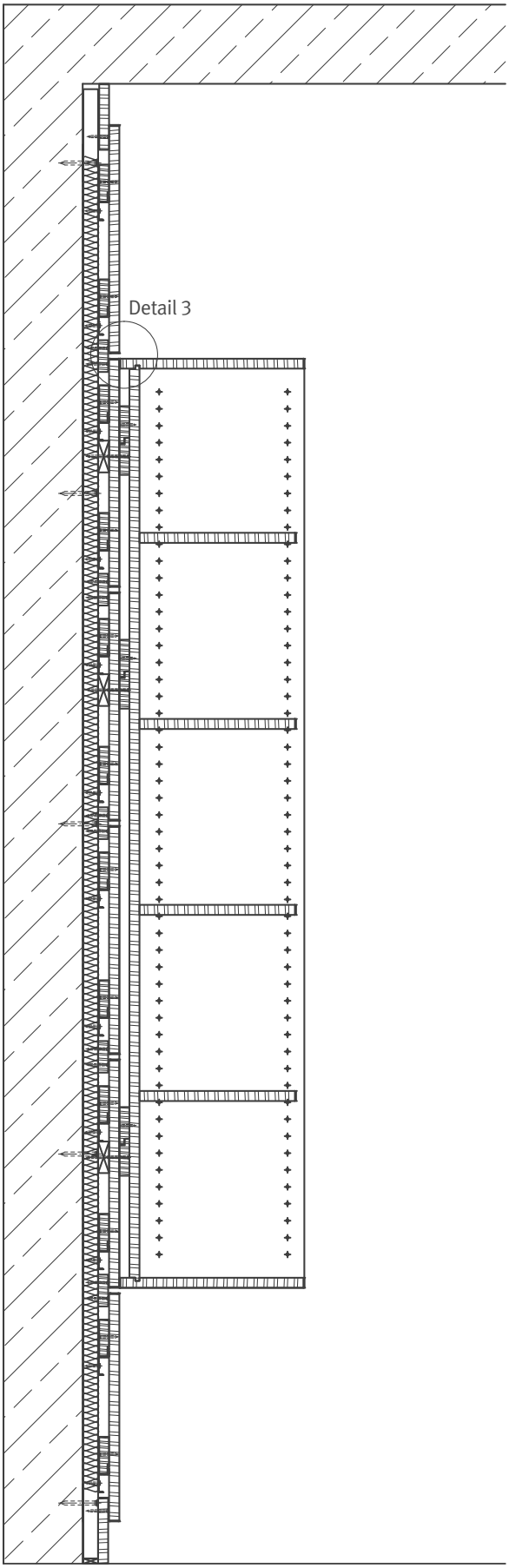


The wall panelling was mounted on the wall with a spacing of 50 mm using a metal Z-rail in combination with wooden suspension rails. 30 mm of mineral wool was installed in the 50 mm space. The ProAcoustic Classic boards available in the format of 2,800 × 1,310 mm, were cut to a width of 432 mm for this project. EGGER ABS security edging with the matching decor was subsequently installed. Please consult the DRAWINGS that follow for the design details.

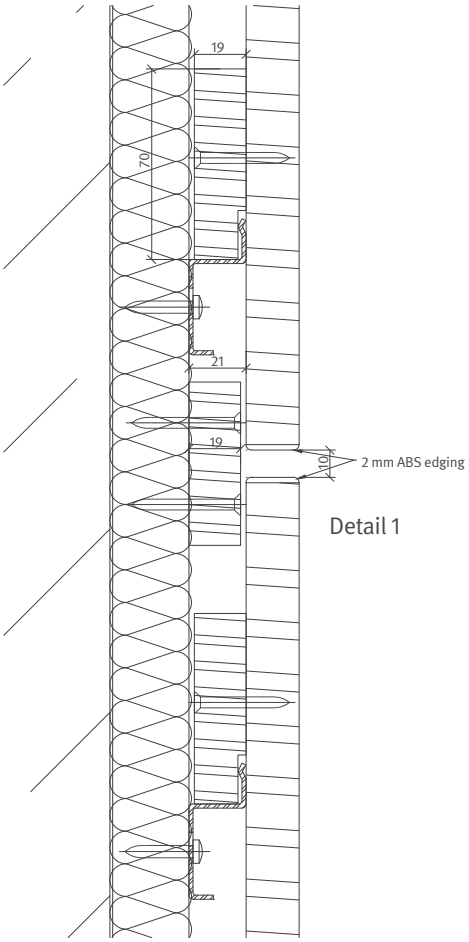
Cross section of wall panelling



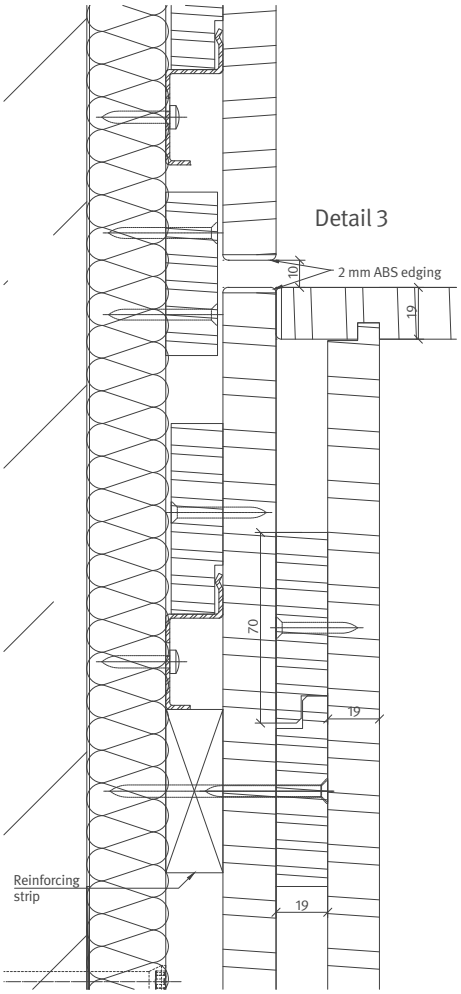
Cross section of wall panelling with cabinet



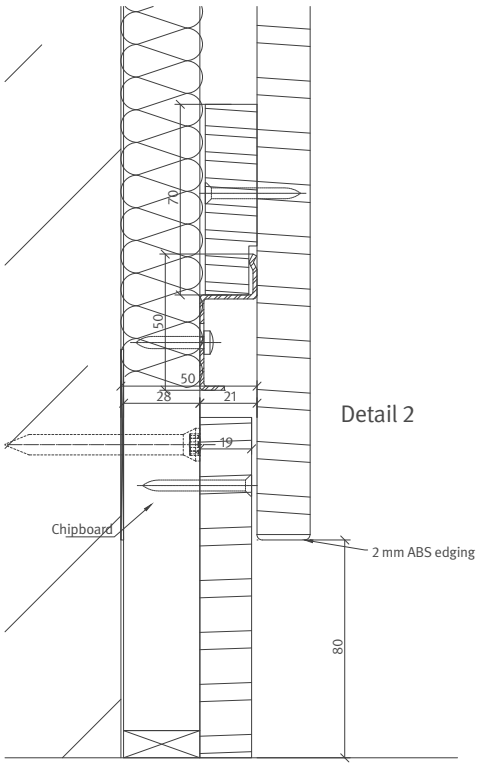
Details



Detail 1



Detail 3



Detail 2

Wall and ceiling panelling:
ProAcoustic Finest

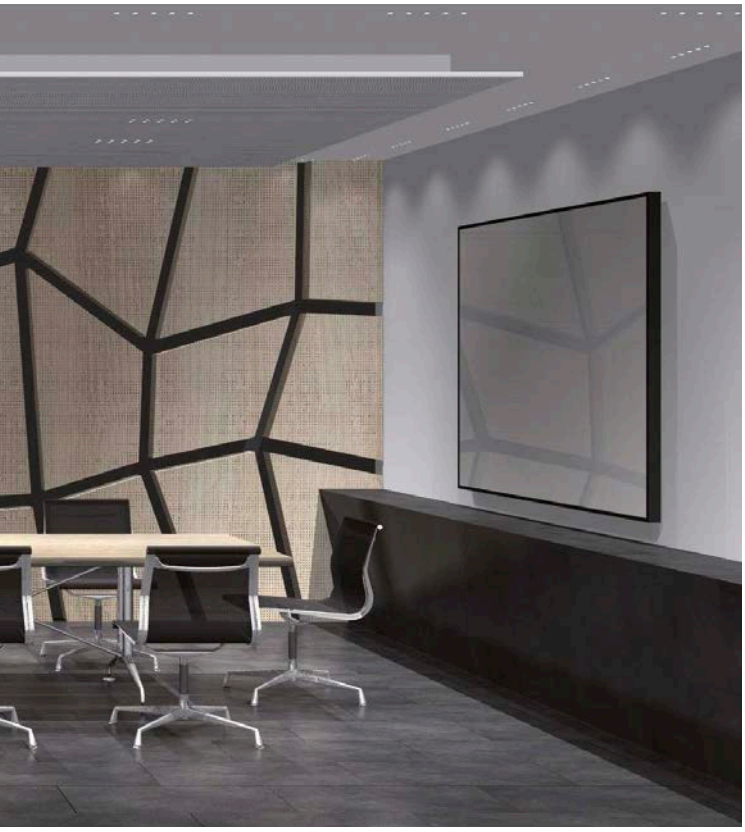
2.2 CONFERENCE ROOM

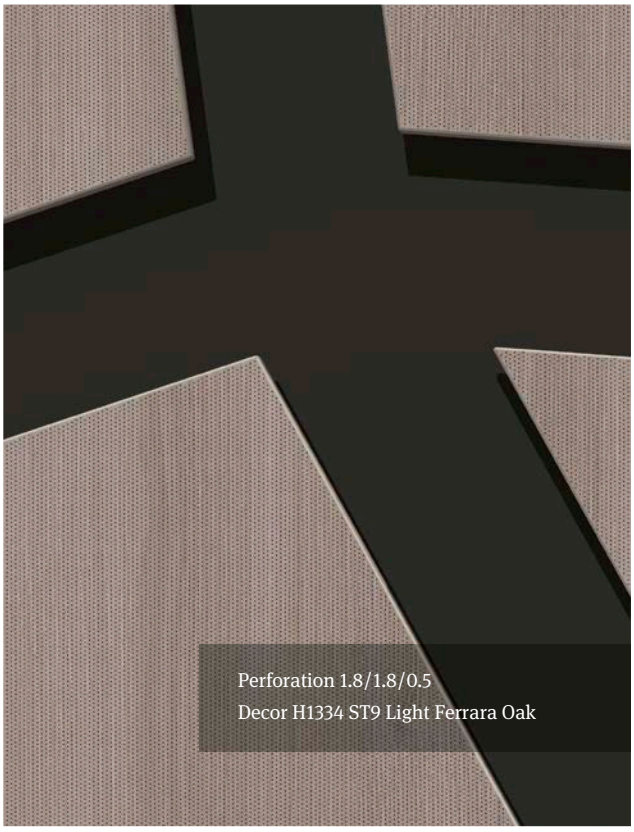
Planning and measuring

In this example, we are planning a conference room with dimensions of 7.8 × 5.2 m and a height of 2.8 m. The room volume is around 114 m³ and the reverberation time requirement according to the DIN 18041 standard is 0.5 seconds. Without acoustic products, the reverberation time in this room would be 1.2 seconds so that meetings in the conference room would be far more strenuous for all participants over the long term.

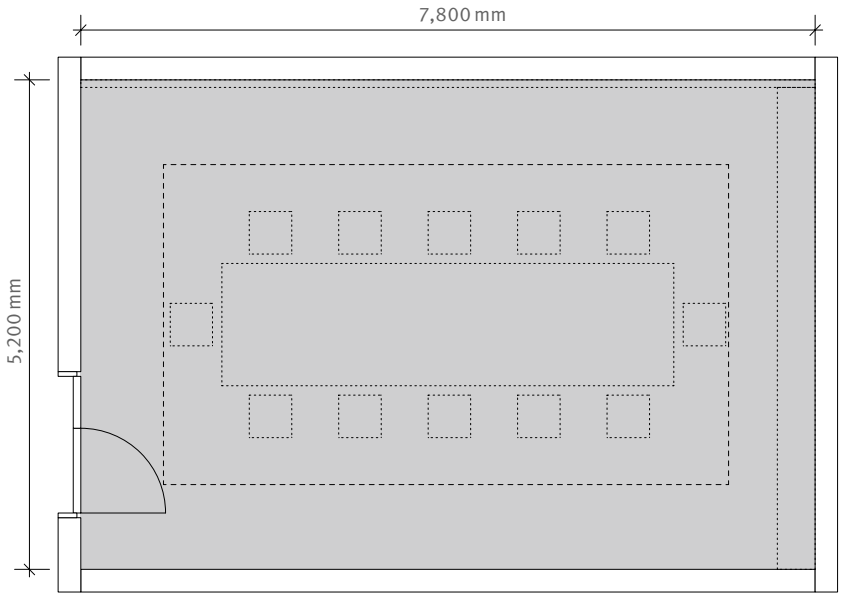
The architect chose the ProAcoustic Finest product in this case, and the surfaces that delimit the room allow sufficient leeway for positioning by the acoustician. The unnoticaeble Finest perforation in a diagonal grid of 1.8/1.8/0.5 with over 300,000 holes per square metre permits such abstract solutions without visual restrictions.

The installation of 20 m² of wall panelling in an abstract design as well as a suspended ceiling, also with an area of 20 m², resulted in the desired reverberation time of 0.5 seconds. A friendly room atmosphere is created thanks to the trendy H1334 ST9 Light Ferrara Oak. Thanks to EGGER matching colours, it was possible to execute the conference table and interior door in a matching decor. The suspended ceiling on the other hand is implemented in W980 ST15 Platinum White.





Perforation 1.8/1.8/0.5
Decor H1334 ST9 Light Ferrara Oak



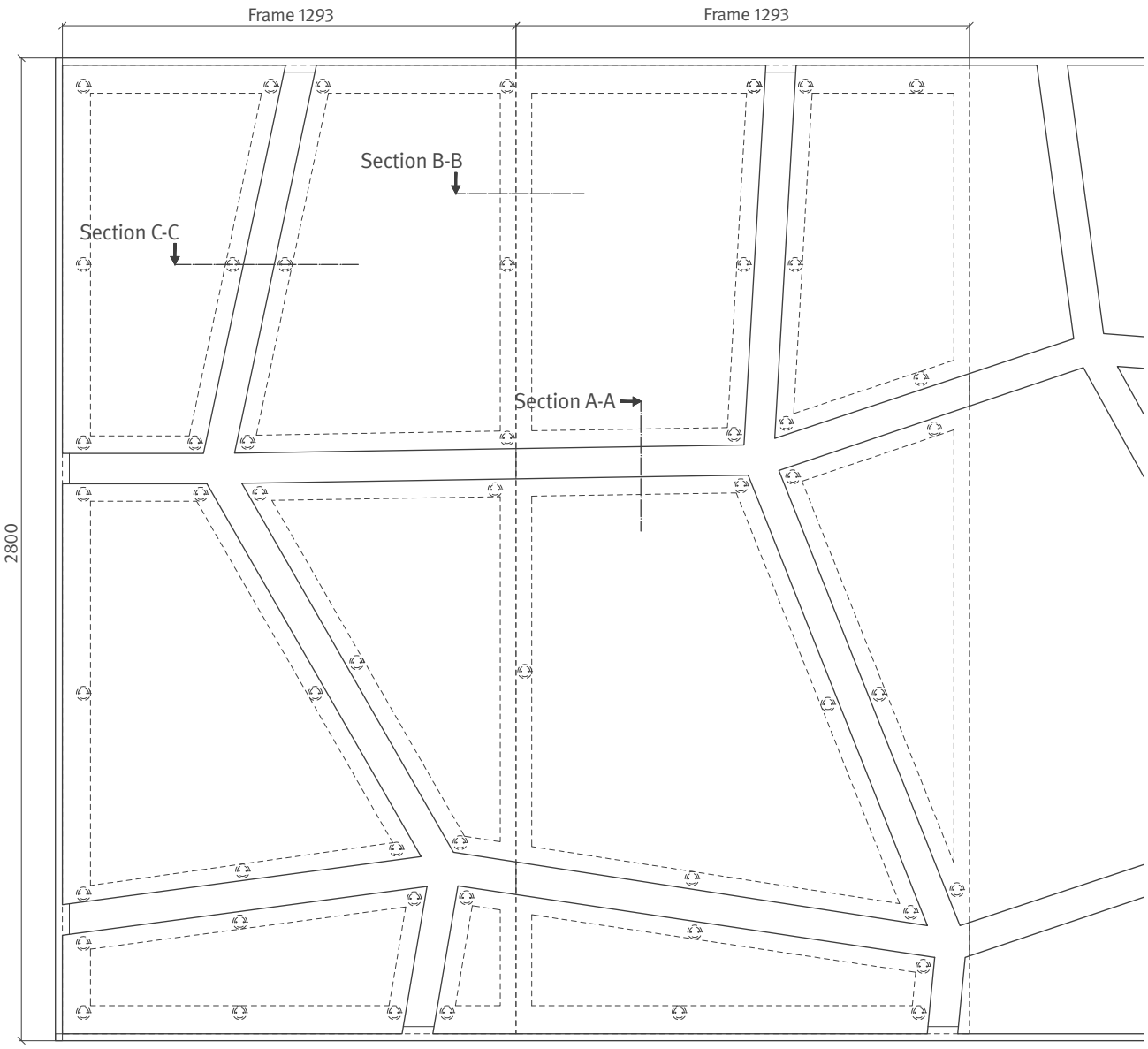
Conference room layout

The installation of 20 m² wall panelling in an abstract design and 20 m² of suspended ceiling reduces the reverberation time from 1.2 seconds to 0.5 seconds as required by the DIN 18041 standard.

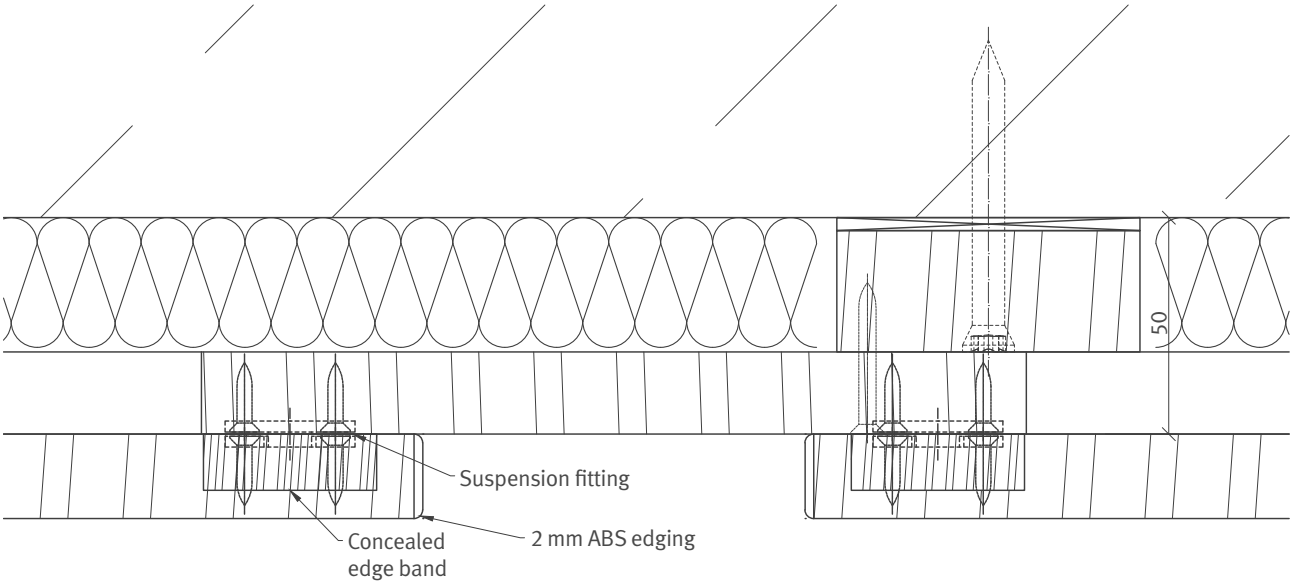
Design and implementation

The wall panelling was mounted on the wall with a spacing of 50 mm using suspension fittings. Here the actual substructure assumes a special role. By using a full-surface melamine faced board in U999 ST2 Black, which was milled in the area of the acoustic surfaces, shadow gap design could be avoided. 30 mm of mineral wool was installed in the 50 mm space. The available ProAcoustic Finest boards in the 2,800 × 1,310 mm format also permit such individual implementations. Please consult the DRAWINGS that follow for the design details.

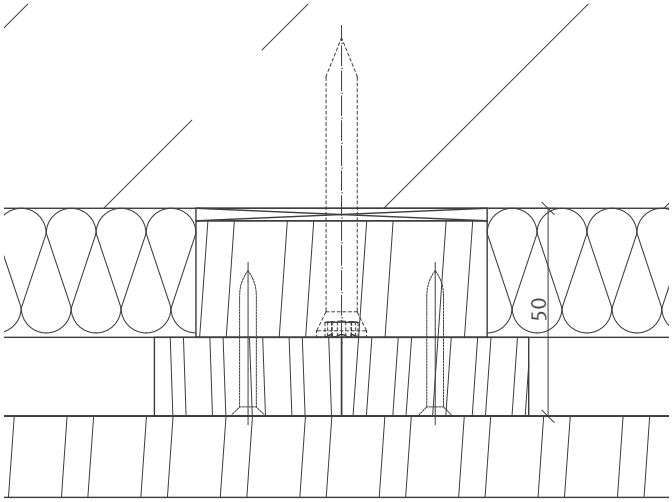
Conference room wall panelling



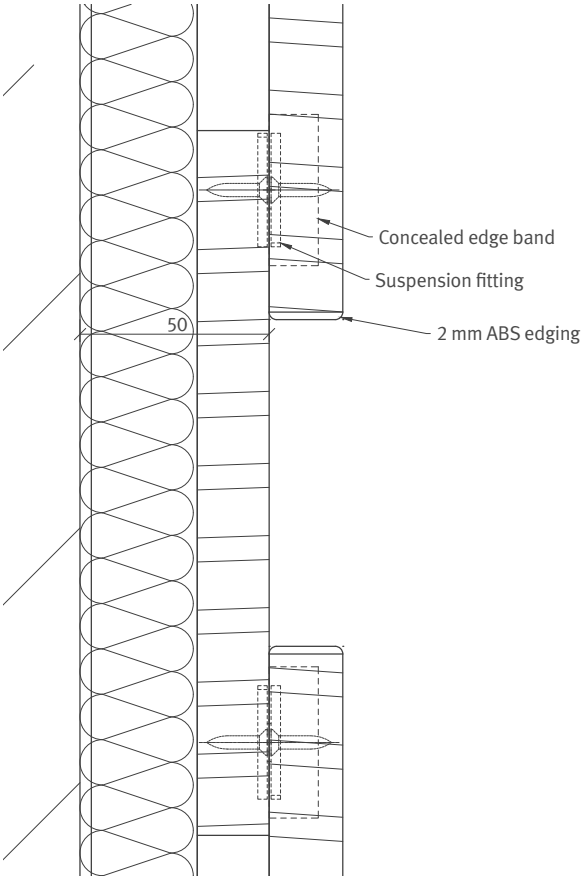
Section C-C



Section B-B

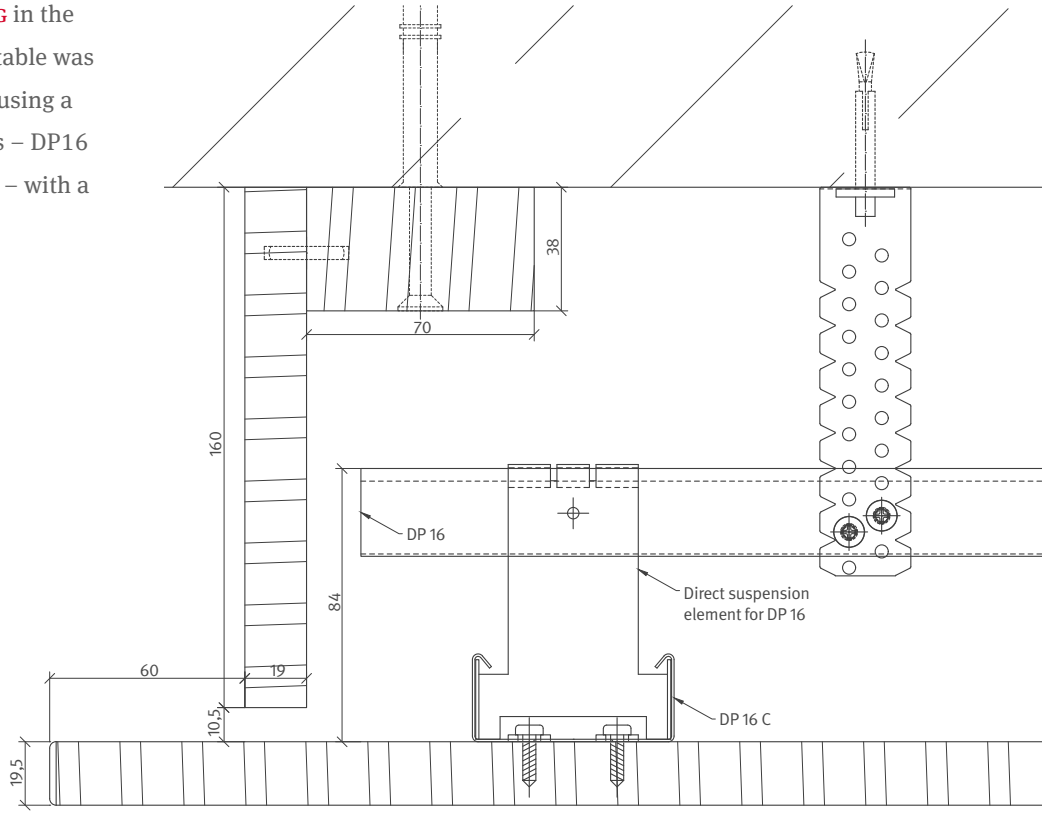


Section A-A



Detail ceiling panelling

The SUSPENDED CEILING in the area of the conference table was attached to the ceiling using a series of ceiling profiles – DP16 from Suckow & Fischer – with a spacing of 170 mm.



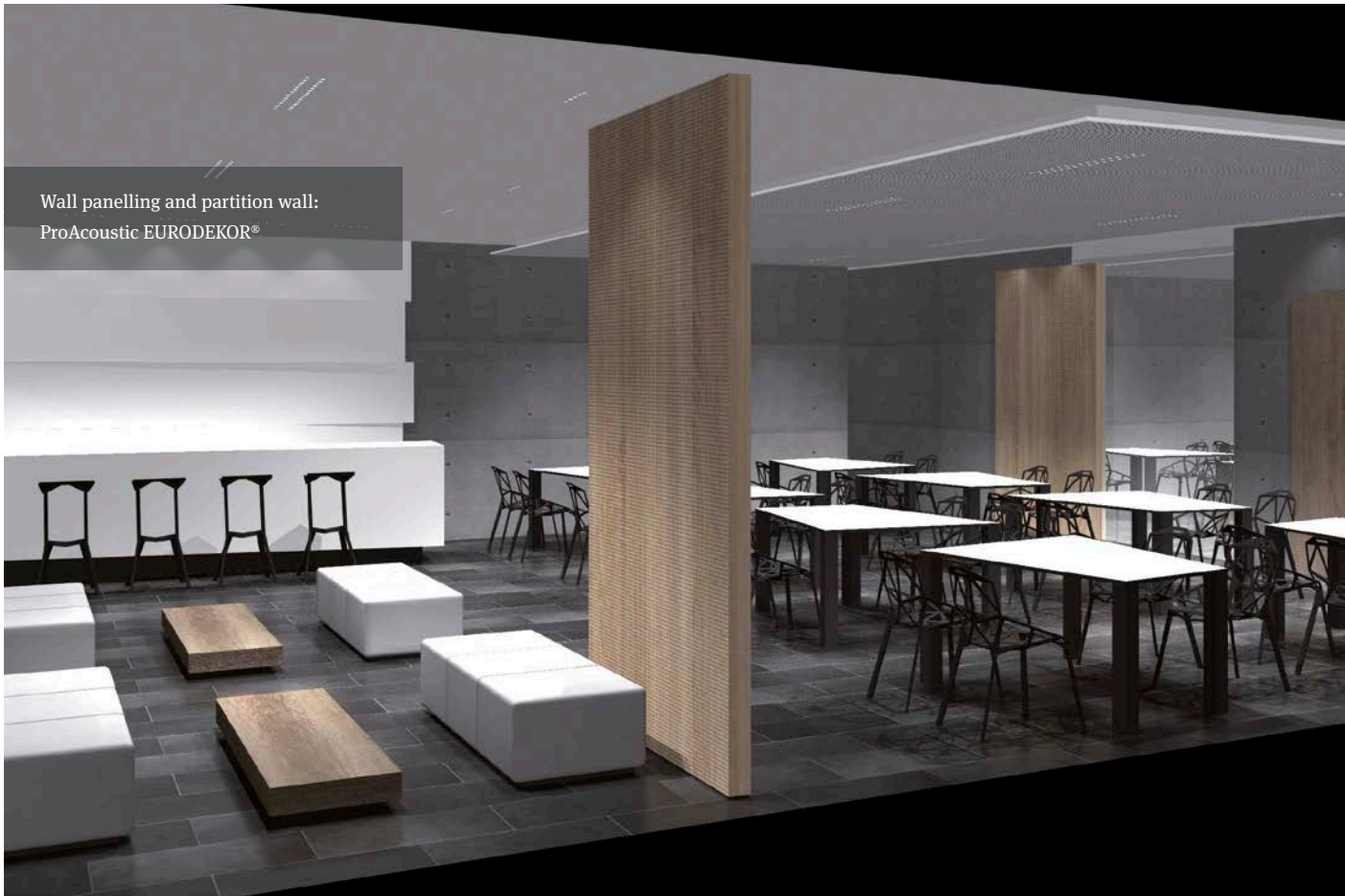
2.3 RESTAURANT

Planning and measuring

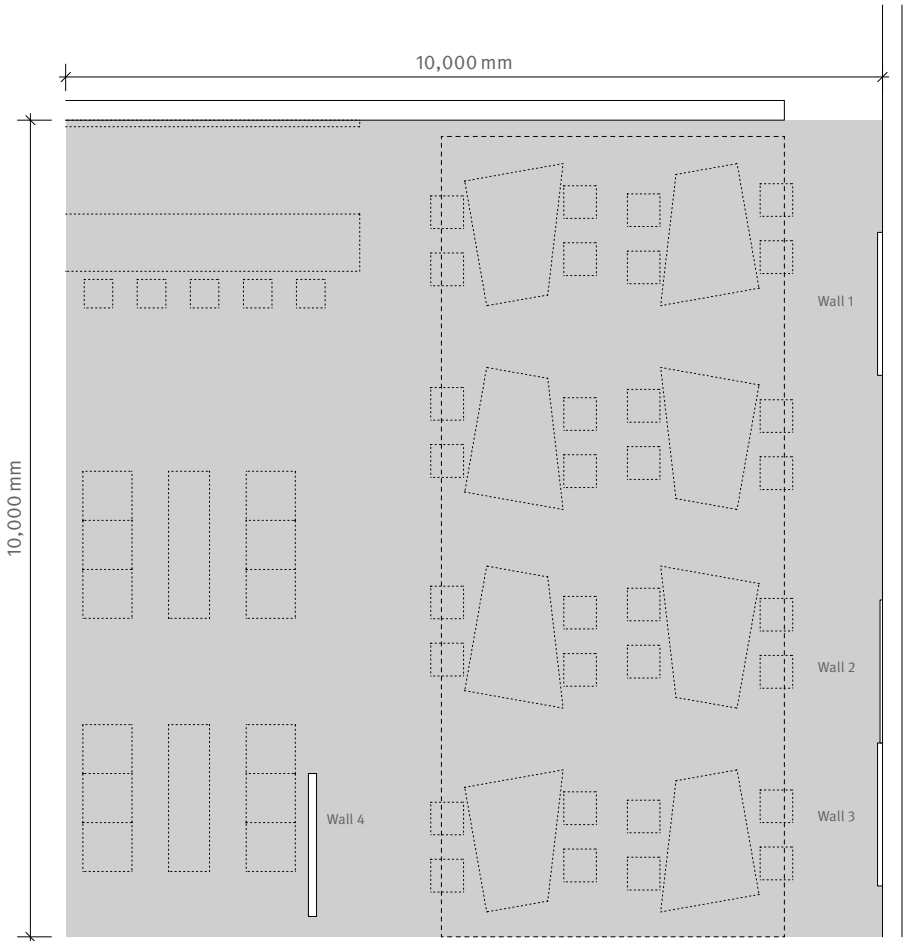
Good acoustics not only play a role in the workplace but also places where many people come together have elevated requirements. A restaurant should be a place where we can enjoy our food in peace and quiet, and where we can communicate easily. Ensuring a pleasant atmosphere means that room acoustics have to be taken into account during planning. In this example, we treated the restaurant based on the DIN 18041 standard in the “education” category. The restaurant shown here has a size of 10 m × 10 m and a room height of 3 m.

This means the room volume is 300 m³, requiring an average reverberation time of 0.8 seconds according to the DIN 18041 standard. Without acoustically effective surfaces, the reverberation time in this room would be approximately 2.0 seconds, and the guests would perceive the restaurant as echoing.

To avoid negative acoustics, the architect in this case chose the product ProAcoustic EURODEKOR® with the 4/4/1.5 perforation. With the diagonal wall panelling, the architect gave the room a sophisticated flair. Furthermore, the acoustically effective surfaces face in various directions within the room. Therefore the acoustic elements were not only included in the plans as wall panelling, but also as acoustically effective partition walls.



Wall panelling and partition wall:
ProAcoustic EURODEKOR®



Restaurant layout

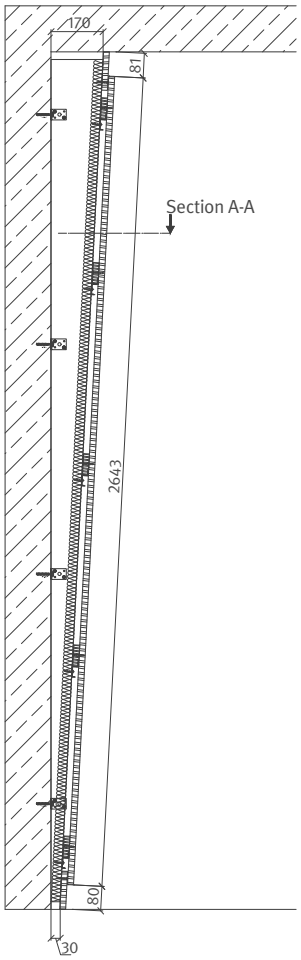
The installation of 60 m² ProAcoustic EURODEKOR® reduces the reverberation time from 2.0 seconds to 0.8 seconds as required based on the DIN 18041 standard.

Perforation 4 / 4 / 1.5
Decor H1145 ST10 Natural Bardolino Oak

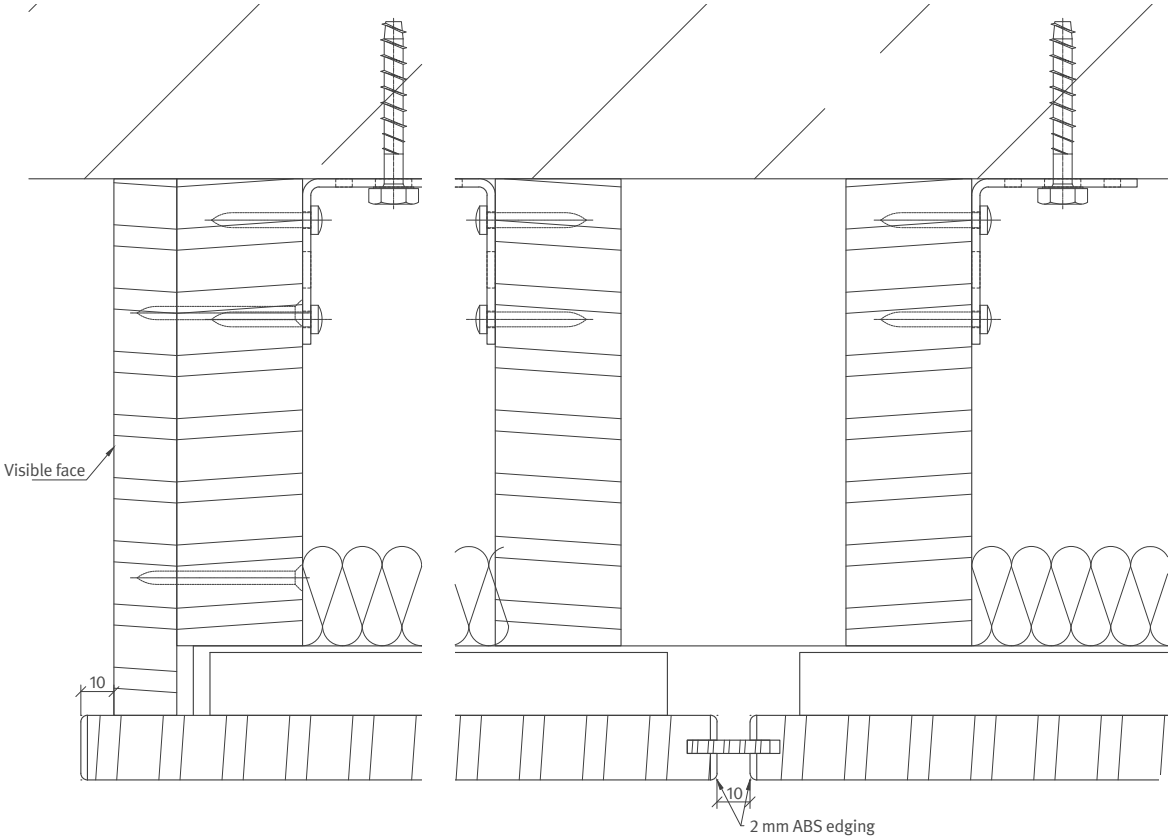
Design and implementation

With the choice of ProAcoustic EURODEKOR®, the required dimensions of 2,643 × 1,000 mm did not pose a problem. The wall panelling was installed diagonally by means of a wedge-shaped substructure. The spacing in the area of the plinth is 30 mm, with 170 mm to the ceiling. 30 mm of mineral wool was installed in the empty space. Please consult the drawings that follow for the design details.

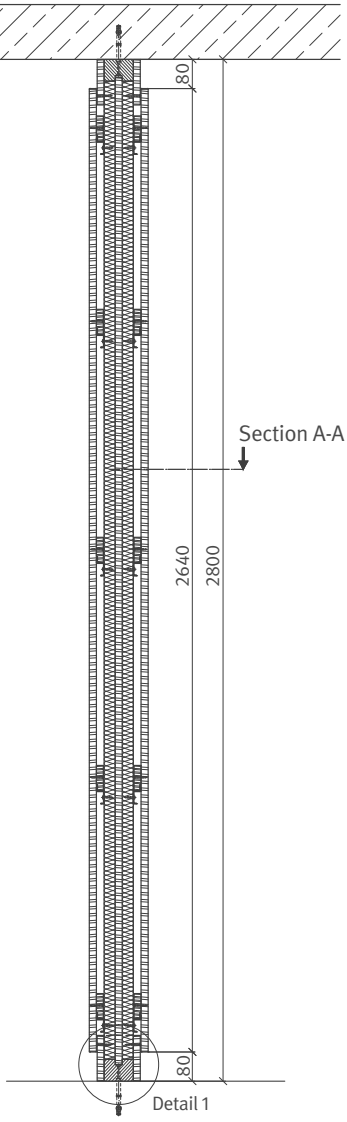
Diagonal wall panelling

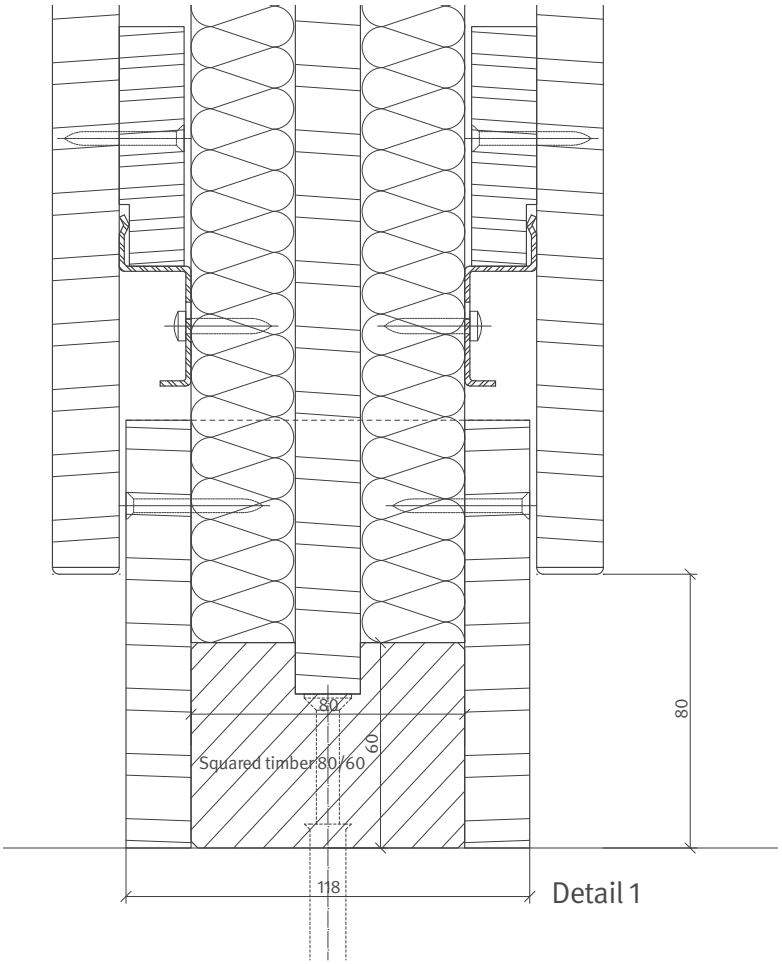


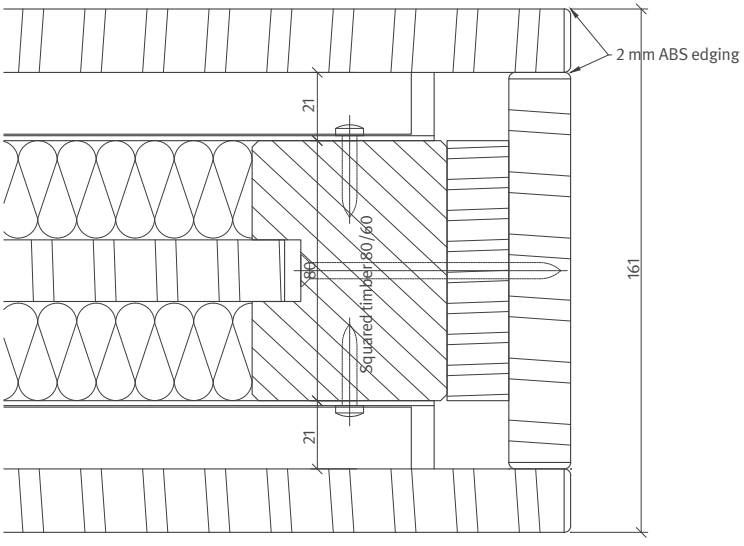
SECTION A-A



The PARTITION WALL not only helps meet the requirements for acoustics, but also acts as a screen. It was executed in wood frame construction and panelled with acoustically effective elements on both sides. The strip without perforations along the edge was implemented on purpose for reasons of appearance.







Section A-A

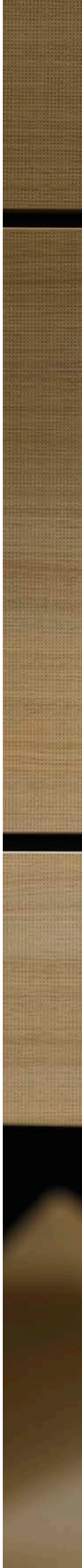
3 AREAS OF APPLICATION FOR EGGER ACOUSTIC PRODUCTS

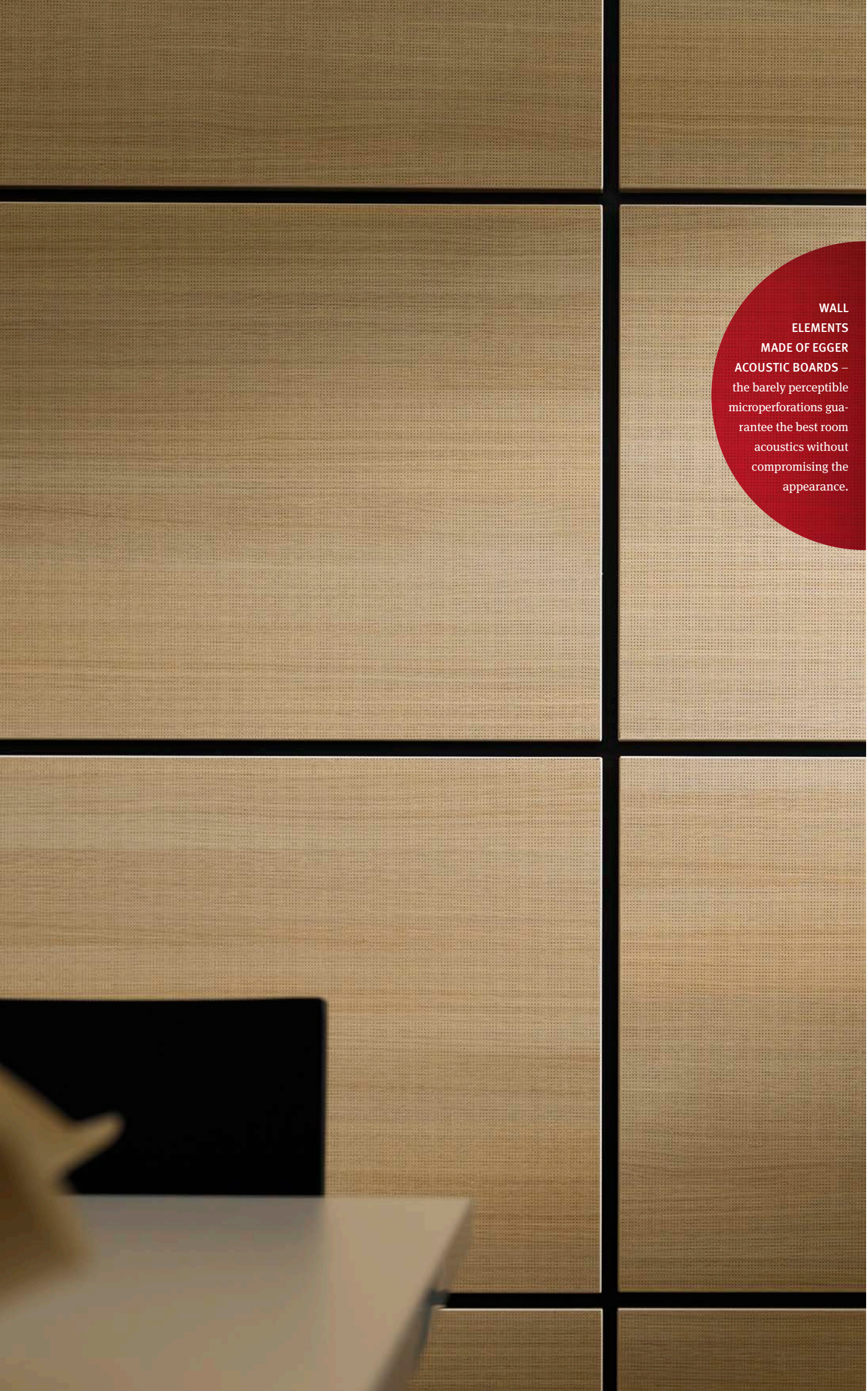
Room acoustic solutions using decorative wood based panel products

To enable us to respond to the large variety of tasks with OPTIMUM TAILORED SOLUTIONS, we have developed a system that offers the most diverse perforation and slot specifications. This allows you to dovetail precisely tuned absorption properties with individual and aesthetic design expectations. The perforation or slot configurations can be applied to certain types of substrate and almost every imaginable surface finish.

We then derive a suitable composition of your acoustically effective elements based on these requirements.

As wood based materials are generally easy to fabricate, the popularity of our decorative acoustic elements in furniture construction is increasing in addition to their classic application as wall panels.





WALL ELEMENTS MADE OF EGGER ACOUSTIC BOARDS – the barely perceptible microperforations guarantee the best room acoustics without compromising the appearance.

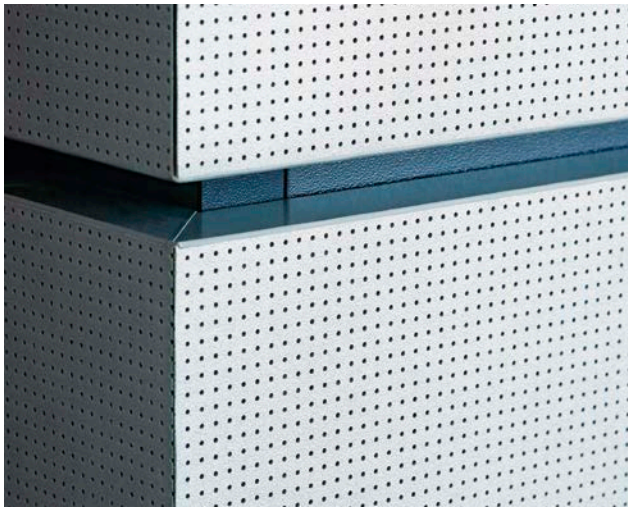
3.1 WALL PANELLING AND PARTITION WALLS

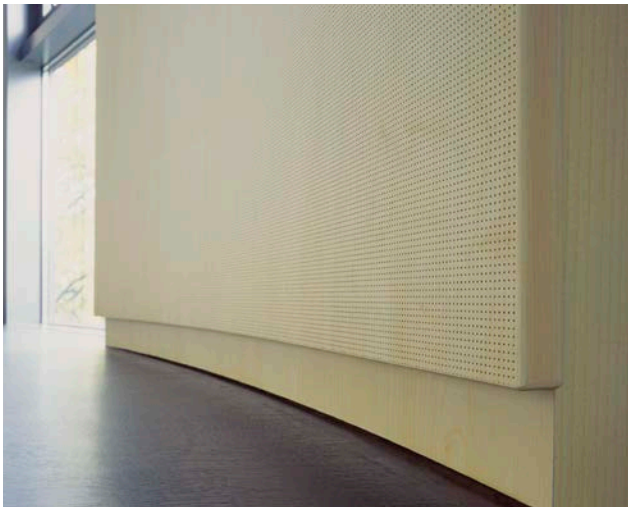
EGGER acoustic products are ideal for fixed wall panel installations, e.g. in foyers, concert or conference halls. They can be used as acoustically effective partition walls in open-plan offices, canteens, restaurants or corridors. For these application areas, products with a SINGLE SIDED DECORATIVE FINISH are usually selected i.e. the reverse of the panels is covered with a black acoustic fleece or balancer as standard.

For partition wall solutions in particular, the product composition as well as the planned subsequent installation must be coordinated in order to ensure that the desired acoustic effect is realised. Our wide range of product options, the composition of our products and the related areas of application are found in this brochure, Section 4 EGGER Acoustic Products.

SAP Casino in Walldorf

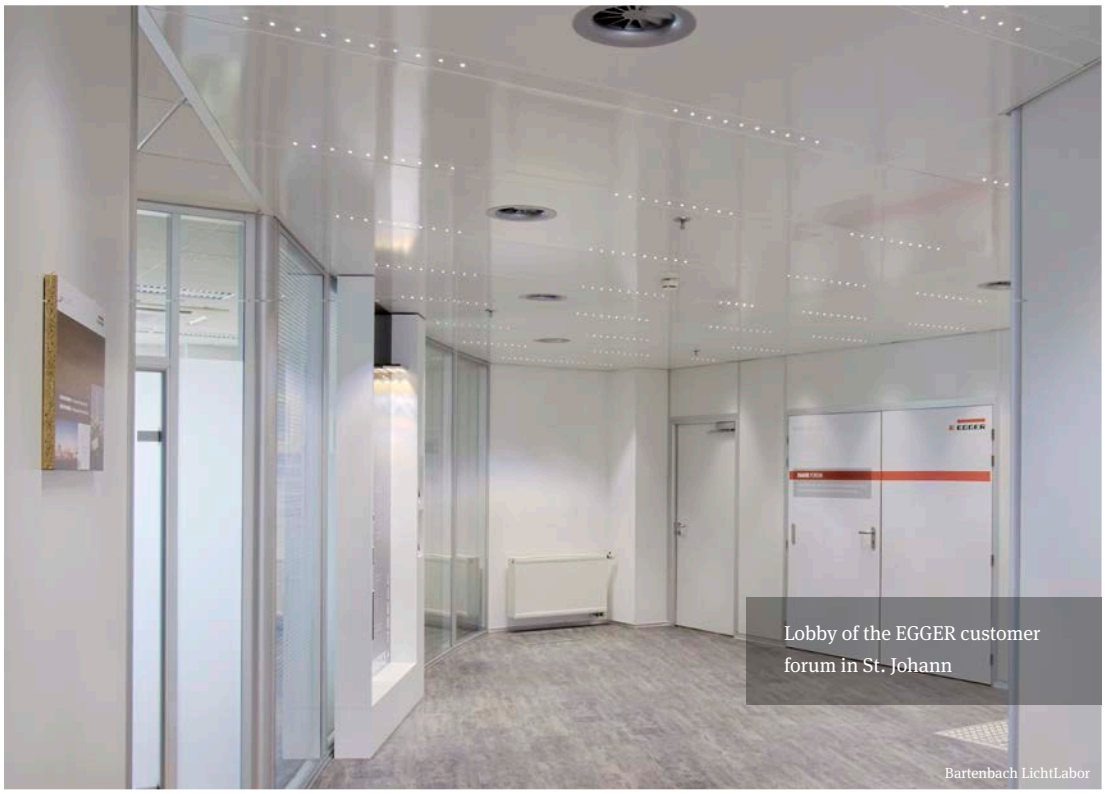
Savings bank in Gevelsberg





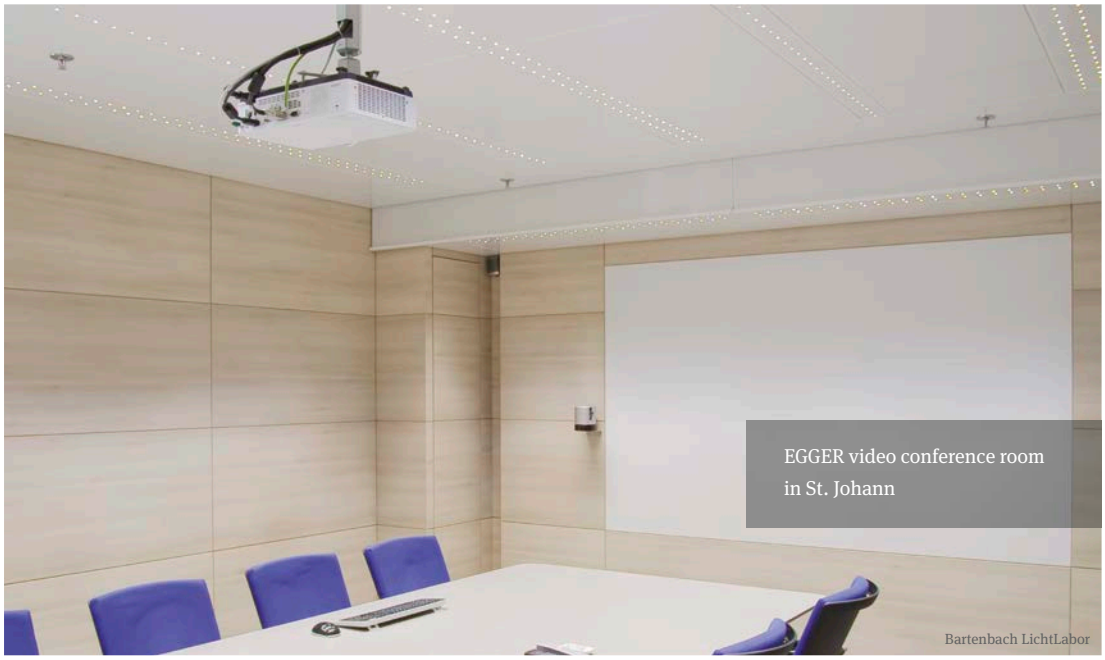
3.2 CEILINGS AND CEILING SYSTEMS

Room boundary surfaces such as ceilings lend themselves particularly well to the installation of acoustic products. If necessary, the entire expanse of a ceiling can be utilised as ABSORPTION SURFACE and what's more, the sub-construction can be accommodated without restricting the available space within a room. The required sub-construction simultaneously provides the necessary clearance or cavity below the actual ceiling, which is essential for effective sound absorption.



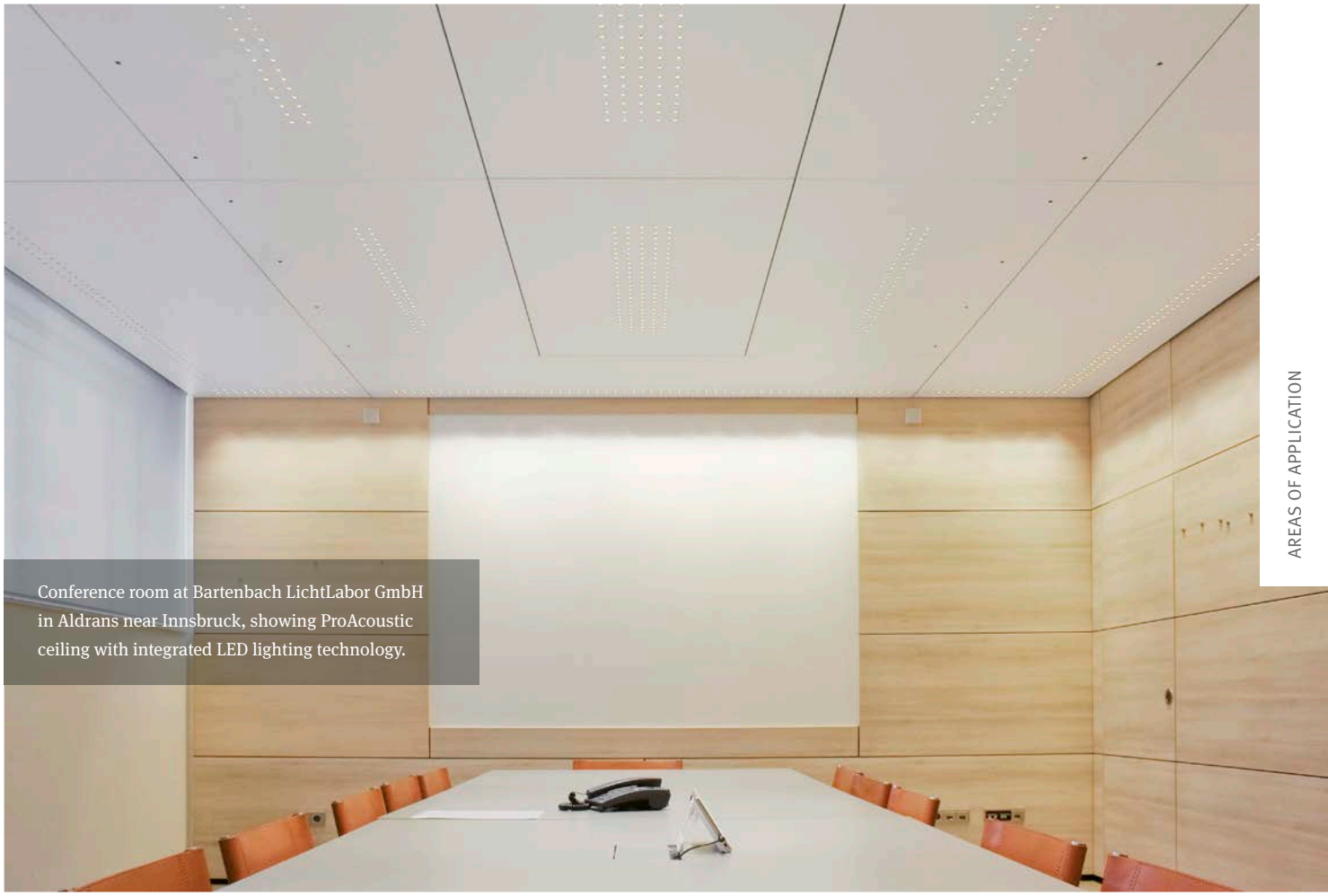
Lobby of the EGGER customer forum in St. Johann

Bartenbach LichtLabor

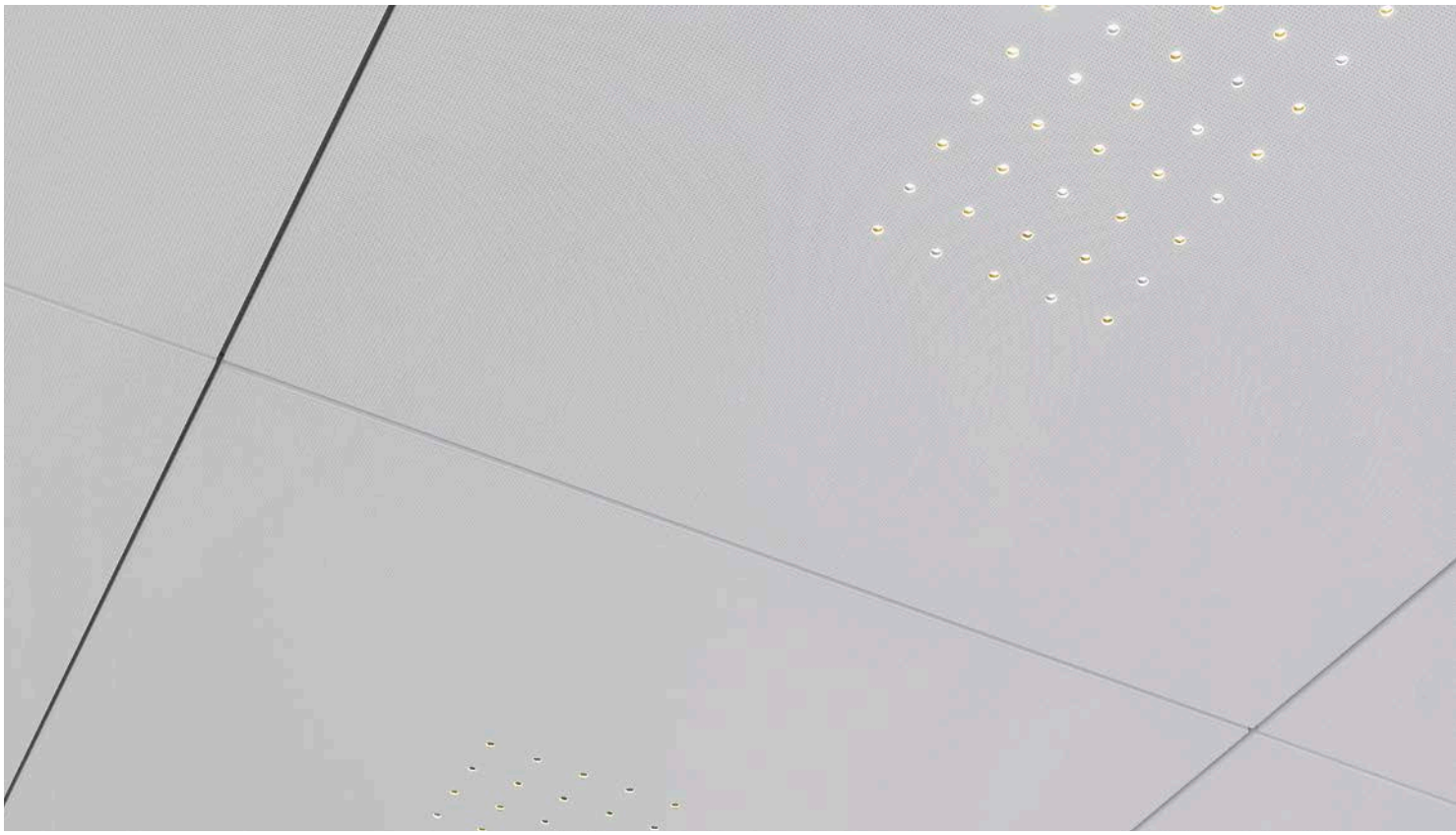


EGGER video conference room in St. Johann

Bartenbach LichtLabor



Conference room at Bartenbach LichtLabor GmbH in Aldrans near Innsbruck, showing ProAcoustic ceiling with integrated LED lighting technology.



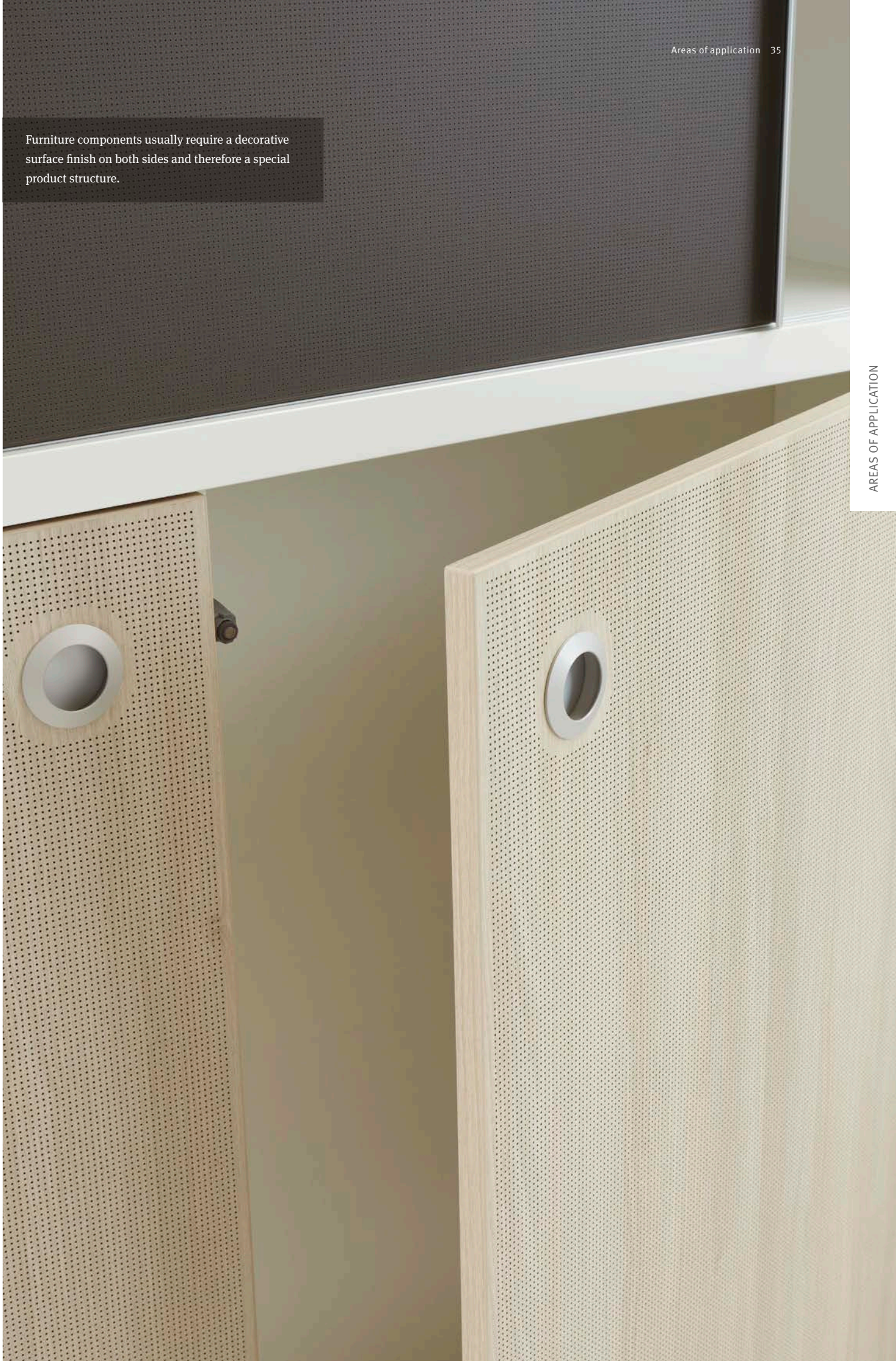
3.3 FURNITURE COMPONENTS

Decor and material combinations allow acoustically effective furniture surfaces to be incorporated into the overall room acoustics concept. When design and structural-physical criteria make the realisation of classic solutions more difficult, acoustically effective furniture components offer additional options for including sufficient SOUND-ABSORBING SURFACES in the plans. Numerous coreboards, surfaces and perforations are available that can be used to replace existing doors and rear panels with acoustically effective furniture.

© EGGER / OMV Wien

© EGGER / OMV Wien

Furniture components usually require a decorative surface finish on both sides and therefore a special product structure.



3.4 RETROSPECTIVE INSTALLATIONS

Our acoustic products are perfect for subsequent installation in order to improve the ATMOSPHERE IN EXISTING ROOMS. With ceiling panels and individually fabricated system components (so-called baffles) made of compact broadband absorbers that are highly effective in the frequency range relevant for speech, custom solutions can be created for any room set.

Our stock product ProAcoustic Finest features barely noticeable microperforations with a hole diameter of just 0.5 mm. A square meter of this board has over 300,0000 holes.

4 EGGER ACOUSTIC PRODUCTS

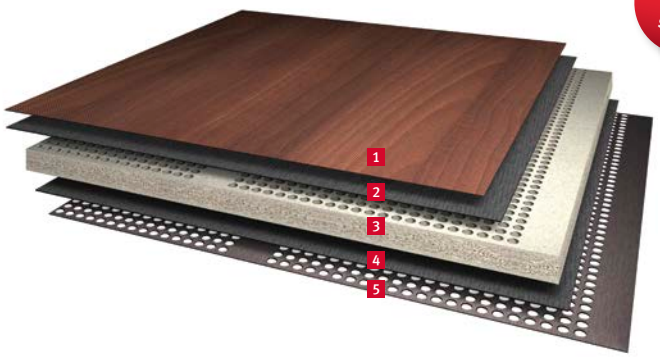
EGGER acoustic products are available in a wide range of chipboard, MDF and lightweight substrates. ProAcoustic A2 products manufactured on the basis of mineral A1 core-boards are new to the product range. More information is found in this brochure in section 4.4 ProAcoustic A2 on pages 48 to 49. Decors for laminate bonded and melamine faced boards may be selected from the comprehensive decor range offered by the EGGER ZOOM® collection. Lacquered paint finishes in RAL and NCS colours, as well as real wood veneers, complement and complete the selection of colours and decors available.

EGGER and Akustik Plus offer a tailor-made product range and individual advice for your specific requirements. Irrespective of whether you are interested in full-size production boards, custom-made components, fire rated or standard substrates and even bespoke solutions with real wood veneers, we shall be pleased to support and advise you in terms of technical application, choice of construction and fittings.

4.1 PERFORATED PRODUCTS

ProAcoustic Finest

AVAILABLE FROM STOCK



1 EGGER Laminate, diagonally perforated 1.8/1.8/0.5
2 Black Acoustic Fleece
3 EUROSPAN® raw chipboard in 18 mm perforated
4 Black Acoustic Fleece
5 Backing laminate, linear perforated

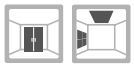
Areas of application:

ProAcoustic Finest Furniture Board

AVAILABLE FROM STOCK

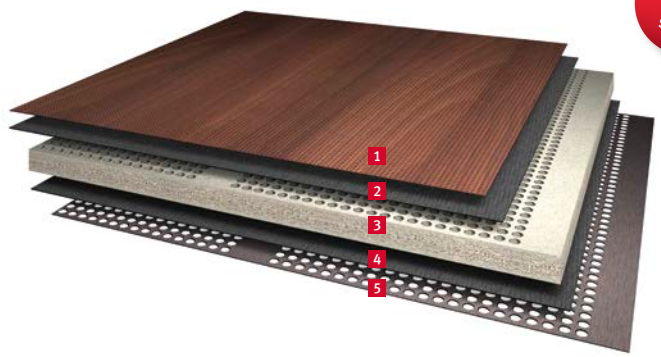
1 EGGER Laminate, diagonally perforated 1.8/1.8/0.5
2 Black Acoustic Fleece
3 EUROSPAN® raw chipboard in 18 mm perforated
4 Black Acoustic Fleece
5 EGGER Laminate, diagonally perforated 1.8/1.8/0.5

Areas of application:



ProAcoustic Classic

AVAILABLE FROM STOCK



1 Laminate, linear perforated 3/3/1.0
2 Black Acoustic Fleece
3 EUROSPAN® raw chipboard in 18 mm perforated
4 Black Acoustic Fleece
5 Backing laminate, linear perforated

Areas of application:

ProAcoustic Classic Furniture Board

AVAILABLE FROM STOCK

1 Laminate, linear perforated 3/3/1.0
2 Black Acoustic Fleece
3 EUROSPAN® raw chipboard in 18 mm perforated
4 Black Acoustic Fleece
5 Laminate, linear perforated 3/3/1.0

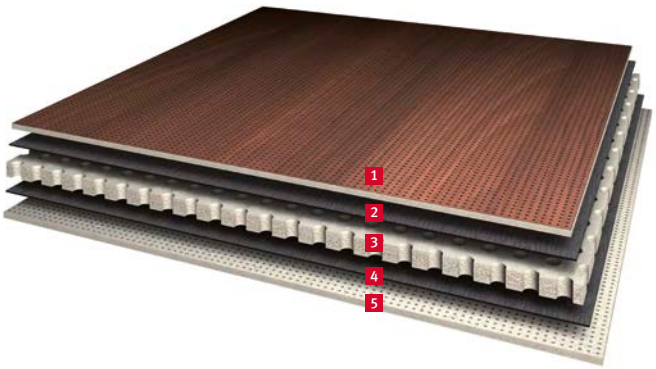
Areas of application:

ProAcoustic EURODEKOR®

1 EURODEKOR® perforated
2 Black Acoustic Fleece

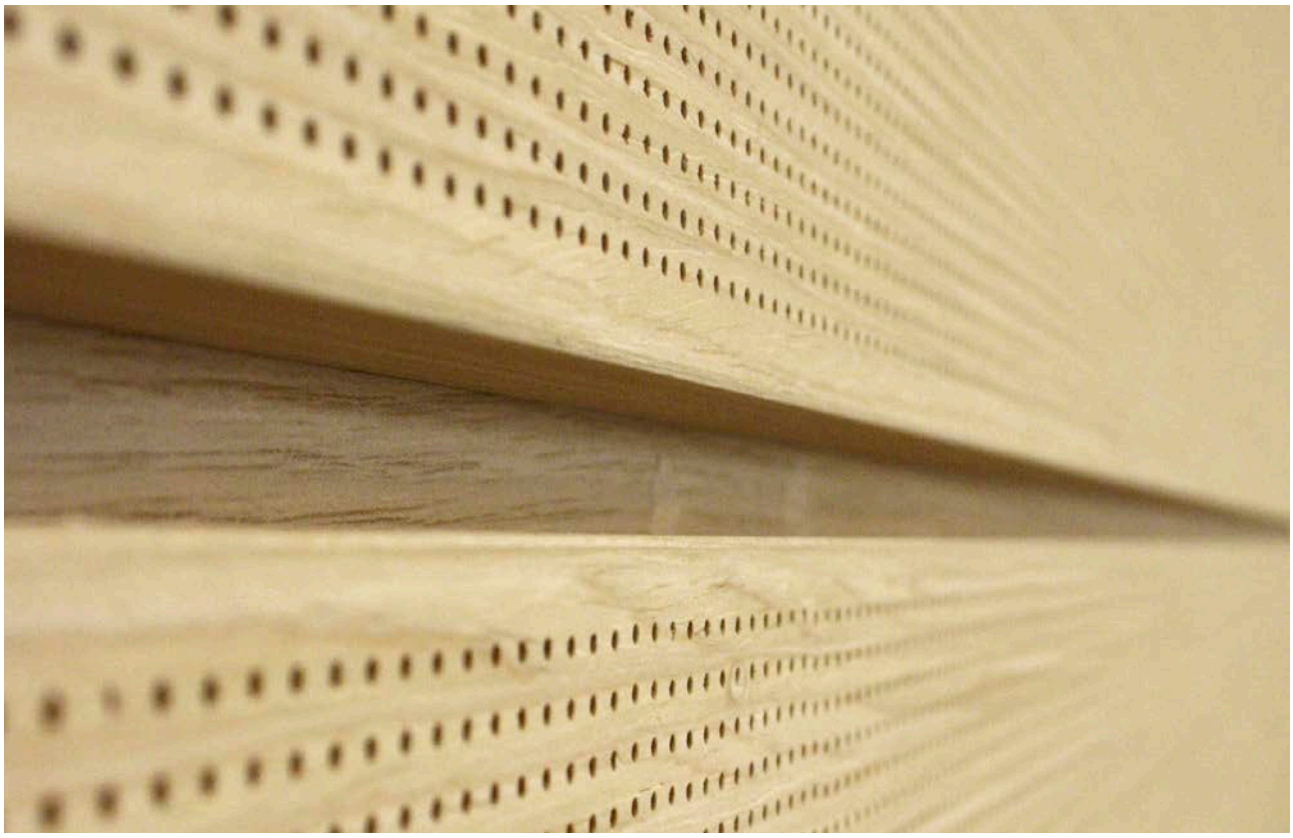
Areas of application:

ProAcoustic EURODEKOR® Furniture Board

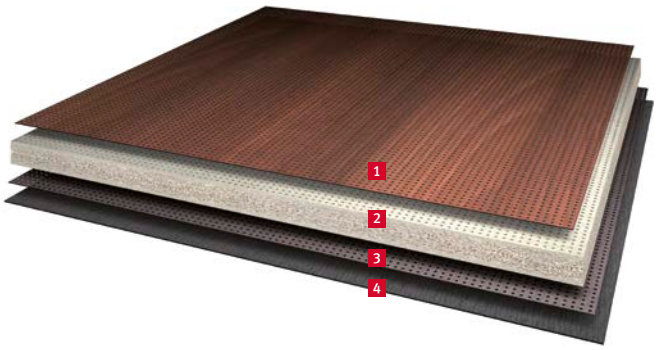


1 EURODEKOR® perforated
2 Black Acoustic Fleece
3 EUROSPAN® perforated
4 Black Acoustic Fleece
5 EURODEKOR® perforated

Areas of application:



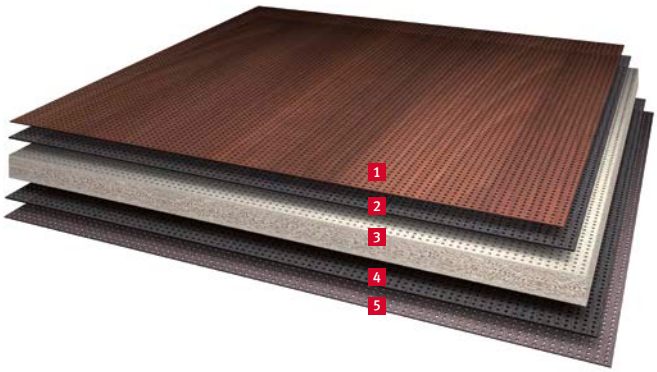
ProAcoustic Laminated Composite Board



1 Laminate perforated
2 EUROSPAN® perforated
3 Laminate balancer paper, perforated
4 Black Acoustic Fleece

Areas of application:

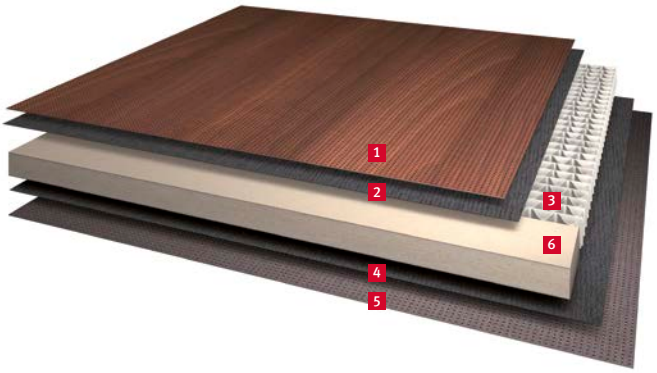
ProAcoustic Laminated Composite Furniture Board



1 Laminate perforated
2 Black Acoustic Fleece
3 EUROSPAN® perforated
4 Black Acoustic Fleece
5 Laminate perforated

Areas of application:

ProAcoustic *light*



1 Laminate perforated
2 Black Acoustic Fleece
3 Paper honeycomb
4 Black Acoustic Fleece
5 Laminate balancer paper, perforated
6 Wood-based material frame

Areas of application:

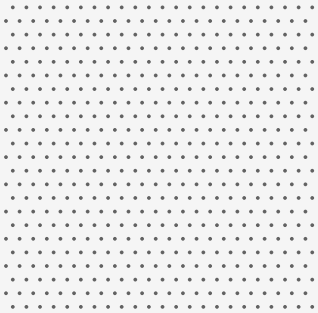
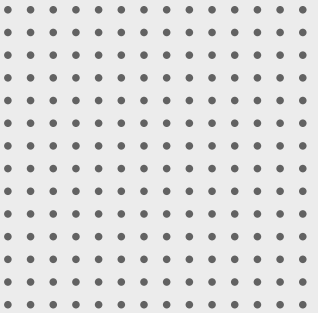
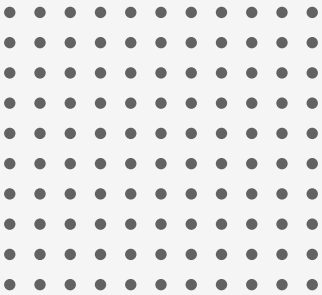
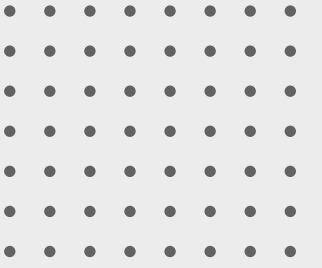
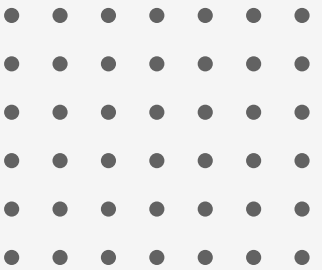
ProAcoustic *light* Furniture Board

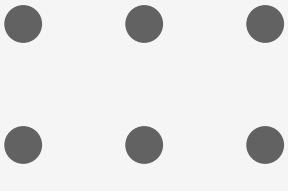
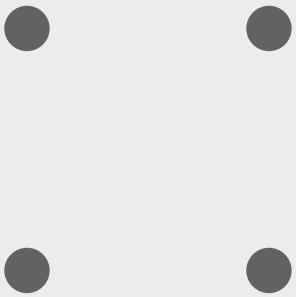
1 Laminate perforated
2 Black Acoustic Fleece
3 Paper honeycomb
4 Black Acoustic Fleece
5 Laminate perforated
6 Wood-based material frame

Areas of application:

PERFORATIONS – OVERVIEW

We offer a wide range of different perforations and can implement them over the entire surface or leave a non-perforated strip along the edges – exception 1.8/1.8/0.5.

Perforation [1]	Illustration scale 1:1	Products	Open surface [%] Number of perforations [No. /m²]	Areas of application: [2]
1.8/1.8/0.5		ProAcoustic Finest ProAcoustic Finest Furniture Board ProAcoustic *light* ProAcoustic *light* Furniture Board	6.1 % 308,642 No. /m²	
3/3/1.0		ProAcoustic Classic ProAcoustic Classic Furniture Board ProAcoustic *light* ProAcoustic *light* Furniture Board	8.7 % 111,111 No. /m²	
4/4/1.5 Further options: 4/4/2.0		ProAcoustic EURODEKOR® ProAcoustic EURODEKOR® Furniture Board ProAcoustic *light* ProAcoustic *light* Furniture Board ProAcoustic Laminated Composite Board ProAcoustic Laminated Composite Furniture Board	11.0 % 62,500 No. /m² 19.6 %	
5.3/5.3/1.5 5.3/5.3/2.0 Further options: 5.3/5.3/2.5		ProAcoustic EURODEKOR® ProAcoustic EURODEKOR® Furniture Board ProAcoustic Laminated Composite Board ProAcoustic Laminated Composite Furniture Board	6.2 % 11.1 % 35,200 No. /m² 17.3 %	
6.4/6.4/2.0 6.4/6.4/3.0 Further options: 6.4/6.4/1.5 6.4/6.4/2.5		ProAcoustic EURODEKOR® ProAcoustic EURODEKOR® Furniture Board ProAcoustic Laminated Composite Board ProAcoustic Laminated Composite Furniture Board	7.7 % 17.3 % 24,414 No. /m² 4.3 % 12.0 %	

Perforation [1]	Illustration scale 1:1	Products	Open surface [%] Number of perforations [No. /m²]	Areas of application: [2]
8/8/2.0 8/8/3.0 Further options: 8/8/1.5 8/8/2.5		ProAcoustic EURODEKOR® ProAcoustic Laminated Composite Board	**4.9 %** 11.0 % **15,625 No. /m²** 2.8 % 7.7 %	
10.6/10.6/3.0 10.6/10.6/4.0 Further options: 10.6/10.6/2.0 10.6/10.6/2.5 10.6/10.6/5.0		ProAcoustic EURODEKOR® ProAcoustic Laminated Composite Board	**6.2 %** 11.1 % **8,800 No. /m²** 2.8 % 4.3 % 17.3 %	
16/16/5.0 Further options: 16/16/3.0 16/16/4.0 16/16/6.0 16/16/8.0		ProAcoustic EURODEKOR® ProAcoustic Laminated Composite Board	**7.7 %** **3,906 No. /m²** 2.8 % 4.9 % 11.0 % 19.6 %	
32/32/6.0 Further options: 32/32/4.0 32/32/5.0 32/32/8.0 32/32/10.0 32/32/12.0		ProAcoustic EURODEKOR® ProAcoustic Laminated Composite Board	**2.8 %** **976 No. /m²** 1.2 % 1.9 % 4.9 % 7.7 % 11.0 %	

[1] Explanatory Note: Perforation example 4/4/1.5 = 4 mm distance horizontally and 4 mm vertically measured from centre hole to centre hole, with a hole diameter of 1.5 mm

[2] Legend, areas of application:

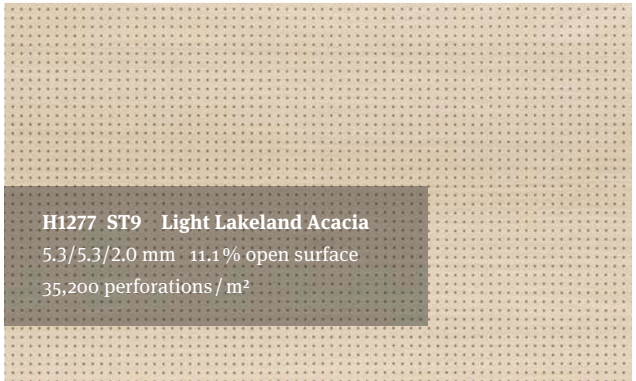
 Wall panelling and partition walls

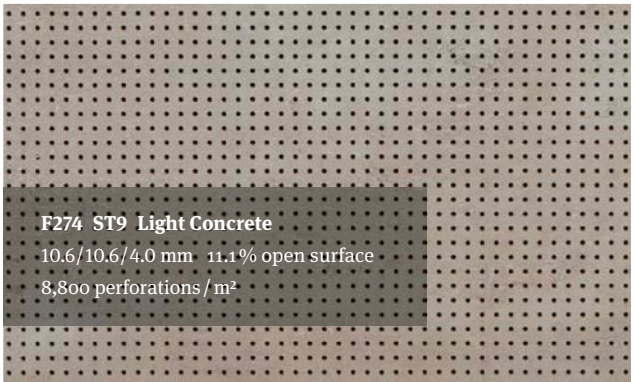
 Furniture components

 Ceilings

 Retrospective Installations

Perforation examples

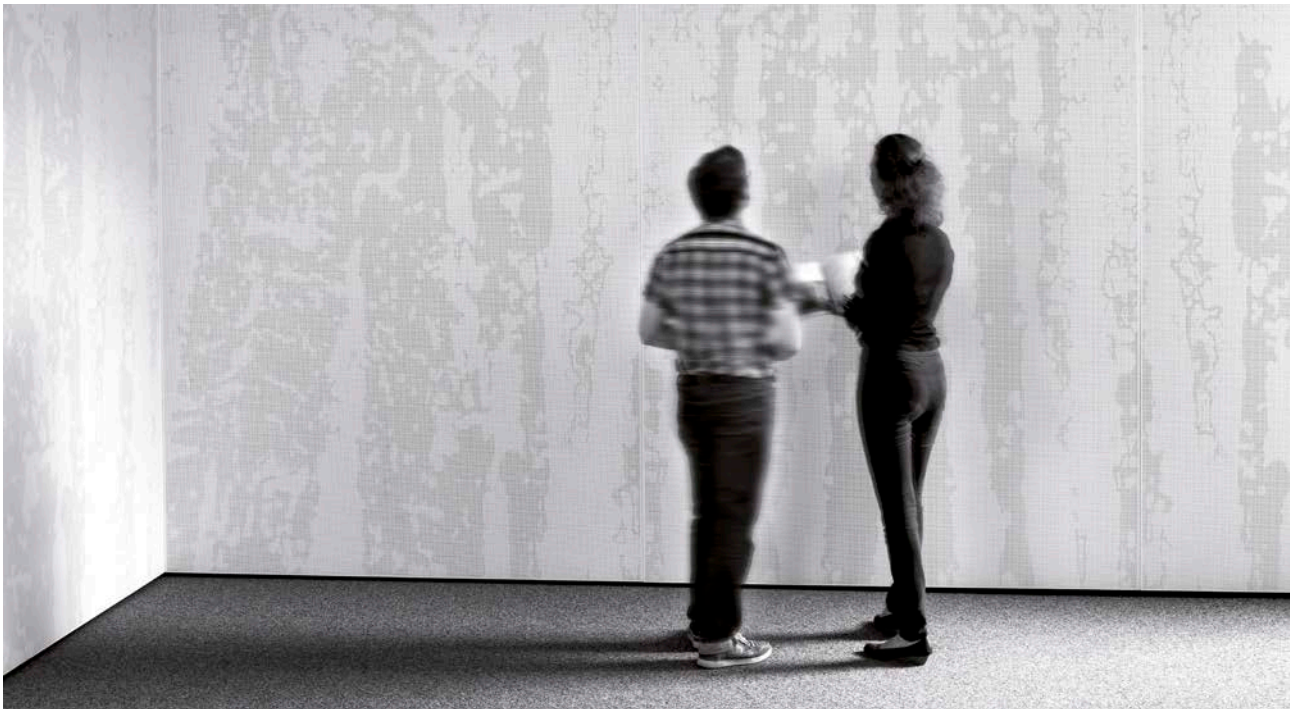




4.2 INDIVIDUAL PERFORATIONS

Unique acoustics solutions – EGGER is the only manufacturer to offer acoustically effective boards with individual perforations.

We are even able to realise CUSTOM IMAGES such as company logos. Regardless of whether this type of perforation is required by you for technical or structural reasons, or whether it is based on design considerations, we realise the solution. All we need for implementation is digital data in the form of image files (e.g. jpg) or CAD files (e.g. dwg).



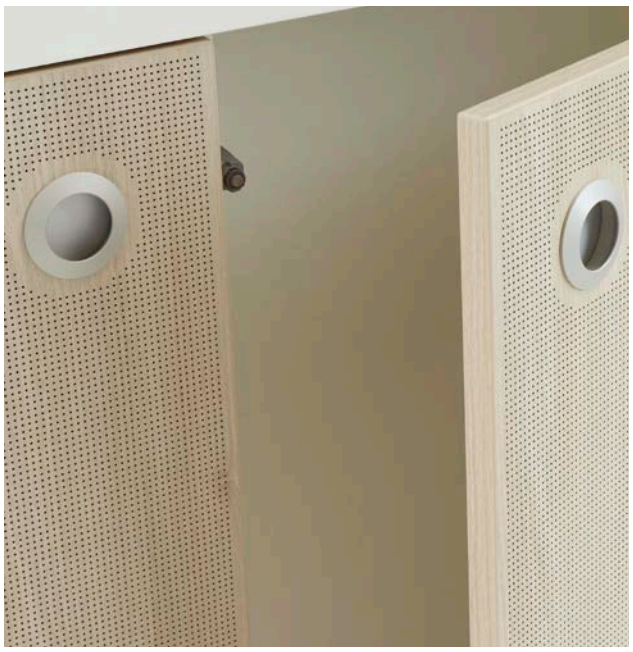
Before: reverberation time 3.1 seconds

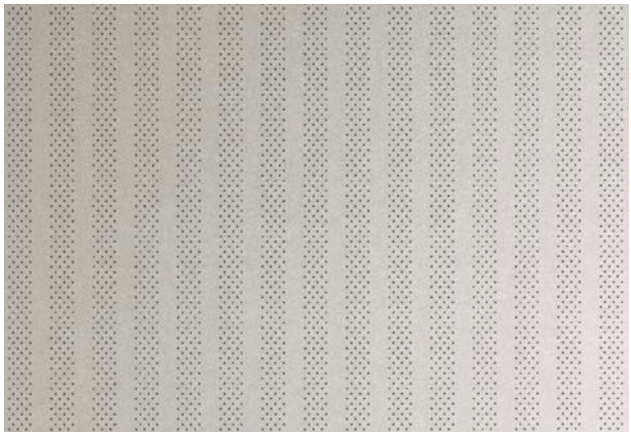
After: reverberation time 0.9 seconds

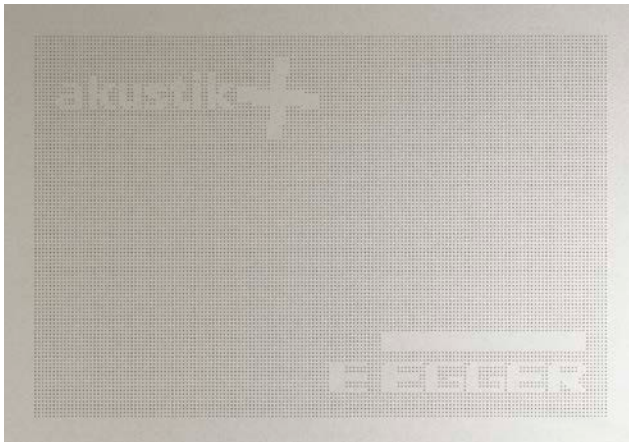
The possibilities are also utilised where acoustic measures are seamlessly integrated into existing rooms through the choice of motifs. As an example, allow us to present the Brockenhaus Hanau which is subject to the protection of historical monuments. The long reverberation times in the event hall of the Brockenhaus were problematic, ProAcoustic wall panelling was therefore chosen. First a suitable image and the perforation grid were selected then a floral motif was chosen.

It was realised in the perforations 4/4/1.5 and 4/4/2.0 using the ProAcoustic EURODEKOR® product, with minimal trimming waste. The EGGER decor W980 ST2 Platinum White was used. The reverberation time without the acoustic measures was 3.1 seconds however today it is an outstanding 0.9 seconds, with a result that not only looks impressive but can also be heard.

Individual perforations starting with a perforation grid of ≥ 4/4/1.5 can be freely selected in terms of hole diameter, grid and proportion of perforated surface. You can also choose whether the elements are executed with or without a framed appearance.







4.3 SLOTTED PRODUCTS

Slotted acoustic products are offered with an MDF coreboard as the standard. A laminate bonded board or alternatively a direct laminated EURODEKOR® MDF board can be used.

ProAcoustic Linear

1 EURODEKOR® MDF, slotted
2 Black Acoustic Fleece

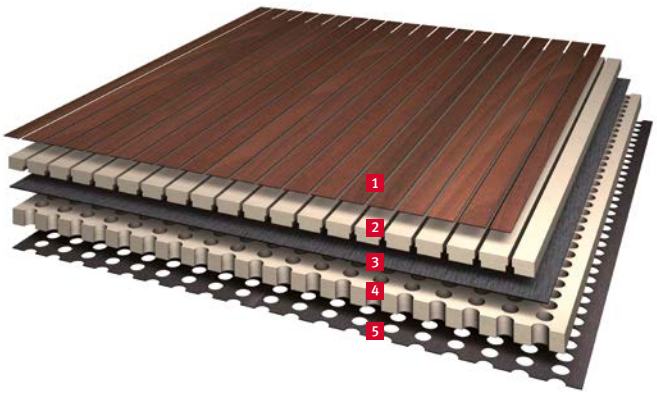
Areas of application:

ProAcoustic Linear Micro

1 EURODEKOR® MDF, slotted
2 Black Acoustic Fleece

Areas of application:

ProAcoustic Linear Deluxe

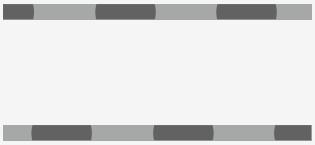
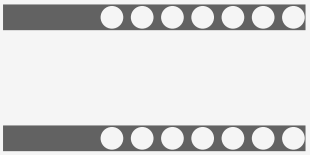
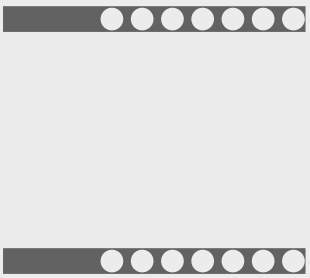
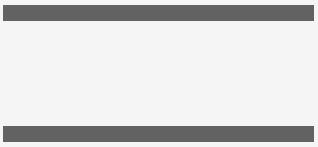


1 Laminate, slotted
2 EURODEKOR® MDF, slotted
3 Black Acoustic Fleece
4 EURODEKOR® MDF, perforated
5 Laminate balancer paper, perforated

Areas of application:

SLOTTED PATTERNS – OVERVIEW

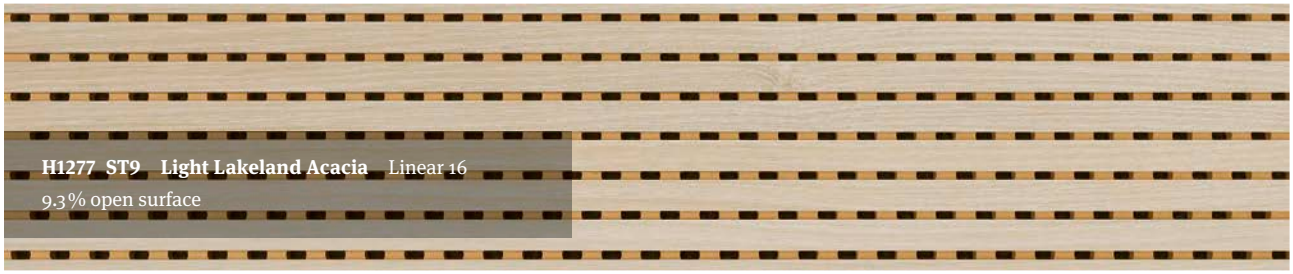
As a visual alternative to classic perforations, we also offer a wide variety of slot patterns in various grids.

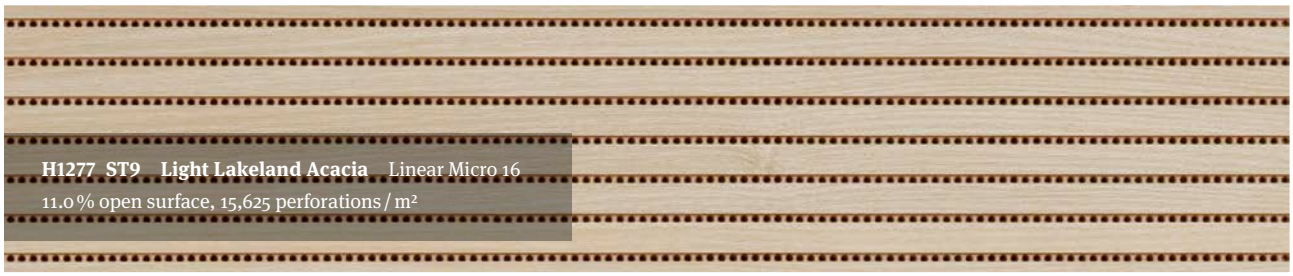
Perforation [1]	Illustration scale 1:1	Products	Open surface [%] Number of perforations [No. /m²]	Areas of application: [2]
Linear 16 16/2.0 16/3.0		ProAcoustic EURODEKOR® MDF ProAcoustic Laminated Composite Board	6.2 % 9.3 %	
Linear 32 32/2.0 32/3.0		ProAcoustic EURODEKOR® MDF ProAcoustic Laminated Composite Board	3.0 % 4.5 %	
Linear Micro 16 16/12.6/3.4		ProAcoustic EURODEKOR® MDF ProAcoustic Laminated Composite Board	11.0 % 15,625 No. /m²	
Linear Micro 32 32/28.6/3.4		ProAcoustic EURODEKOR® MDF ProAcoustic Laminated Composite Board	5.5 % 7,812 No. /m²	
Linear Deluxe 16 16/13.9/2.1		ProAcoustic Laminated Composite Board	12.3 %	
Linear Deluxe 32 32/29.9/2.1		ProAcoustic Laminated Composite Board	6.1 %	

[1] Slotting example, 16/2.0 = 16 mm distance from centre of slot to centre of slot / 2.0 mm slot width.

[2] Legend, areas of application:  Wall panelling andp artition walls

Examples of slot patterns:



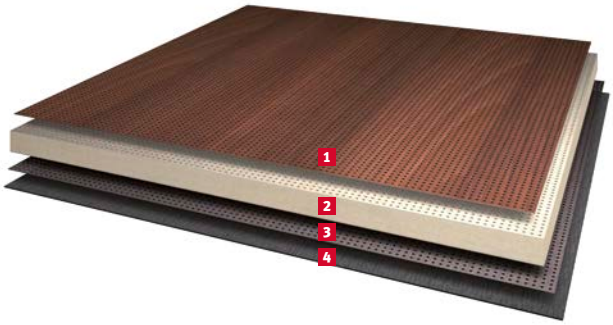


4.4 PROACOUSTIC A2

NEW

We now offer our new ProAcoustic A2 products, based on A2 laminate bonded boards, in the form of perforated or slotted elements. Naturally, the reaction to fire of the acoustic products has been tested; they are available with select perforations and slot patterns with the classification A2 - s1, d0 (as joining elements according to EN 13501-1).

PERFORATED PRODUCTS

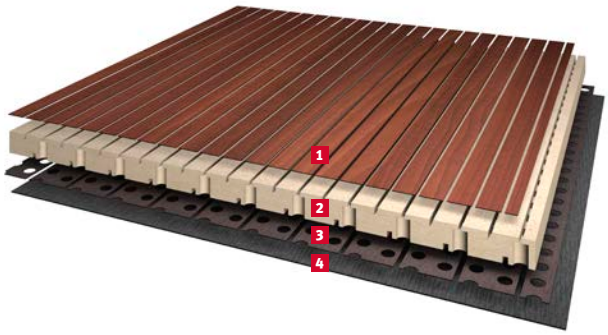


We offer a wide variety of perforations and are able to execute these over the entire surface or in certain areas.

1 Micro-laminate, perforated
2 A1 coreboard, perforated
3 Balancer paper, perforated
4 Black acoustic membrane

Possible perforations:
4/4/1.5 – 5.3/5.3/1.5 – 5.3/5.3/2.0 – 6.4/6.4/2.0 – 6.4/6.4/3.0 – 8/8/2.0 – 8/8/3.0 – 10.6/10.6/3.0 – 10.6/10.6/4.0 – 16/16/5.0 and 32/32/6.0

SLOTTED PRODUCTS



Slotted elements are offered as a visual alternative to classic perforations.

1 Micro-laminate, slotted
2 A1 coreboard, slotted
3 Balancer paper, slotted
4 Black acoustic membrane

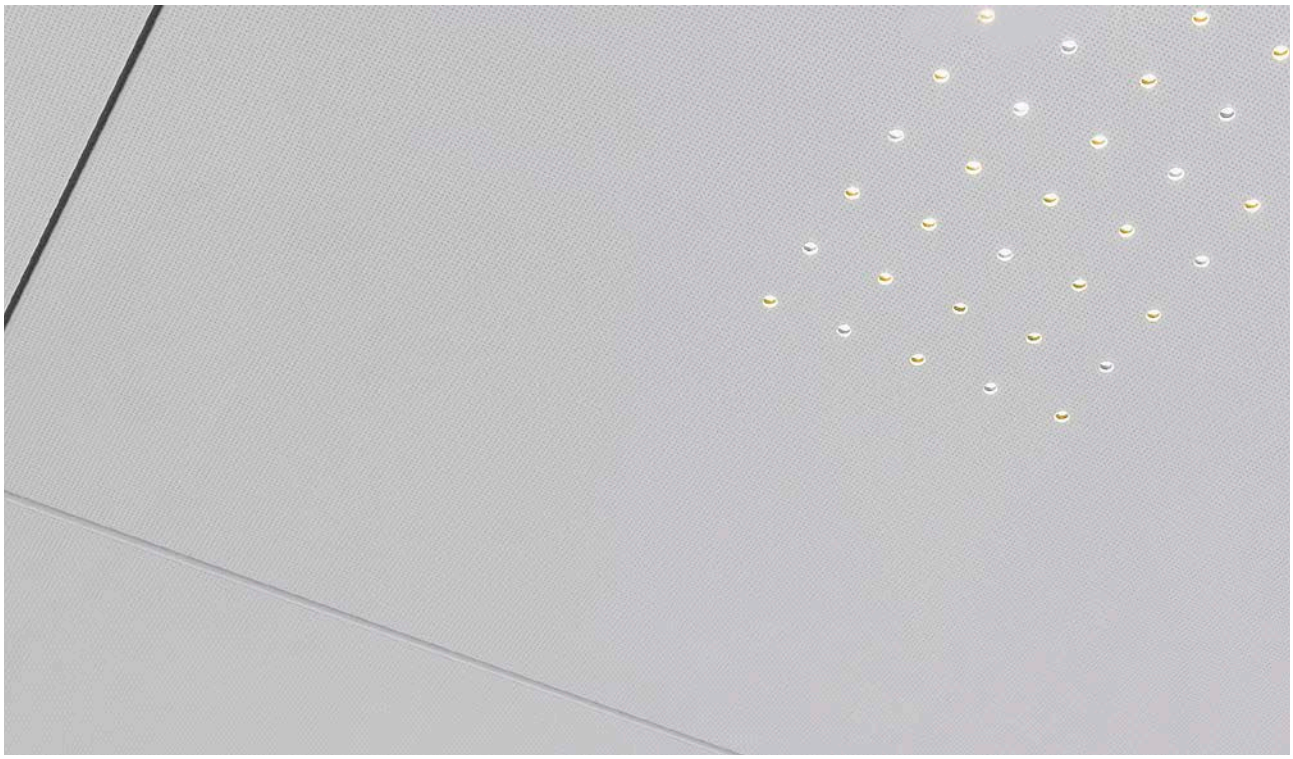
Possible slot patterns:
Linear 16: 16/2.0 and 16/3.0 – Linear 32: 32/2.0 and 32/3.0

PREFABRICATION

When prefabricating certified A2 products, it is important to ensure that edging is executed in compliance with regulatory requirements, i.e. either coated or with genuine aluminium edging. The use of ABS or other thermoplastic edging is not permitted.

Like all other acoustic products, A2 products can also be supplied as prefabricated components.

4.5 auriLUX® LED LIGHTING SYSTEM

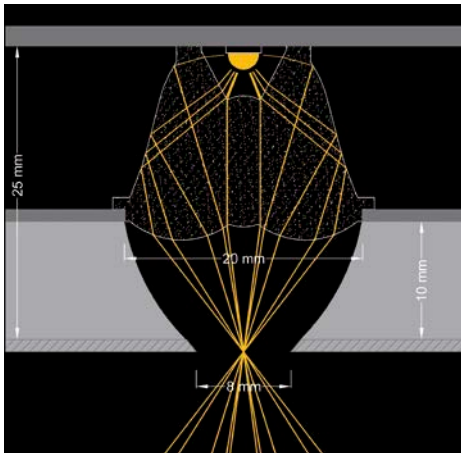


The auriLUX® lighting system with high-power LEDs meets rising architectural demands as well. It combines lighting and acoustics in one system.

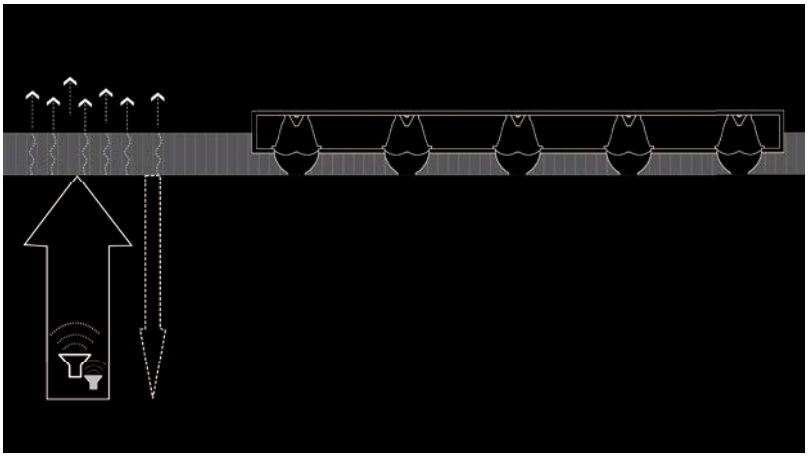
The concept developed by EGGER and its partners Akustik Plus, Bartenbach Lichtlabor and Digital Elektronik is a lighting solution that meets the highest design and functional standards, combining lighting and acoustics into an integrated system. One of the numerous advantages is the low structural height of just 30 mm.

As a modular ceiling system with a layout that can be customised, the concept with a broad selection of wood, uni and material decors offers extensive design freedom. Recyclable components and mercury-free illuminants ensure the environmental compatibility of the system. Thanks to energy-efficient lighting technology and acoustic boards made of the renewable raw material wood, the concept is sustainable with a long lifespan of up to 50,000 hours.

Thanks to the specially designed lens optics, light is emitted in a cone that assures glare-free lighting under all normal viewing angles. As a result, only small openings just 8 mm in size are visible in the ceiling viewed from below. The high-power LEDs with lens optics and integrated driver electronics are concealed in a compact housing behind the acoustically effective surface. These units form a plug-in system with a modular structure, permitting a variety of arrangements such as rows or arrays. Combining warm white and daylight white LEDs allows the colour temperature to be continuously adjusted from 3,000 to 6,000 Kelvin. The intelligent combination of energy-efficient lighting technology, acoustic effectiveness and ceiling panels opens up entirely new interior design possibilities without any competition between lighting and architecture. The system is a highly functional and sustainable lighting solution that meets demanding design standards.



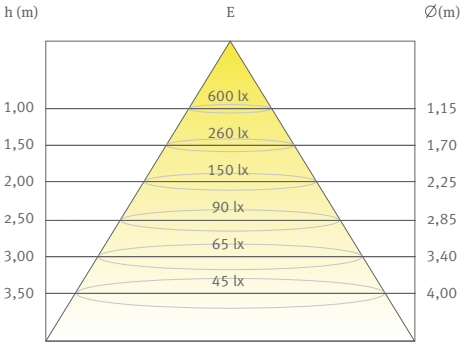
auriLUX® detailed cross section



Principal cross section through a ceiling panel

auriLUX® LED MODULE 64 2 × 5

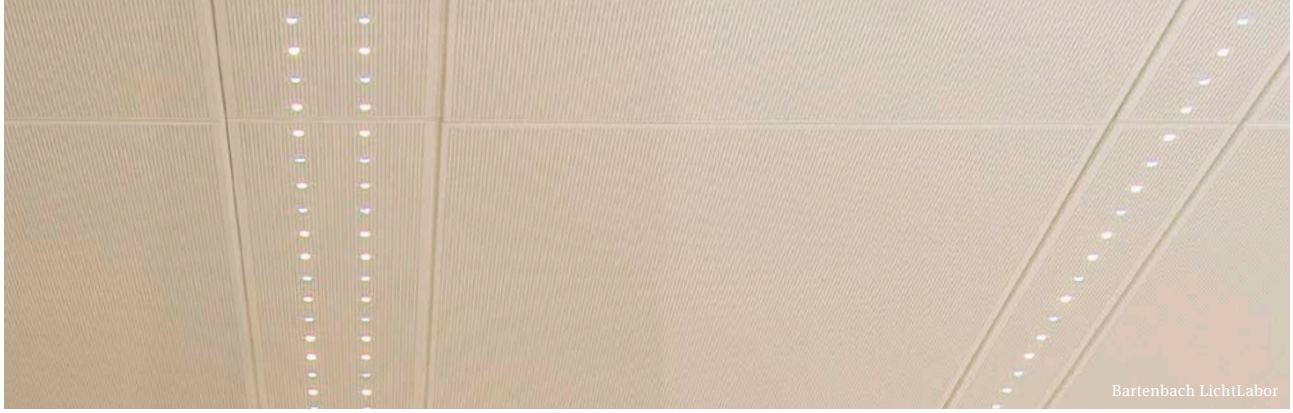
The dual-row module from the auriLUX® system with 5 high-power LEDs at 64 mm intervals per row is ideal for rooms with a high luminous flux demand per unit area. It can be realised with single-colour lighting such as cool white, neutral white and warm white or as a dimmable system. Sophisticated, thermally optimised heat transfer from the LED to the housing guarantees the longest possible LED lifespan. An additional heat sink is no longer required.



auriLUX® cone diagram 64,2 × 5

DIMENSIONING THE LIGHTING SYSTEM

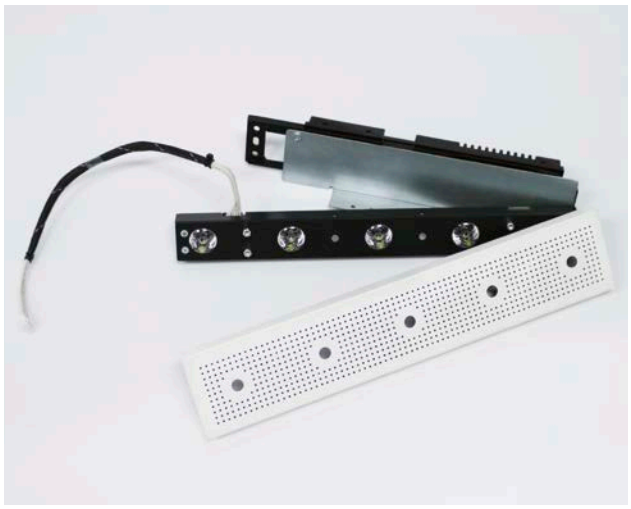
The cone diagram models the achievable average illumination in relation to the installation height of the lighting system. This allows the user to determine the approximate dimensioning. However, a lighting designer should be consulted in order to precisely calculate and plan a high-quality lighting system.



Microperforations that are barely perceptible to the user are applied to the acoustically effective ceiling elements. A highly effective broad-spectrum absorber, which is especially well suited to the frequency range of human speech, is concealed behind the surface which is available in a large selection of decors. The coreboard is made of sustainable wood-based materials.

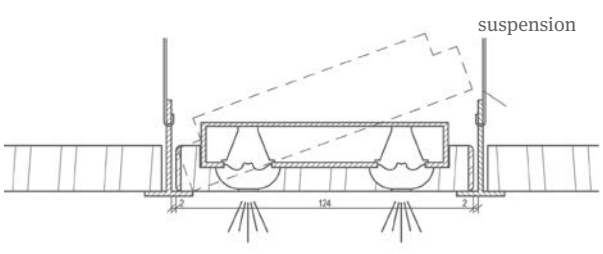
MODULAR STRUCTURE

Akustik Plus preassembles the installation and connection modules in accordance with individual project planning. All modules include preinstalled wiring and pass a quality assurance process on the test stand.



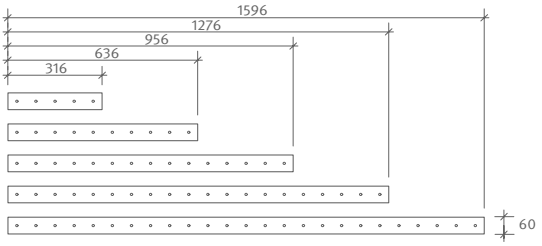
PRINCIPAL CROSS SECTION THROUGH A CEILING PANELL

All commercially available ceiling systems are suitable for installation. The example shows a classic suspended ceiling.

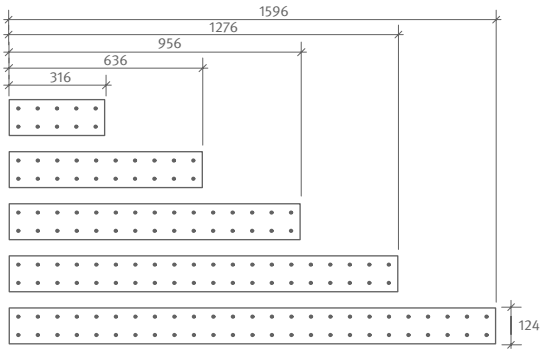


STRAIGHTFORWARD INSTALLATION

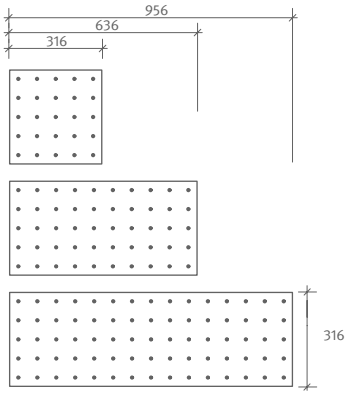
Working with prefabricated modules facilitates planning, commissioning and installation while also making subsequent revisions straightforward.



1 × series module sizes



2 × series module sizes



5 × series module sizes

ENTRANCE AREA OF THE EGGER CUSTOMER FORUM

The entrance area of the EGGER visitor forum was equipped with the light and acoustics concept in June of 2010. A modern ambiance results from the combination of the W1000 Premium White decor and a glossy ST30 surface. Prior to the conversion, the lighting situation in the room was unbalanced as a result of an unsuitable luminance distribution. Direct and reflection glare in the reflective floor was another problem. The redesign increased the illumination and luminance level. A balanced luminance distribution was achieved thanks to the lighting system, which fades into the background and puts the architecture into the spotlight.

Before the conversion

EGGER VIDEO CONFERENCE ROOM

An LED ceiling made of ProAkustik boards in the W1000 Premium White decor with the glossy ST30 surface was installed in the EGGER video conference room in June of 2010. The functionally and aesthetically appealing solution creates a pleasant atmosphere in the room.

Before the conversion: Glare from the dominant light fixtures impairs perception.

After the conversion, even basic lighting that has been optimally integrated into the room layout ensures a stable optical perception, leading to physical well-being and fatigue-free work.

YOUR ADVANTAGES

Light and acoustics in one system
- Integrated into the architecture
- Low structural height of just 30mm
- Especially well suited for projects in existing structures

Brilliant, two-dimensonal light
- brilliant light gives materials a high-quality effect
- soft shadows due to two-dimensional array

Glare free
- suitable for computer screen work stations and areas with high demands on visual comfort

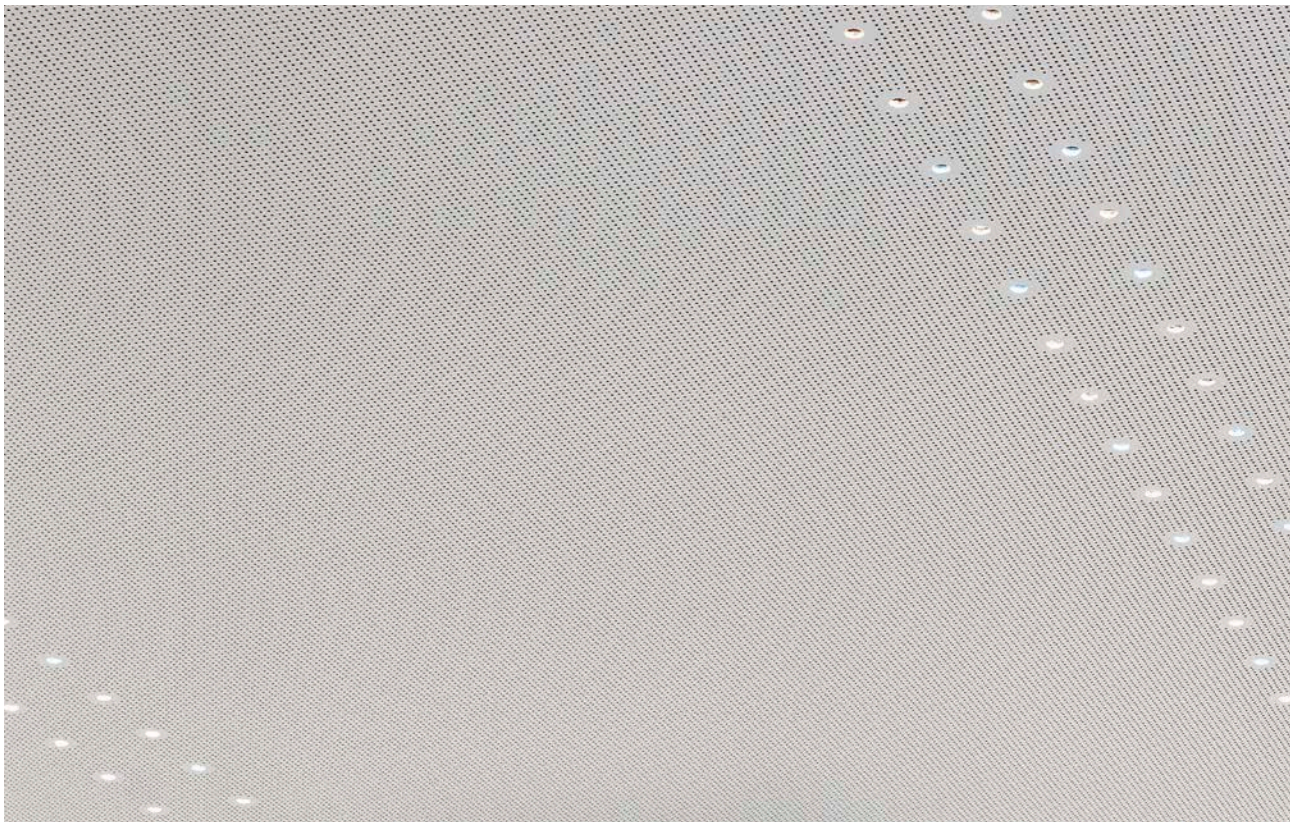
Changeable light colour
- adjustable from warm white to cool white for various light ambiences

High-quality acoustic solution
- barely noticeable micro perforation and optimal room acoustic
- Numerous perforation patterns possible

Creative freedom
- modular, freely designable ceiling system
- large choice of plain decors, wooden decors and material designs.

Projects in existing structure
- Subsequent renovation and remediation
- Improvement of room acoustics and lighting conditions

Sustainable
- Energy-efficient
- Mercury-free illuminants
- Long lifespan up to 50,000 hours
- Sustainable material wood
- Recyclable components



CONTACT LED auriLUX®

Consulting, planning, fabrication and distribution of pre-assembled light and acoustic modules ready for installation represent the core competence of Akustik Plus.

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F +43 512 3338 - 88
info@bartenbach.com
www.bartenbach.com

5 STOCK PROGRAMME AND AVAILABILITY

PROACOUSTIC

Our ProAcoustic Classic and ProAcoustic Finest acoustic elements are available from inventory in quantities of 1 unit in 10 decors, with the decor on one side or as furniture boards with the decor on both sides.

ProAcoustic Finest 1.8/1.8/0.5 and ProAcoustic Classic 3/3/1.0

1. Diagonally perforated laminate 1.8/1.8/0.5 or linear 3/3/1,0
2. Black acoustic fleece
3. EUROSPAN® raw chipboard in 18 mm perforated
4. Black acoustic fleece
5. Laminate balancer paper, linear microperforation

Areas of application:

Availability

Format: 2,800 × 1,310 × 20 mm – perforated usable length, Finest 2,770 mm

Delivery: stock decors from 1 unit or 10 units per package. Other ProAcoustic Classic decors from 1 unit and from 10 units for ProAcoustic Finest

LOW-FLAMMABILITY AND FIRE-RESISTANT ACOUSTIC BOARDS can also be produced with Euroclass B coreboards or with Euroclass A2 coreboards.

Euroclass B – tested coreboard

Format: 2,800 × 1,310 × 21 mm – maximum dimensions 3,500 × 1,310 mm

Delivery: stock decors from a quantity of 1 unit, other decors from 10 units

Euroclass A2 – tested coreboard

Format: 2,800 × 1,260 × 16 and 18 mm

Delivery: stock decors from a quantity of 1 unit, other decors from 10 units

ProAcoustic Finest Furniture Board 1.8/1.8/0.5 and ProAcoustic Classic Furniture Board 3/3/1.0

1. Diagonally perforated laminate 1.8/1.8/0.5 or linear 3/3/1.0
2. Black acoustic fleece
3. EUROSPAN® Rohspanplatte in 18 mm perforated
4. Black acoustic fleece
5. Diagonally perforated laminate 1.8/1.8/0.5 or linear 3/3/1.0

Areas of application:

Availability

Format: 2,800 × 1,310 × 19 mm – perforated usable length, Finest 2,770 mm

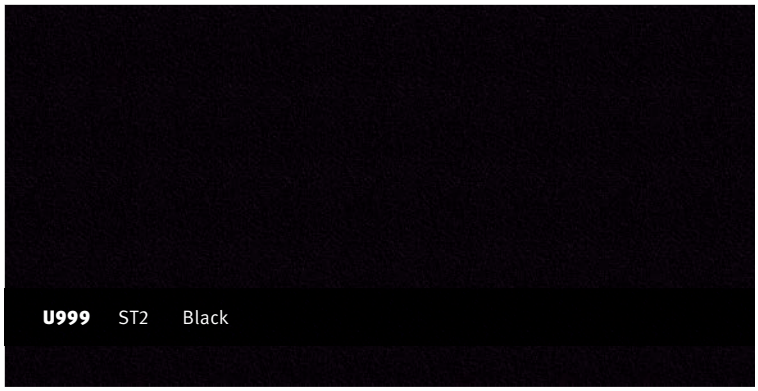
Delivery: stock decors from 1 unit or 10 units per package. Other ProAcoustic Classic Furniture Board decors from 1 unit and from 10 units for ProAcoustic Finest furniture board

OTHER PRODUCT OPTIONS

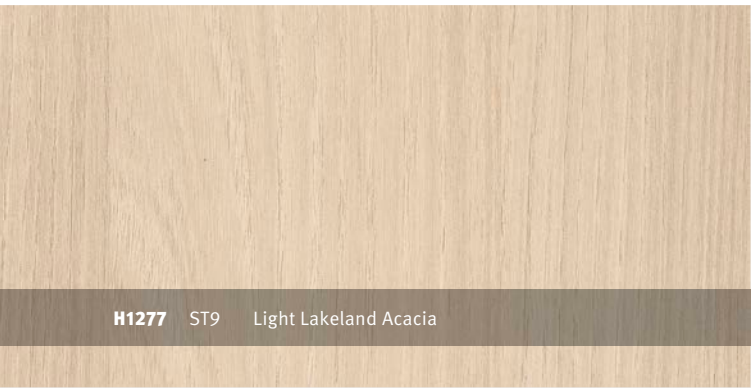
Our stock products can be made to order up to a maximum length of 3,500 mm. In addition to other formats, the assembly and delivery of components can also be realised without any difficulties. EURODEKOR® melamine faced chipboard, laminates and EGGER ABS security edging are available from inventory in matching decors.

STOCK DECORS PROAKUSTIK

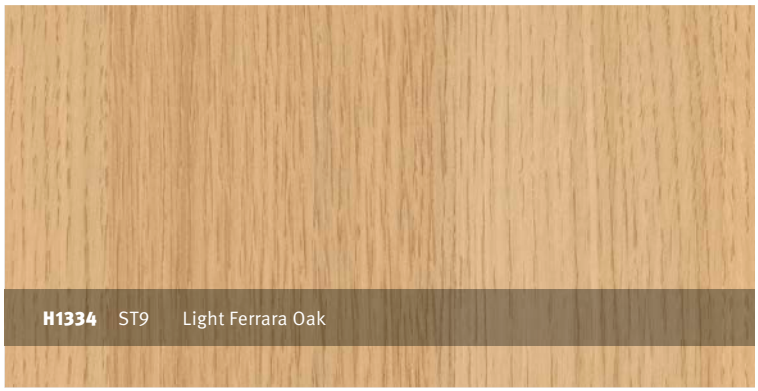
W980 ST15 Platinum White



U999 ST2 Black

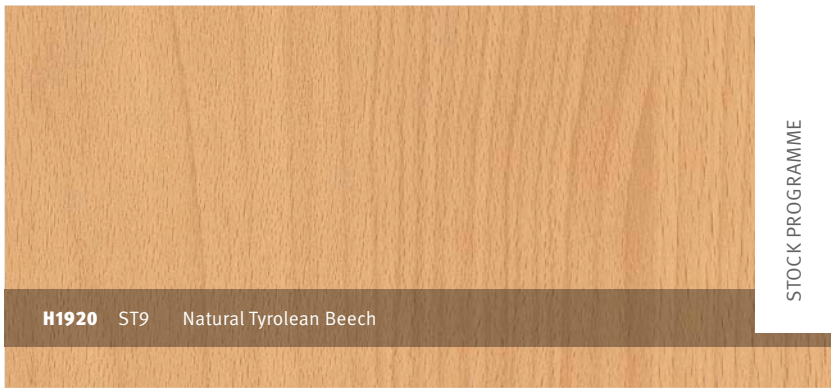


H1277 ST9 Light Lakeland Acacia

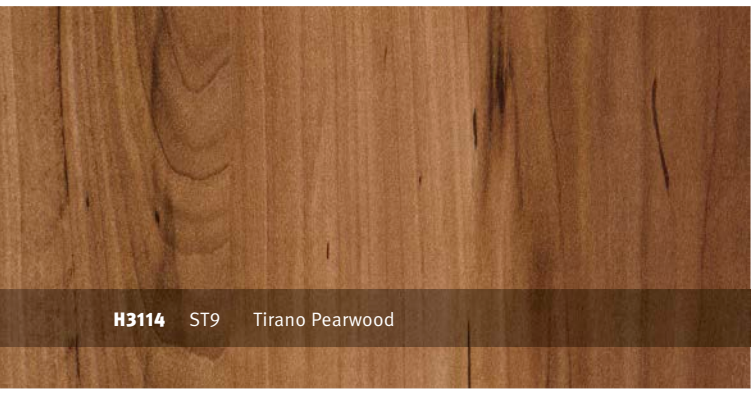


H1334 ST9 Light Ferrara Oak

H1615 ST9 Romana Cherry

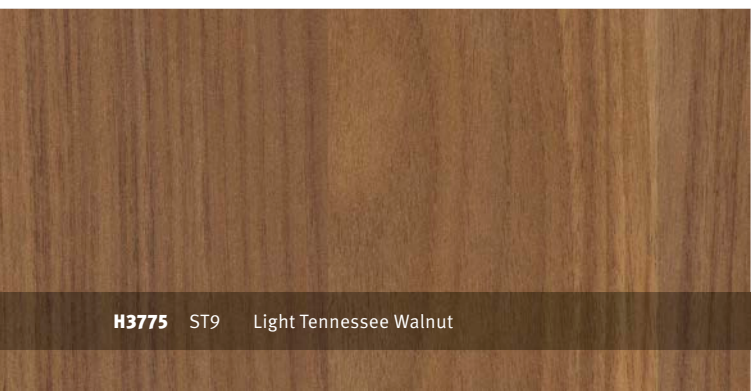


H1920 ST9 Natural Tyrolean Beech

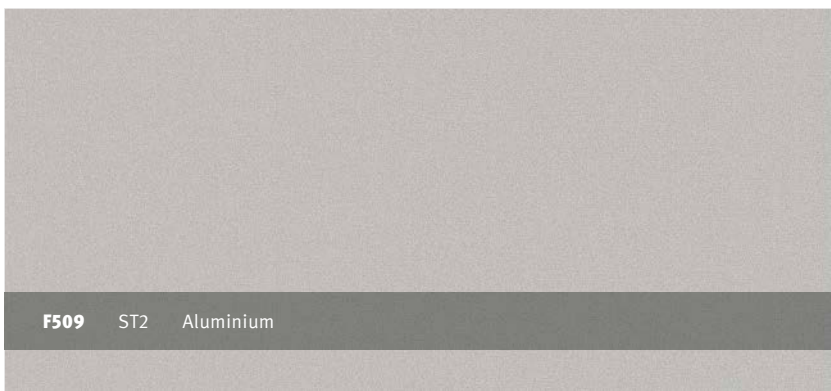


H3114 ST9 Tirano Pearwood

H3704 ST15 Tobacco Aida Walnut



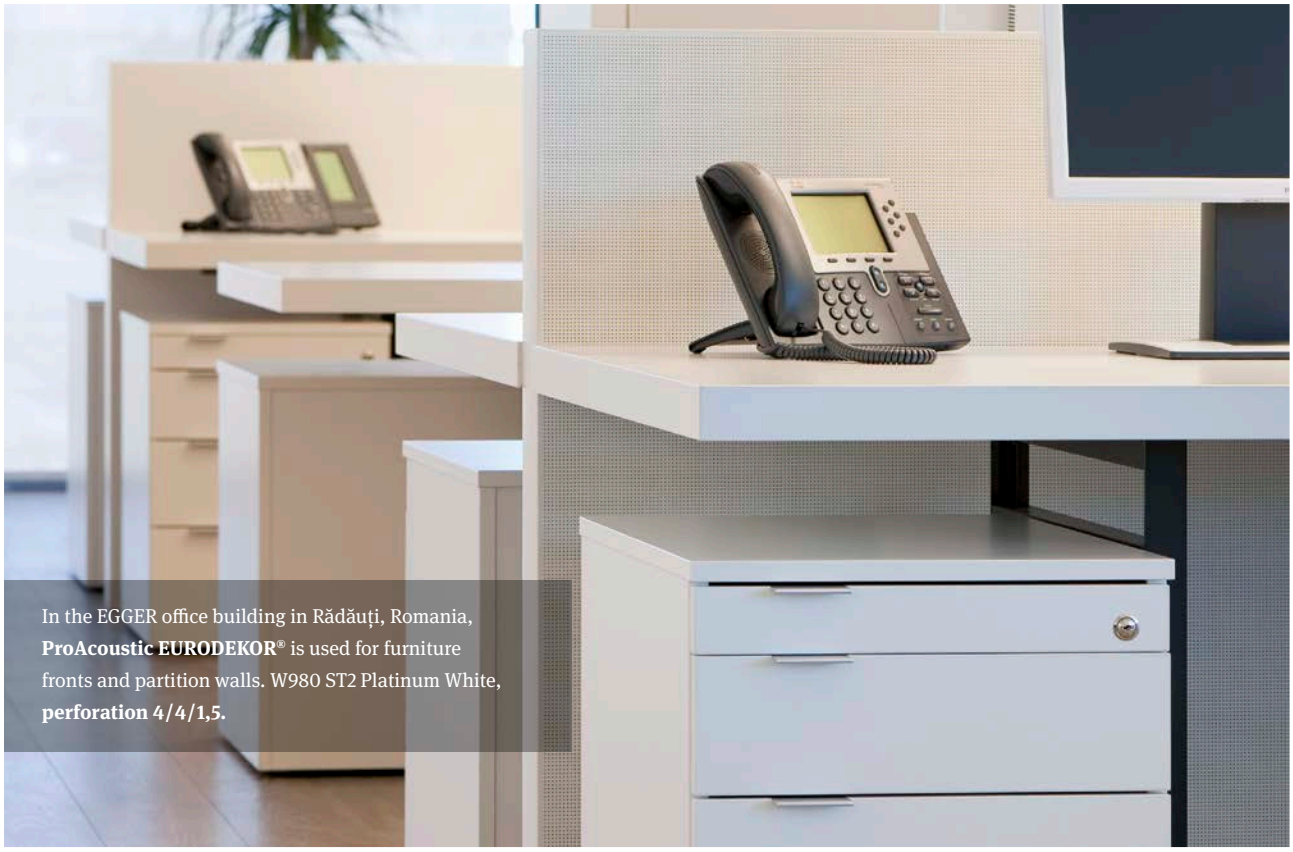
H3775 ST9 Light Tennessee Walnut



F509 ST2 Aluminium

ORDER SPECIFIC PRODUCTS

On the basis of the decor stock programme, the products ProAcoustic *light* and ProAcoustic *light* furniture board can be offered in the 1.8/1.8/0.5 and 3/3/1.0 perforations from a quantity of 1 unit in the dimensions 2,800 × 1,310 mm. All other acoustic products, whether perforated or slotted, are produced by individual customer request and therefore made to order. Thanks to the large number of different coreboards that can be realised with a wide variety of surfaces, perforations and slot patterns, the selection is virtually unlimited.



In the EGGER office building in Rădăuți, Romania, **ProAcoustic EURODEKOR®** is used for furniture fronts and partition walls. W980 ST2 Platinum White, **perforation 4/4/1,5.**

Availability

- Surface version – maximum dimensions:
  Laminate surfaces: 3,500 × 1,310 mm
  EURODEKOR® melamine faced*: 3,500 × 2,070 mm
  Veneered boards: 3,500 × 2,070 mm
  Lacquered surfaces: 3,500 × 1,320 mm
  * Including width separating cut at no charge, max. 1,600 mm
- Board thicknesses: from 4 to 38 mm – dependent upon type of substrate and surface finish
- Delivery: Supplied in full sheet sizes or as bespoke pre-fabricated components, exclusively made to order
- Lead times: Upon request

PROACOUSTIC A2

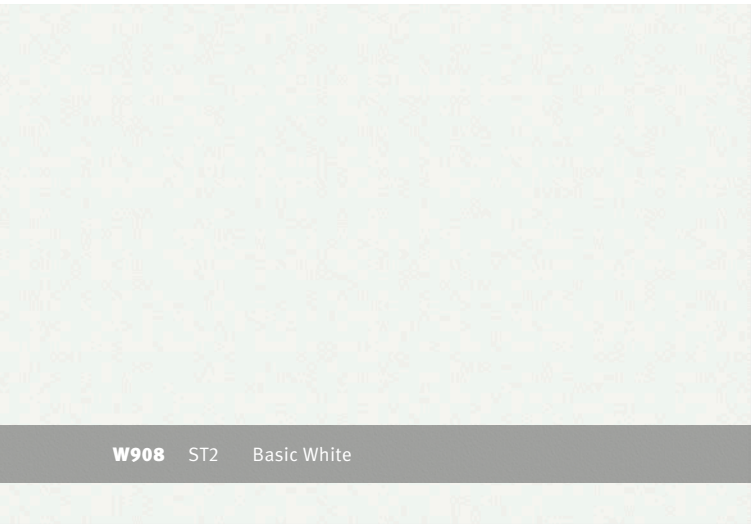
Availability

Formats: 2,800 and 2,300 × 1,260 mm or alternatively 2,800 and 2,300 × 625 mm

Thicknesses: 16 and 18 mm

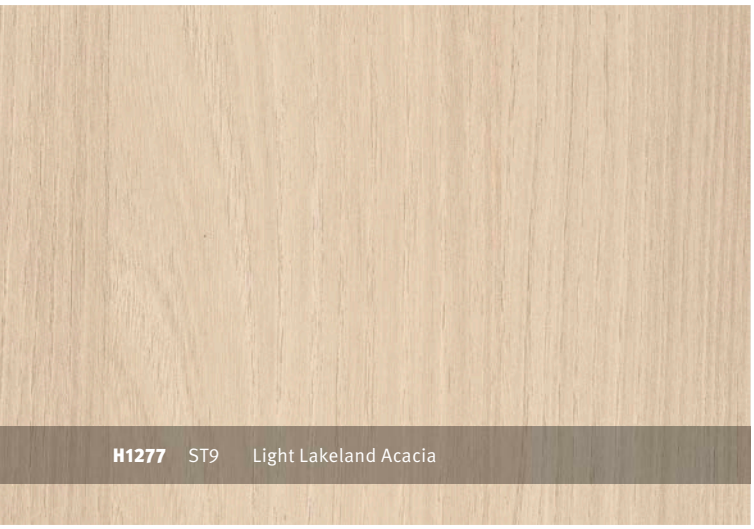
Delivery: Stock decors from 1 unit upwards, multiples of two boards in 2,800 and 2,300 × 625 mm, other decors from 35 units, in size 2,800 × 1,260 mm

STOCK DECORS PROACOUSTIC A2

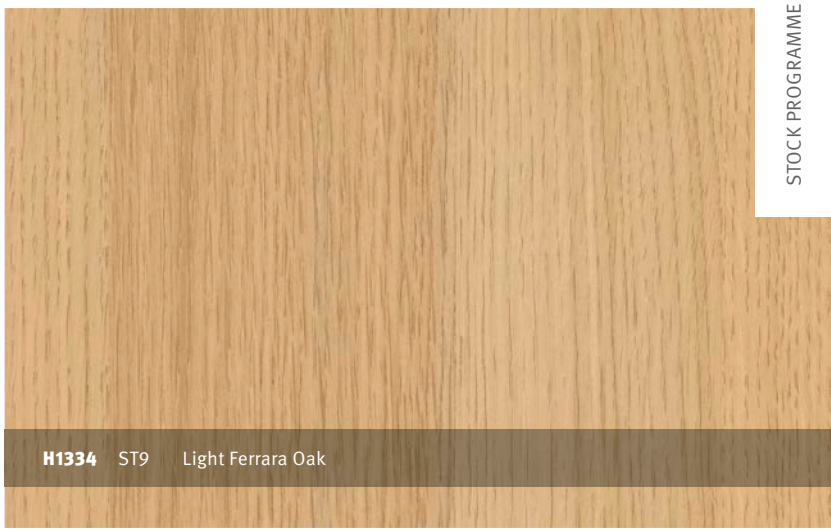


W908 ST2 Basic White

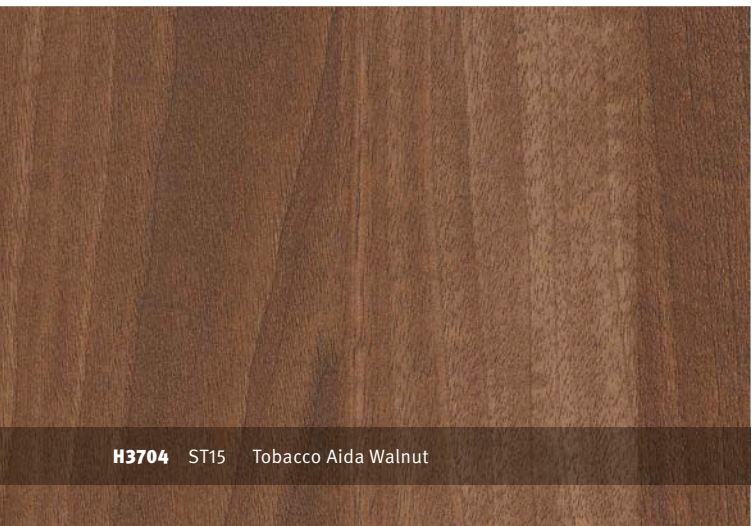
U708 ST15 Light Grey



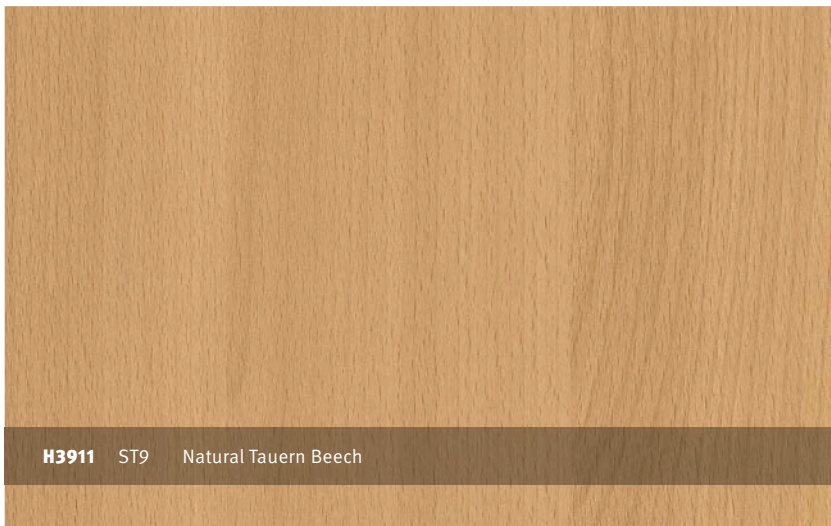
H1277 ST9 Light Lakeland Acacia



H1334 ST9 Light Ferrara Oak



H3704 ST15 Tobacco Aida Walnut



H3911 ST9 Natural Tauern Beech

6 SOUND ABSORPTION COEFFICIENT VALUES

Sound absorption coefficient values for all our products are of course available and, on application, we shall be pleased to submit the relevant certificates to you. The measurements were determined and evaluated in accordance with EN ISO 354 “Measurement of sound absorption in a reverberation room”, 2003 edition. The absorption coefficient values illustrated below apply to a CAVITY OF 50 MM and additional attenuation provided by a 30 MM LAYER of acoustic mineral wool.

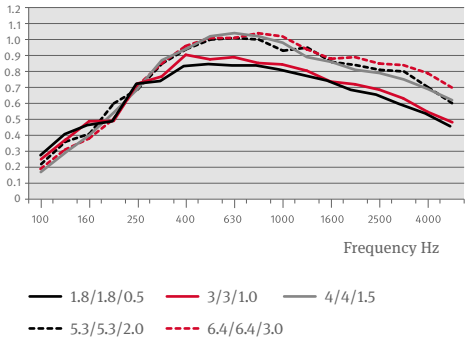
6.1 PERFORATIONS

SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 354:2003

Frequency [Hz]	Perforations				
	1.8/1.8/0.5 [α_S]	3/3/1.0 [α_S]	4/4/1.5 [α_S]	5.3/5.3/2.0 [α_S]	6.4/6.4/3.0 [α_S]
100	0.28	0.25	0.17	0.21	0.19
125	0.40	0.38	0.29	0.35	0.31
160	0.47	0.49	0.40	0.40	0.38
200	0.49	0.49	0.54	0.59	0.50
250	0.71	0.71	0.69	0.68	0.71
315	0.73	0.77	0.87	0.84	0.85
400	0.83	0.90	0.94	0.93	0.96
500	0.84	0.87	1.02	0.99	1.01
630	0.83	0.89	1.04	1.00	1.01
800	0.83	0.85	1.02	0.99	1.04
1000	0.80	0.84	0.98	0.92	1.02
1250	0.76	0.80	0.89	0.94	0.94
1600	0.73	0.73	0.86	0.85	0.88
2000	0.68	0.71	0.81	0.83	0.89
2500	0.65	0.69	0.79	0.80	0.85
3150	0.59	0.62	0.75	0.79	0.84
4000	0.53	0.54	0.69	0.69	0.79
5000	0.46	0.48	0.62	0.59	0.70
SAA*	0.74	0.77	0.87	0.86	0.89
NRC**	0.75	0.75	0.90	0.85	0.90

* **SAA** = **S**ound **A**bsorption **A**verage according to ASTM C 423
** **NRC** = **N**oise **R**eduction **C**oefficient according to ASTM C 423

SOUND ABSORPTION COEFFICIENT α_S

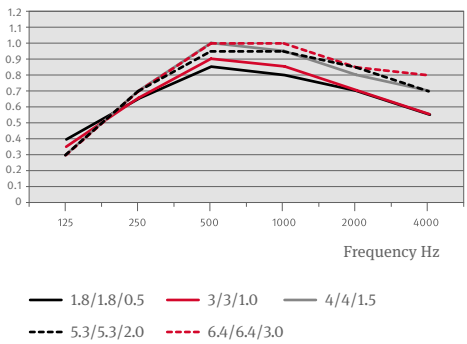


SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 11654

Frequency [Hz]	Perforations				
	1.8/1.8/0.5 [α_P]	3/3/1.0 [α_P]	4/4/1.5 [α_P]	5.3/5.3/2.0 [α_P]	6.4/6.4/3.0 [α_P]
125	0.40	0.35	0.30	0.30	0.30
250	0.65	0.65	0.70	0.70	0.70
500	0.85	0.90	1.00	0.95	1.00
1000	0.80	0.85	0.95	0.95	1.00
2000	0.70	0.70	0.80	0.85	0.85
4000	0.55	0.55	0.70	0.70	0.80

Perforations	1.8/1.8/0.5	3/3/1.0	4/4/1.5	5.3/5.3/2.0	6.4/6.4/3.0
α_w	0.70	0.70	0.85	0.85	0.90
Absorber class	C	C	B	B	A

SOUND ABSORPTION COEFFICIENT α_P

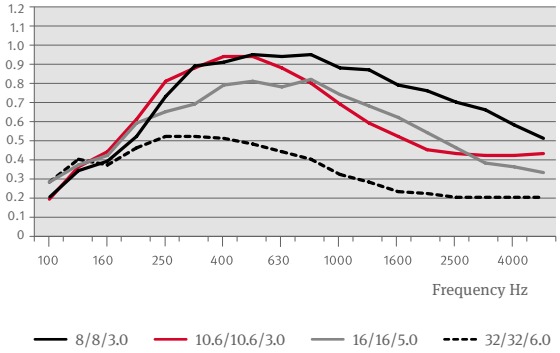


SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 354:2003

Frequency [Hz]	Perforations			
	8/8/3.0 [α_s]	10.6/10.6/3.0 [α_s]	16/16/5.0 [α_s]	32/32/6.0 [α_s]
100	0.21	0.29	0.20	0.29
125	0.35	0.38	0.37	0.41
160	0.40	0.43	0.45	0.38
200	0.53	0.60	0.62	0.47
250	0.74	0.66	0.82	0.53
315	0.90	0.70	0.89	0.53
400	0.92	0.80	0.95	0.52
500	0.96	082	0.95	0.49
630	0.95	0.79	0.89	0.45
800	0.96	0.83	0.81	0.41
1000	0.89	0.75	0.70	0.33
1250	0.88	0.69	0.60	0.29
1600	0.80	0.63	0.53	0.24
2000	0.77	0.55	0.46	0.23
2500	0.71	0.47	0.44	0.21
3150	0.67	0.39	0.43	0.21
4000	0.59	0.37	0.43	0.21
5000	0.52	0.34	0.44	0.21
SAA*	0.83	0.69	0.72	0.39
NRC**	0.80	0.70	0.70	0.40

* **SAA** = **S**ound **A**bsorption **A**verage according to ASTM C 423
** **NRC** = **N**oise **R**eduction **C**oefficient according to ASTM C 423

SOUND ABSORPTION COEFFICIENT α_s

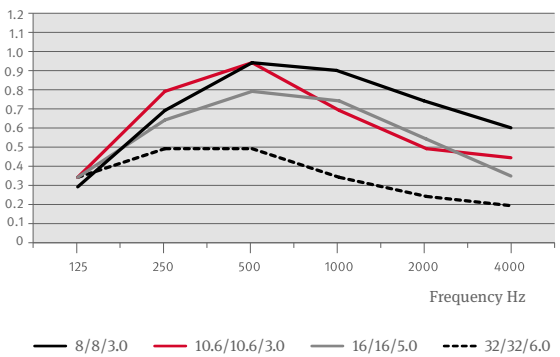


SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 11654

Frequency [Hz]	Perforations			
	8/8/3.0 [α_p]	10.6/10.6/3.0 [α_p]	16/16/5.0 [α_p]	32/32/6.0 [α_p]
125	0.30	0.35	0.35	0.35
250	0.70	0.65	0.80	0.50
500	0.95	0.80	0.95	0.50
1000	0.90	0.75	0.70	0.35
2000	0.75	0.55	0.50	0.25
4000	0.60	0.35	0.45	0.20

Perforations	8/8/3.0	10.6/10.6/3.0	16/16/5.0	32/32/6.0
α_w	0.75	0.55 (LM)	0.55 (LM)	0.3 (L)
Absorber class	C	D	D	D

SOUND ABSORPTION COEFFICIENT α_p



6.2 SOUND ABSORPTION SURFACE FOR PERFORATED FURNITURE BOARDS

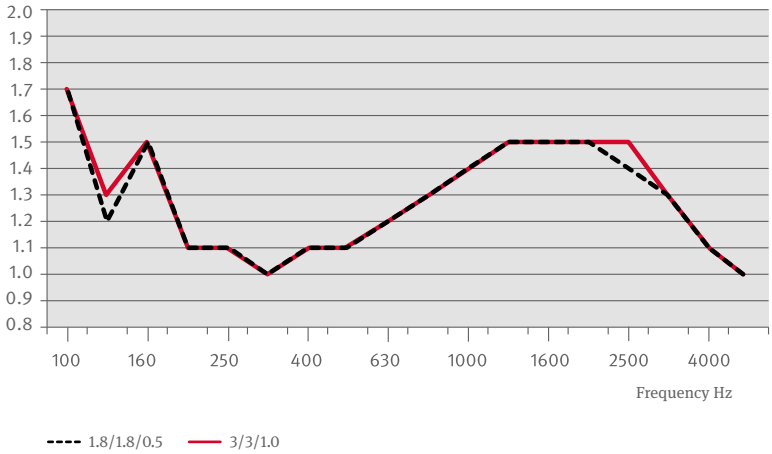
Equivalent absorption area of a cabinet, set up in free space. The following measurements were taken and evaluated according to EN ISO 354:2003-12.

Version 1

Office cabinet with acoustically effective sliding doors;
with folders – cabinet 70 % full
Dimensions: 1,600 × 1,163 × 453 mm
incl. 40 mm base

Frequency [Hz]	Equivalent absorption area A [m²]	
	1.8/1.8/0.5 [A_{obj}]	3/3/1.0 [A_{obj}]
100	1.7	1.7
125	1.2	1.3
160	1.5	1.5
200	1.1	1.1
250	1.1	1.1
315	1.0	1.0
400	1.1	1.1
500	1.1	1.1
630	1.2	1.2
800	1.3	1.3
1000	1.4	1.4
1250	1.5	1.5
1600	1.5	1.5
2000	1.5	1.5
2500	1.4	1.5
3150	1.3	1.3
4000	1.1	1.1
5000	1.0	1.0

EQUIVALENT ABSORPTION AREA A [m²]



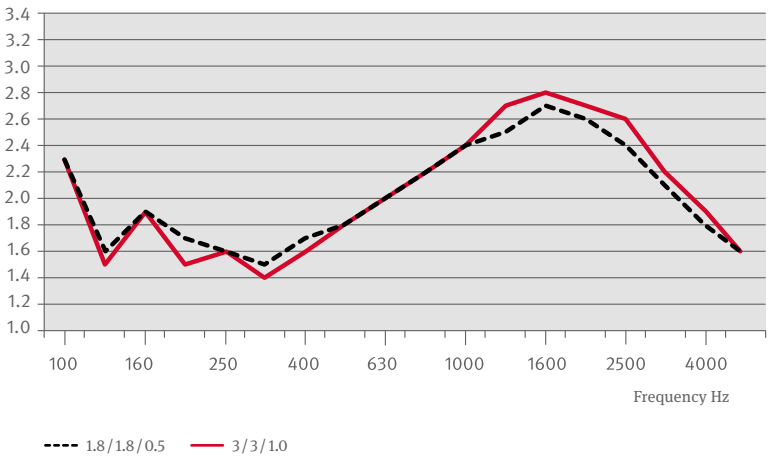
Version 2

Same as 1, but also with acoustically effective rear panel

Dimensions: 1,600 × 1,163 × 453 mm incl. 40 mm base

Frequency [Hz]	Equivalent absorption area A [m²]	
	1.8/1.8/0.5 [A_{obj}]	3/3/1.0 [A_{obj}]
100	2.3	2.3
125	1.6	1.5
160	1.9	1.9
200	1.7	1.5
250	1.6	1.6
315	1.5	1.4
400	1.7	1.6
500	1.8	1.8
630	2.0	2.0
800	2.2	2.2
1000	2.4	2.4
1250	2.5	2.7
1600	2.7	2.8
2000	2.6	2.7
2500	2.4	2.6
3150	2.1	2.2
4000	1.8	1.9
5000	1.6	1.6

EQUIVALENT ABSORPTION AREA A [m²]



6.3 SLOTTED SPECIFICATIONS

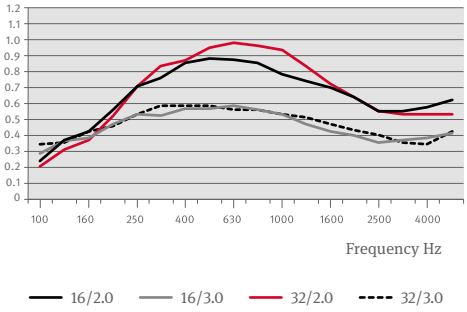
The absorption coefficient values illustrated below apply to a CAVITY OF 50 MM and additional attenuation provided by a 30 MM LAYER of acoustic mineral wool.

SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 354

Frequency [Hz]	Slot Patterns			
	Linear Micro 16 [α_s]	Linear Micro 32 [α_s]	Linear Deluxe 16 [α_s]	Linear Deluxe 32 [α_s]
100	0.24	0.29	0.21	0.35
125	0.38	0.38	0.21	0.36
160	0.42	0.39	0.38	0.42
200	0.57	0.48	0.52	0.47
250	0.71	0.54	0.71	0.53
315	0.76	0.53	0.84	0.59
400	0.86	0.57	0.88	0.59
500	0.89	0.57	0.96	0.59
630	0.88	0.59	0.99	0.57
800	0.86	0.56	0.97	0.57
1000	0.79	0.53	0.93	0.54
1250	0.75	0.48	0.84	0.51
1600	0.70	0.42	0.72	0.48
2000	0.63	0.40	0.64	0.43
2500	0.56	0.36	0.56	0.40
3150	0.56	0.37	0.54	0.36
4000	0.58	0.38	0.54	0.35
5000	0.61	0.4	0.54	0.43
SAA*	0.75	0.50	0.80	0.52
NRC**	0.75	0.50	0.80	0.50

* **SAA** = **S**ound **A**bsorption **A**verage according to ASTM C 423
** **NRC** = **N**oise **R**eduction **C**oefficient according to ASTM C 423

SOUND ABSORPTION COEFFICIENT α_s

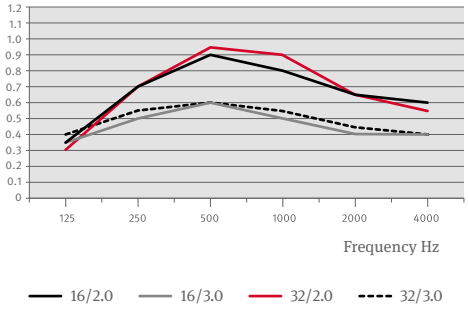


SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 11654

Frequency [Hz]	Slot Patterns			
	Linear Micro 16 [α_p]	Linear Micro 32 [α_p]	Linear Deluxe 16 [α_p]	Linear Deluxe 32 [α_p]
125	0.35	0.35	0.30	0.40
250	0.70	0.50	0.70	0.55
500	0.90	0.60	0.95	0.60
1000	0.80	0.50	0.90	0.55
2000	0.65	0.40	0.65	0.45
4000	0.60	0.40	0.55	0.40

Slot Patterns	Linear Micro 16	Linear Micro 16	Linear Deluxe 16	Linear Deluxe 32
α_w	0.70	0.50	0.70	0.50
Absorber class	C	D	C	D

SOUND ABSORPTION COEFFICIENT α_p

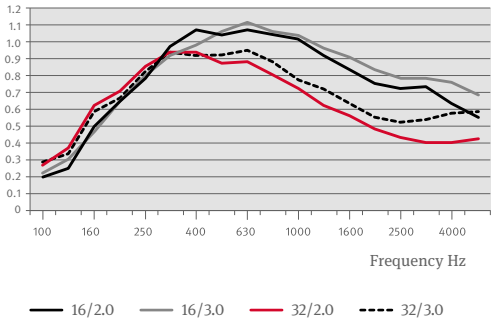


SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 354

Frequency [Hz]	Slot Patterns			
	Linear 16/2.0 [α_S]	Linear 16/3.0 [α_S]	Linear 32/2.0 [α_S]	Linear 32/3.0 [α_S]
100	0.21	0.22	0.27	0.29
125	0.26	0.30	0.37	0.34
160	0.51	0.48	0.62	0.59
200	0.65	0.65	0.71	0.67
250	0.79	0.80	0.85	0.81
315	0.97	0.92	0.93	0.94
400	1.07	0.99	0.93	0.92
500	1.04	1.07	0.88	0.93
630	1.07	1.11	0.89	0.95
800	1.04	1.06	0.80	0.89
1000	1.01	1.04	0.73	0.78
1250	0.91	0.96	0.63	0.71
1600	0.84	0.90	0.56	0.63
2000	0.75	0.84	0.49	0.55
2500	0.72	0.79	0.43	0.52
3150	0.73	0.79	0.40	0.54
4000	0.63	0.76	0.40	0.58
5000	0.56	0.69	0.42	0.59
SAA*	0.91	0.93	0.74	0.78
NRC**	0.85	0.90	0.75	0.80

* **SAA** = **S**ound **A**bsorption **A**verage according to ASTM C 423
** **NRC** = **N**oise **R**eduction **C**oefficient according to ASTM C 423

SOUND ABSORPTION COEFFICIENT α_S

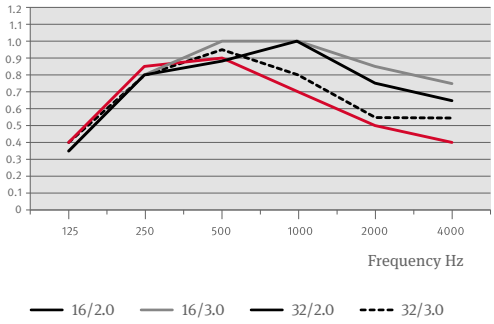


SOUND ABSORPTION COEFFICIENT ACCORDING TO EN ISO 11654

Frequency [Hz]	Slot Patterns			
	Linear 16/2.0 [α_P]	Linear 16/3.0 [α_P]	Linear 32/2.0 [α_P]	Linear 32/3.0 [α_P]
125	0.35	0.35	0.40	0.40
250	0.80	0.80	0.85	0.80
500	0.89	1.00	0.90	0.95
1000	1.00	1.00	0.70	0.80
2000	0.75	0.85	0.50	0.55
4000	0.65	0.75	0.40	0.55

Slot Patterns	Linear 16/2.0	Linear 16/3.0	Linear 32/2.0	Linear 32/3.0
α_w	0.80	0.90	0.55	0.65
Absorber class	B	A	D	C

SOUND ABSORPTION COEFFICIENT α_P



The stated sound absorption coefficient values and tests are excerpts only. Other test fixtures have also been tested and certificates of the relevant sound absorption coefficients are available on request. Please let us know if you would like to receive these.

7 PROCESSING AND INSTALLATION

7.1 PROCESSING RECOMMENDATIONS

EGGER acoustic boards are based on wood-based panel products which have been laminated with a decorative surface – A1 or A2 substrates excepted. Processing is as straightforward as working with other wood-based panel products. General safety rules and fundamental processing guidelines for wood-based panel products apply. To avoid the risk of injury, it is recommended that protective gloves be worn when handling EGGER ProAcoustic panels.

Additional system technology or special adhesives are not required. If you have decided to work with full press size boards, we shall be pleased to support you with technical advice ranging from application to processing, through to construction and fittings.

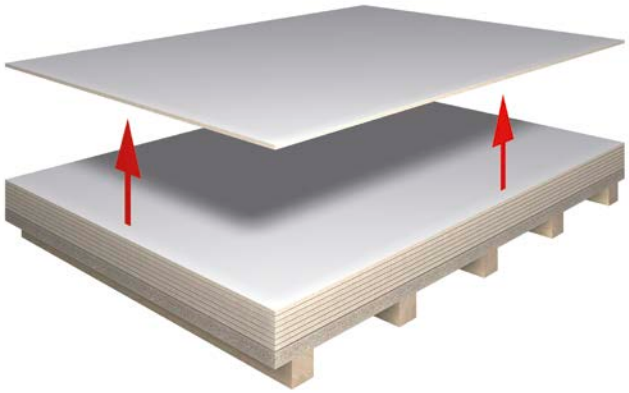
TRANSPORT AND STORAGE

The transportation and storage of acoustic elements requires the original packaging or the use of flat and sturdy pallets. When the original packaging is removed, the acoustic elements must be stored on full-surface, horizontal, level, sturdy protective boards. Direct floor contact and / or exposure to the sun must be avoided in all cases.

A protective board of at least the same format should be used to cover the top board. The acoustic elements must be stored in enclosed, dry storage rooms under normal climate conditions (approx. 18 – 25 °C and 50 – 65 % relative humidity).

HANDLING

After removing the packaging and prior to processing, the acoustic elements should be inspected for visual damage. Special care is required during transportation and handling, since the elements lose stability compared to continuous, homogenous, conventional board materials due to the perforations or slotting – depending on the size of the component. In principle, all persons transporting and / or handling acoustic boards should wear personal protective equipment such as gloves, safety footwear and suitable work clothing. The boards have to be lifted; shifting the decorative sides against each other or pulling them across each other must be avoided (see illustration).



CONDITIONING

Special attention must be paid to conditioning, in particular with acoustic elements. Even conventional wood-based materials are hygroscopic, which means they absorb humidity from the air and then release it again. The product responds to this behaviour with dimensions changes, which are referred to as shrinking or swelling. These dimension changes have to be taken into account, both during installation and when choosing the type and number of hardware elements. Due to their opened surfaces, acoustic elements respond to climate changes with greater dimension changes. A dimension change of 2.5 mm per metre has to be expected.

In principle, the storage and processing conditions for the elements should correspond as closely as possible to the climate at the subsequent place of use. Prior to the installation of acoustic elements, they should be conditioned for a few days at the installation location under the conditions of subsequent use. Complying with the storage recommendations is also required on construction sites.

PANEL SIZING

Before cutting to size, the element must be aligned in line with the first row of perforations. If the elements are to be edged subsequently, it is important that oversized cut panels or blanks are prepared and that the longitudinal cross cut is not carried out until after both sides have been edged. The elements are cut using panel or panel sizing saws. The quality of the cut is dependent upon a variety of factors. Apart from the correct height setting of the saw blade, machine and saw parameters must be observed. These include:

- Feed rate: 10 to 20 m / min
- Speed of rotation: 3,000 to 4,000 rpm
- Cutting speed: 40 to 70 m / sec.
- Tooth shape (carbide tipped): Trapezoidal flat tooth, alternating tooth or pointed Duplovit tooth

When cutting double-sided laminated furniture boards on machines without scoring blade, a hollow / pointed tooth saw blade has consistently proved to give an excellent finish.

EDGE PROCESSING

For the final sizing it is possible to employ a DIA jointing cutter on the edge banding machine. However, the maximum raw board allowance should not exceed 2 mm. If at all possible, the panels should be sized as part of the cutting process. Due to the alternating surface characteristics of the substrate it is recommended that only EGGER ABS Edging in a thickness of 2 mm be applied. Thinner edges should not be used in view of their inferior spanning characteristics.

Conventional hot melt adhesives such as EVA, Polyolefin or PUR are suitable for bonding EGGER ABS edge banding to acoustic elements. Due to the special machining of the substrate and the surface perforations or slot configurations, some of the hot-melt adhesive may ooze out; for this reason the application of a transparent adhesive is recommended. Please observe the machinery and adhesive suppliers' instructions.

7.2 INSTALLATION INSTRUCTIONS AND MOUNTING SYSTEMS

EGGER acoustic boards are suitable exclusively for INTERIOR APPLICATIONS. Interior applications are defined by a moisture content of the material that corresponds to a temperature of 20 °C and an ambient relative humidity that exceeds 65 % during only a few weeks of the year.

Before installing the acoustic elements, it is important to ensure that the structure has dried, i.e. the high humidity caused by concrete floor installation or plastering has to be reduced to a minimum. The perforations or slotting greatly increase the board surface, so that a change in the relative humidity and climate can result in dimension changes or warping. This point is important as both the room temperature and the relative humidity in modern office buildings can change drastically due to “night setback” – also see point “Conditioning”.

Acoustic elements can be mounted and installed in a wide variety of ways and with the help of various mounting systems.

The selection of mounting systems is varied and hardware that has undergone special testing must be used depending on the use of the rooms – for ball-impact-resistant applications for example. Mounting systems and hardware have to be tailored to the subsequent applications.

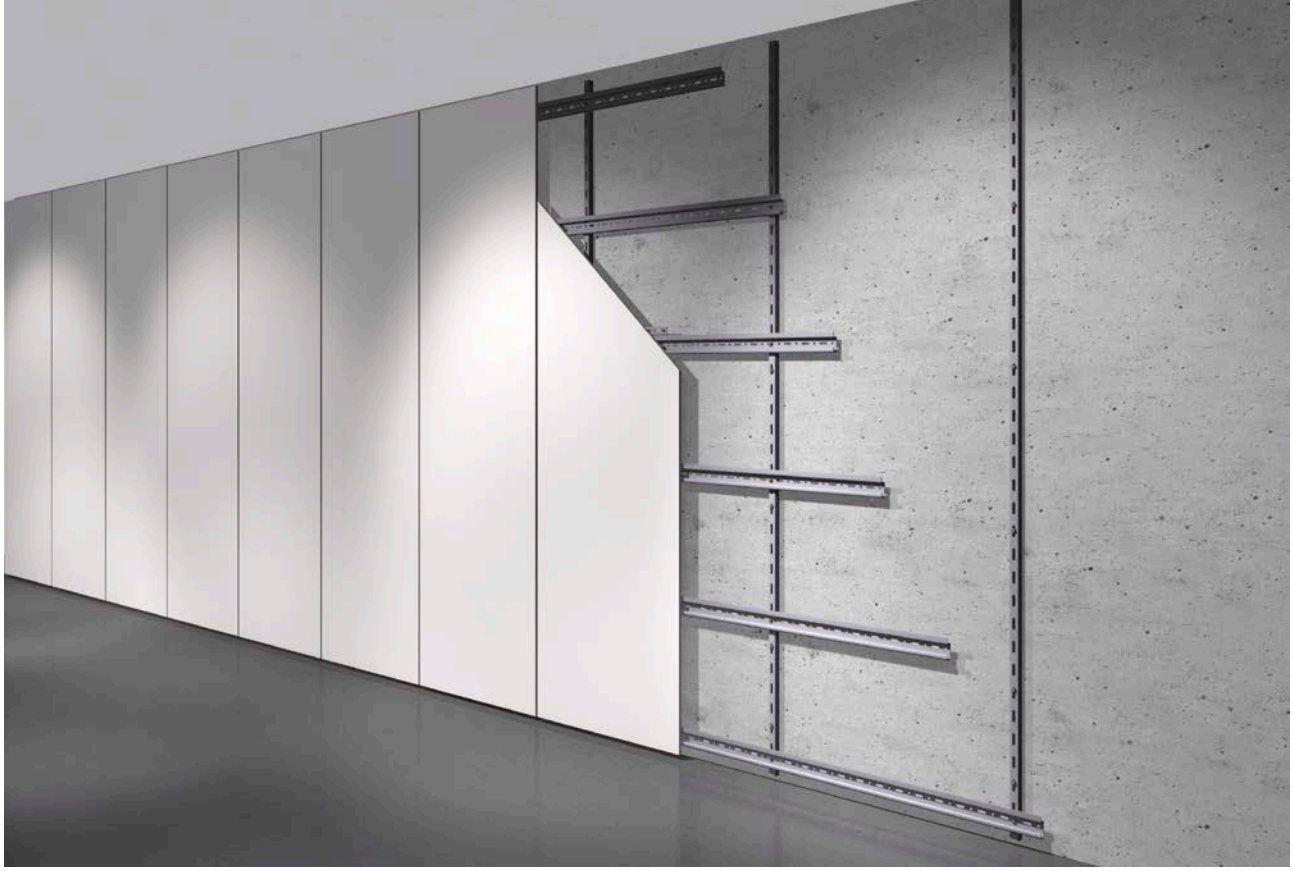
WALL PANELLING

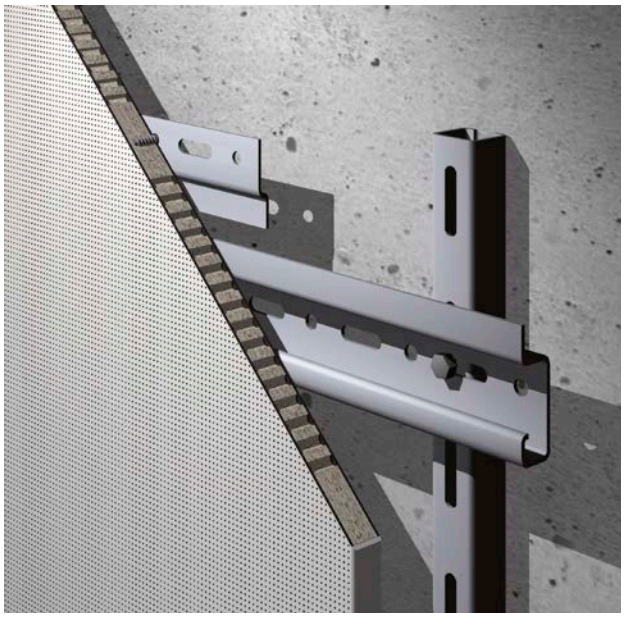
Wall panelling is a very common application. It requires a corresponding substructure for the visible or concealed mounting of the elements. Observe the following:

- Substructures and expansion joints have to be adapted to the swelling and shrinking behaviour of the elements – for a length of one meter, we recommend an expansion joint of at least 2.5 mm.
- The mounting points for the acoustic elements should not be spaced farther apart than 500 mm.
- Adequate ventilation behind the acoustic elements for climate equalisation has to be ensured.

THE CONCEALED FASTENING OF ACOUSTIC ELEMENTS by hanging permits straightforward disassembly and appears more visually appealing in comparison to visible screw connections. Removing the boards is quick and simple. Cables and pipework installed behind the elements are easy to reach. Depending on the chosen mounting system, the elements can be adjusted later on. Stress-relieved mounting of the elements is also possible. For all mounting methods that involve hanging, sufficient play must be allowed to raise and lower the elements. This air space or “hanging play” remains visible as a shadow gap.

HANGING BY MEANS OF SECTIONAL STRIPS – for this mounting method, a groove is cut into the horizontal substructure to hold the rebate rail attached to the wall element. For easier fitting, the rebate rail tongue should be thinner than the groove. The rebate rails on the acoustic elements should not extend across the full width of the elements but should be shortened in order to permit vertical air circulation. Rebate rails made of plywood or metal Z-profiles can be readily used. Insofar as screw connections with locking elements cannot be realised, additional gluing is possible.





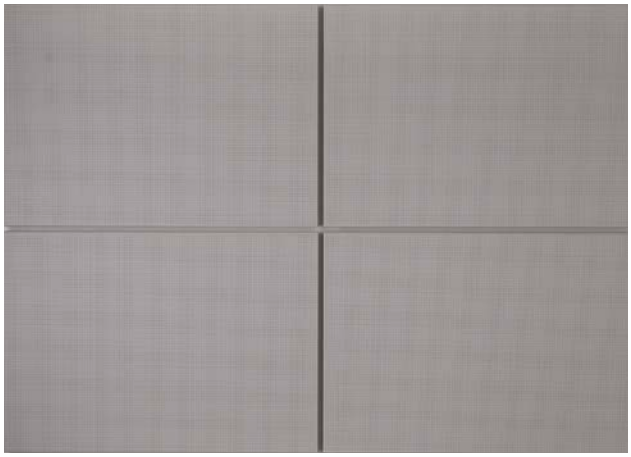
HANGING BY MEANS OF METAL HARDWARE – systems with metal hardware are also offered for mounting wall elements (see illustration on the left). The chosen system must be used according to the recommendations of the manufacturer in order to ensure secure installation.

Wall panelling with acoustic elements must be realised with a sufficient air space in all cases. Different climate conditions in front of and behind the elements can cause warping. This is prevented by ventilation behind the elements that equalises the temperature and humidity. It is important to ensure that the air intake and exhaust spaces remain unobstructed so that air circulation is not impeded. Numerous options are available to realise horizontal and vertical joints or seams.

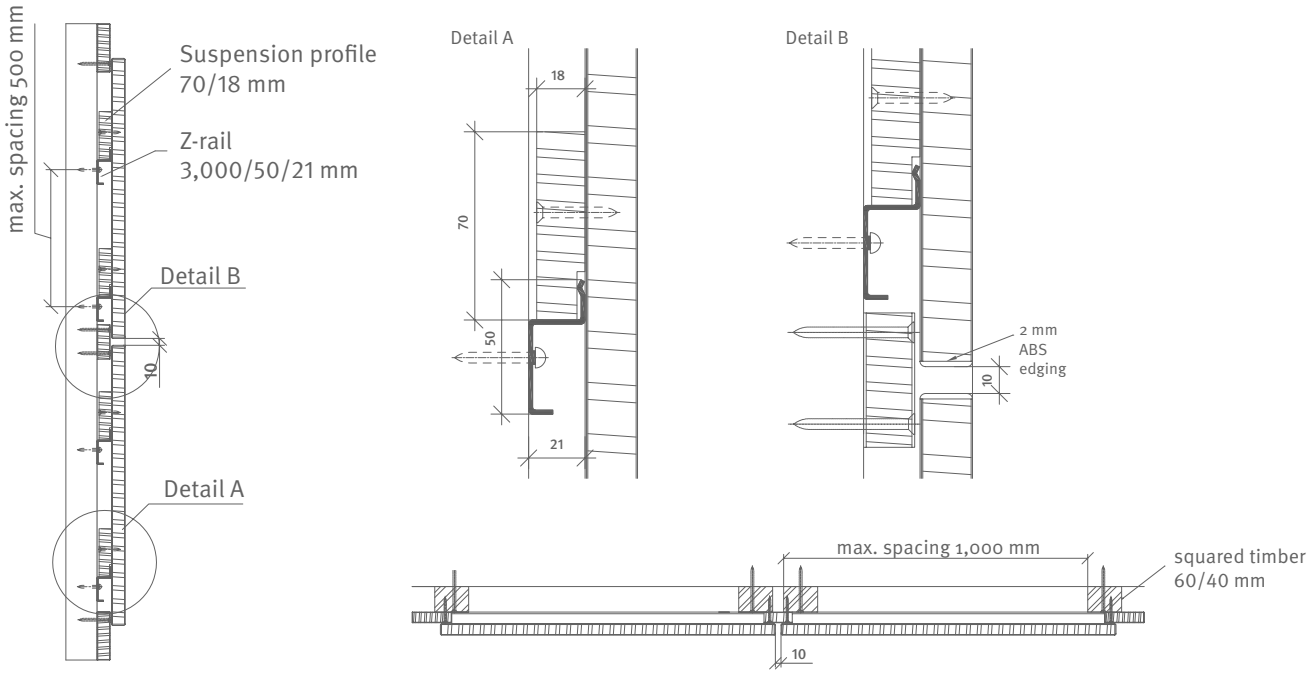
However, it is important to ensure that the elements have sufficient clearance for expansion.

The choice of the mounting system as well as the size and execution of the elements affect the subsequent appearance. We would like to present a few examples below.

EXAMPLE 1: Wall panelling with a 10 mm gap

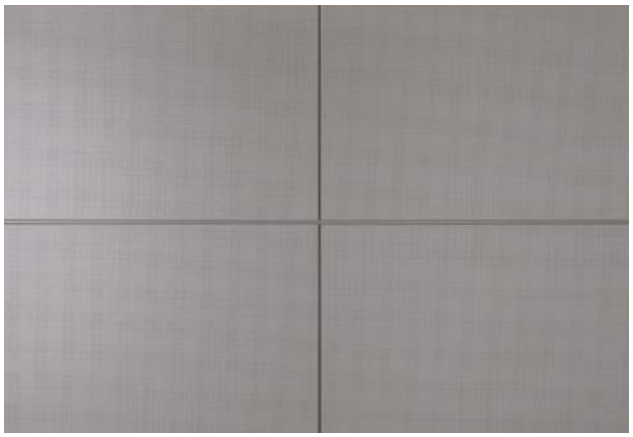


Substructure: vertical wood laths; max. distance to each other 1,000 mm; metal Z-rail suspension profile 21 mm; max. distance to each other 500 mm; EURODEKOR® as joint profile or shadow gap
Element mounting system: chipboard rebate rail
Element version: edged on four sides, 2 mm ABS edging, gap width 10 mm
Floor transition: EURODEKOR® shadow gap

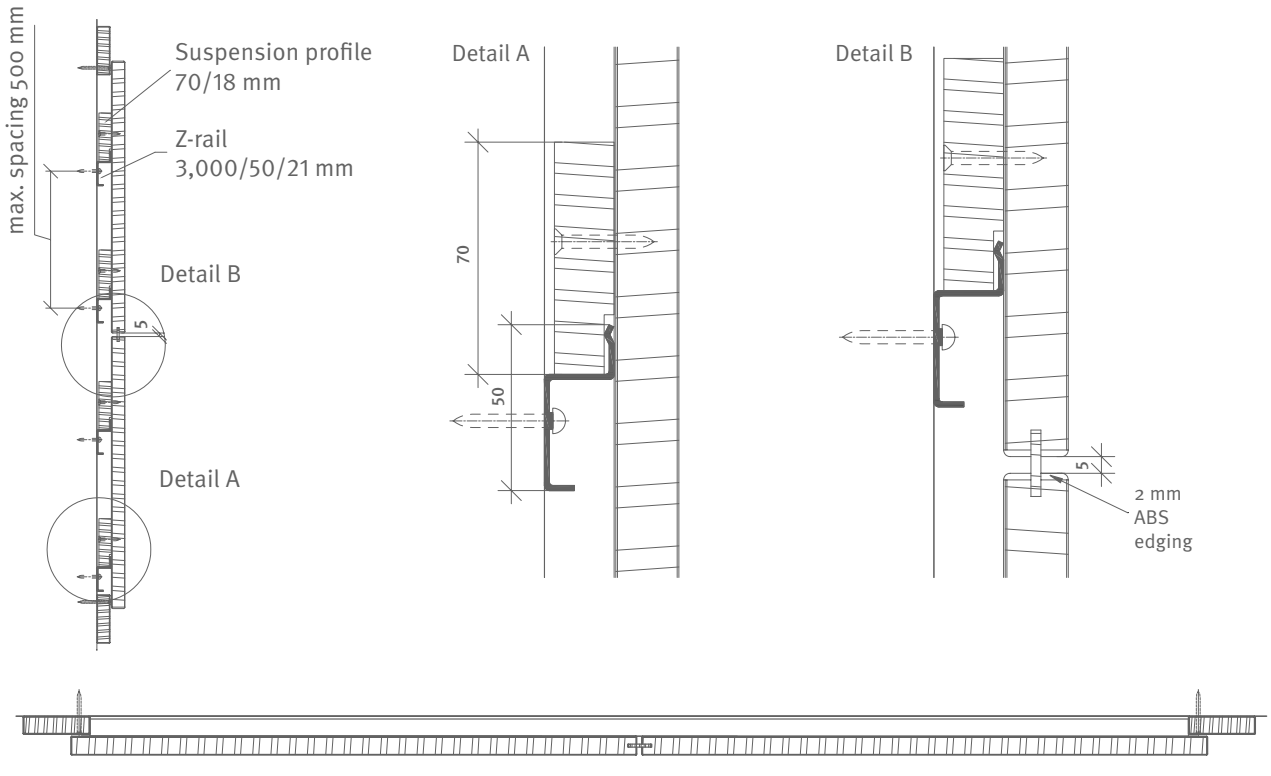


Depending on the required acoustic sound absorption coefficient values, the sub-construction may or may not include SOUND ATTENUATION MATERIAL.

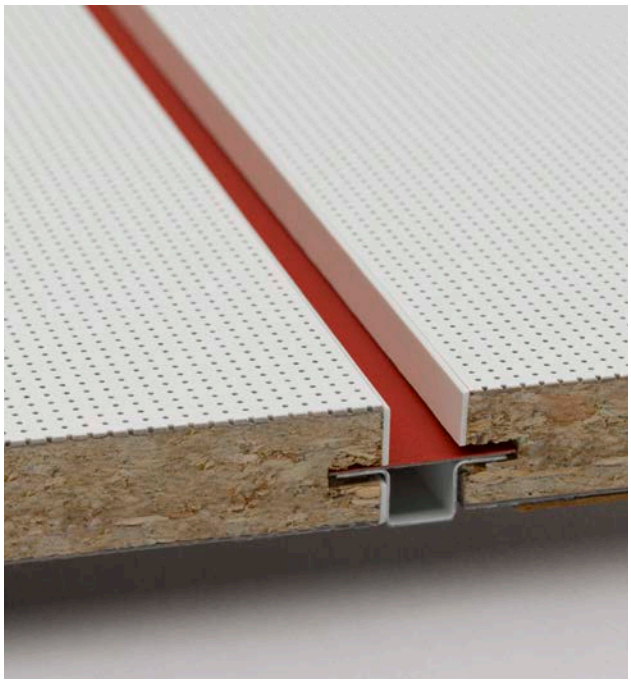
Example 2: Wall panelling with a 5 mm gap



Substructure: metal Z-rail suspension profile 21 mm; max. distance to each other 500 mm.
Element mounting system: chipboard rebate rail
Element version: edged and grooved on four sides, 2 mm ABS edging; visible wood tongue; joint 5
Floor transition: EURODEKOR® shadow gap

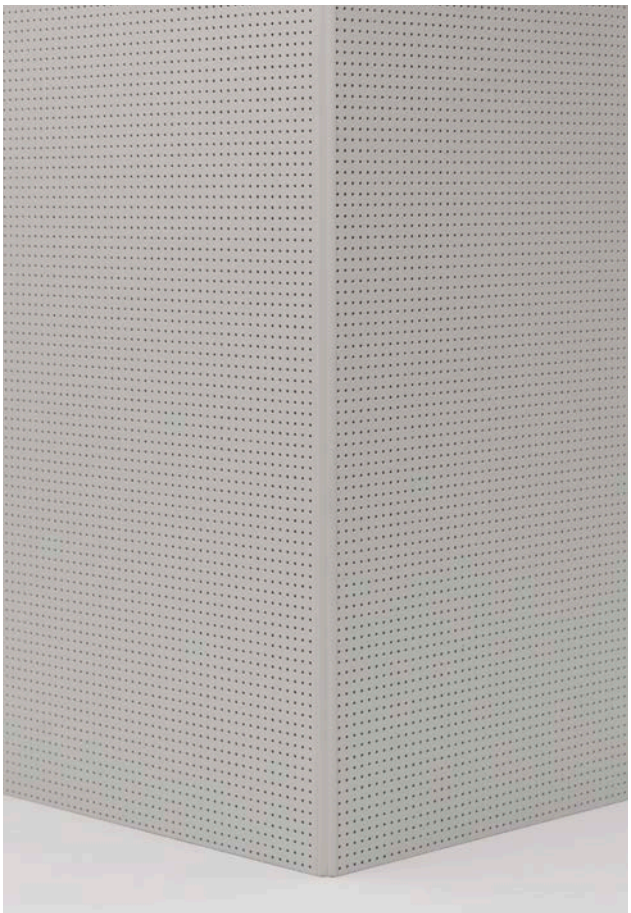


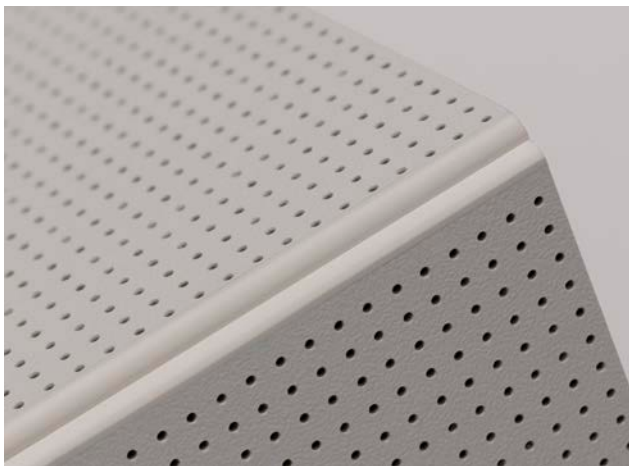
Example 3: Hat profile with visible laminate inlay as design feature

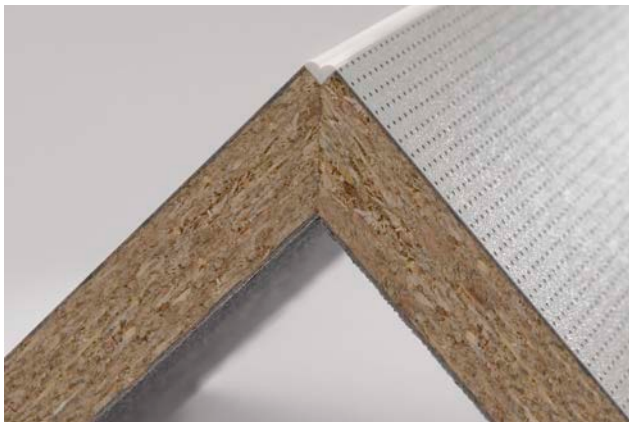


Detail: External corners

Example of external corners on mitered ProAcoustic Classic with 2 mm ABS edge banding







Alternative solutions For sub-construction and fixing systems

As already mentioned, there are many different alternative solutions available from a variety of manufacturers such as:

Suckow & Fischer Systeme GmbH & Co. KG
Waldstr. 2
64584 Biebesheim
Germany
T +49 6258 - 802 - 00
F +49 6258 - 802 - 11
www.suckow-fischer.de

Häfele GmbH & Co KG
Adolf-Häfele-Str. 1
72202 Nagold
Germany
T +49 7452 95 - 0
F +49 7452 95 - 200
www.haefele.de

PARTITION WALLS

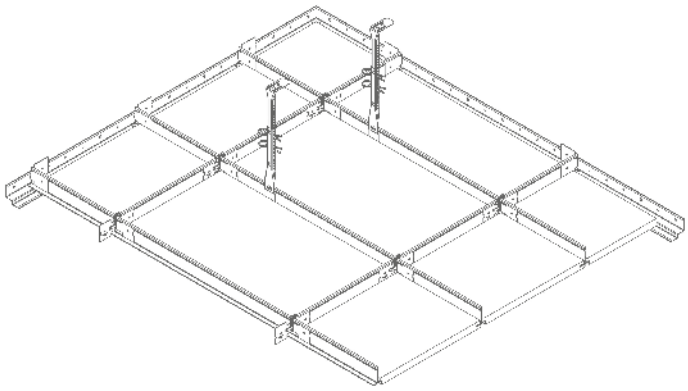
Room acoustics and building acoustics frequently clash in this field of application since partition walls need to be specially constructed in order to meet the requirements of sound insulation and sound absorption in equal measures. Sound insulation deals with the ability of building components to keep the sound transmission between two rooms at the lowest level possible. Sound absorption on the other hand describes the ability of materials to absorb sound or respectively to attenuate the incident sound energy. For detailed information on the fundamentals of room acoustics please refer to Section 8 The ABC's of Acoustics. For the construction of partition walls, our sound absorbing panels can be integrated into the systems of many partition wall manufacturers, but they can also be incorporated in special, custom-built structures. In these applications, the basic structure of the wall partition element assumes the function of a room dividing, sound transmission reducing building component. The integral sound absorbing elements provide optimum sound absorption.

Please contact us during your early planning stages – we shall be pleased to advise you on this complex subject in terms of acoustics as well as construction.

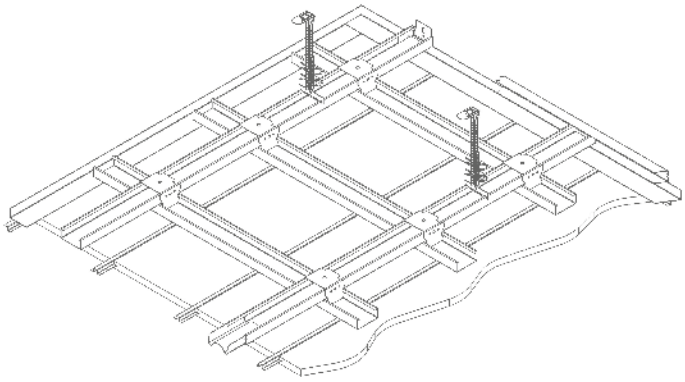
CEILINGS

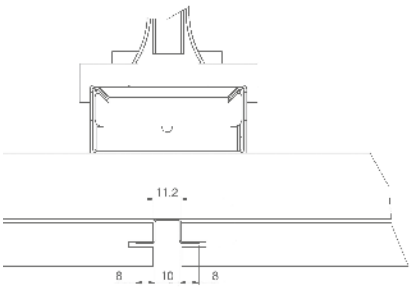
For the installation of ceiling systems, criteria similar to those for wall panelling systems apply. In other words, this field of application is also well covered by a large selection of different fixing system suppliers such as Suckow & Fischer or Häfele for example.

Example 1: Ceiling system 200 Suckow & Fischer

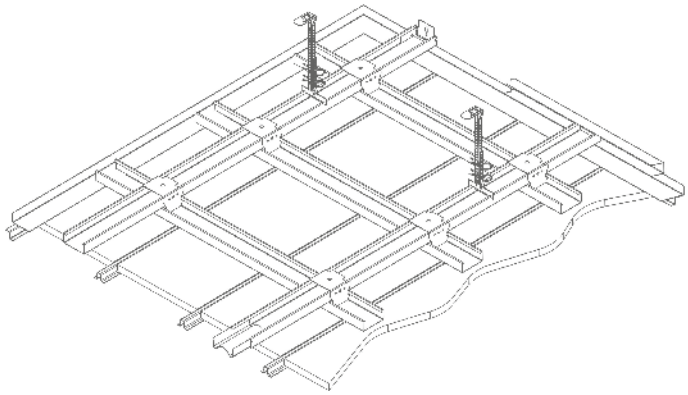


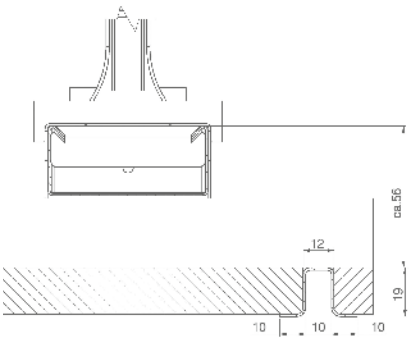
Example 2: Ball impact resistant ceiling system 270 Suckow & Fischer





Example 3: Ball impact resistant ceiling system 280 Suckow & Fischer

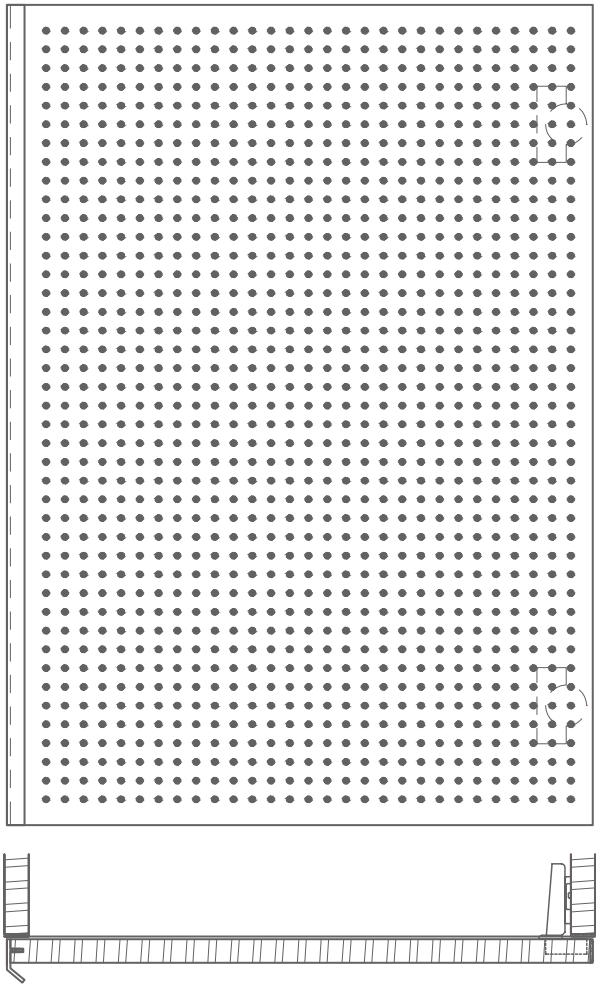


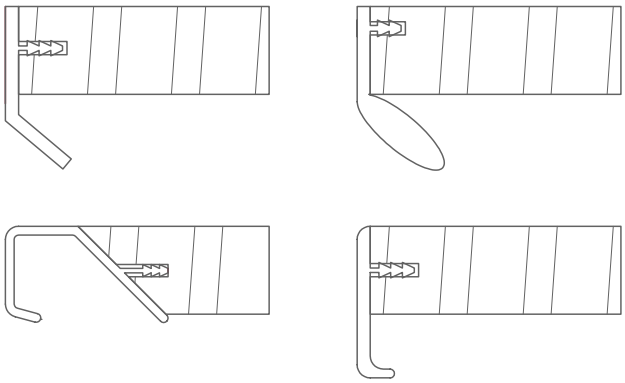


FURNITURE COMPONENTS

Individual solutions are in demand in the furniture component segment because a wide variety of dimensions, custom designs and hardware as well as technical particularities have to be taken into account. Depending on the room climate and component size, dimension changes or warping may occur with movable furniture components such as hinged and sliding doors. This is minimised or corrected by the use of continuous handle profiles and / or alignment fittings.

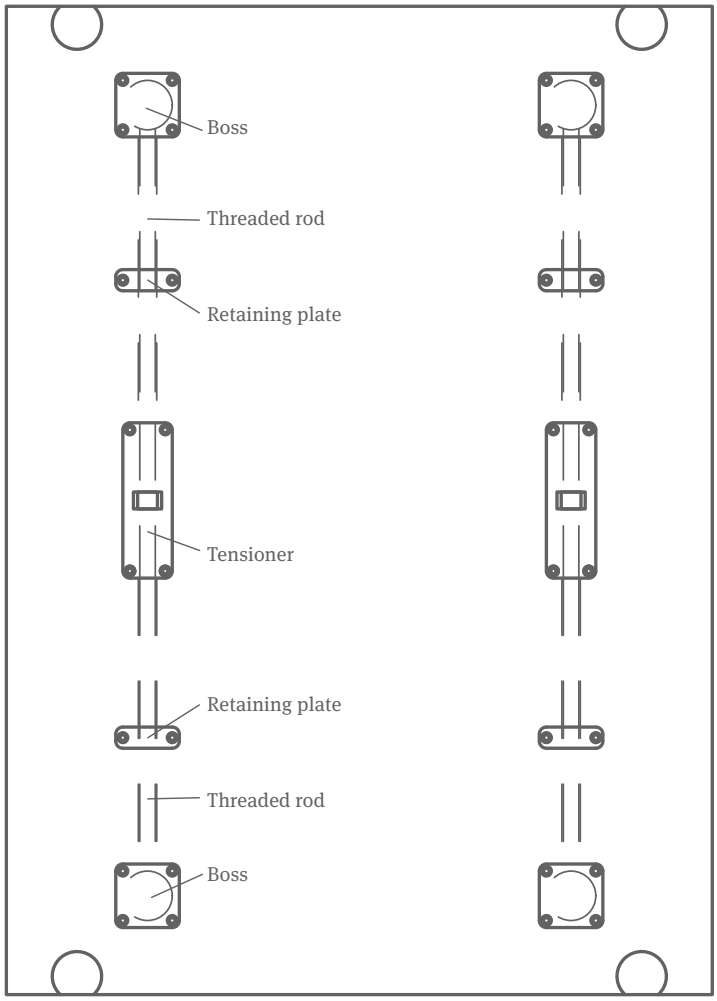
Example 1: Hinged door with full-length handle profile

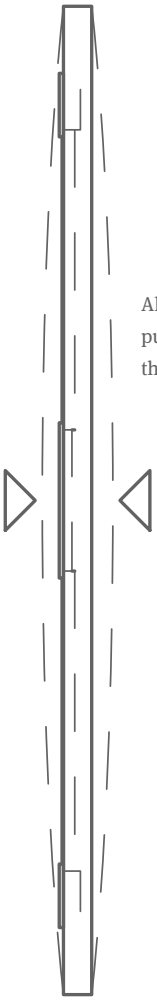




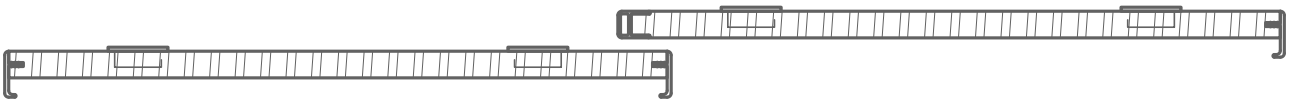
Example 2: Sliding door with alignment fittings

Alignment fitting for sliding doors
Flush-fitting on reverse (example)





Alignment of a door by pull and push force at the turn of the tensioner

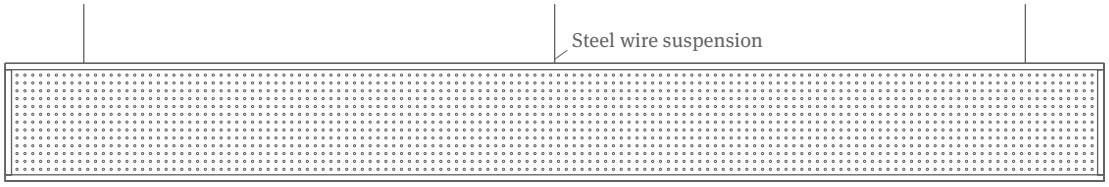


Components of > 700 mm should be fitted with alignment fittings to counteract possible distortion. Suitable alignment fittings, as well as handle profiles are available from Häfele, Würth etc. Implementing these particularities and supplying you with prefabricated furniture components is our strength. For your edge banding requirements we are pleased to offer as part of the EGGER ZOOM® Collection decor-matched ABS edging tape to complement our melamine faced chipboard.“

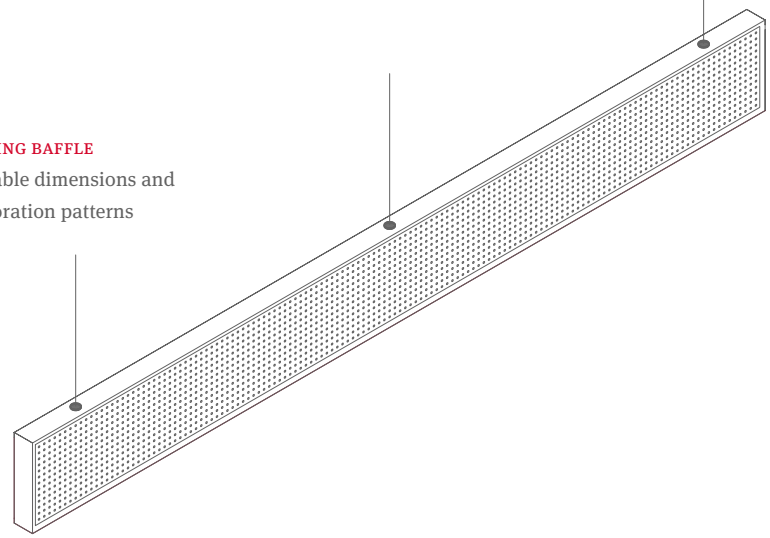
RETROSPECTIVE INSTALLATIONS

Example 1: Ceiling baffle

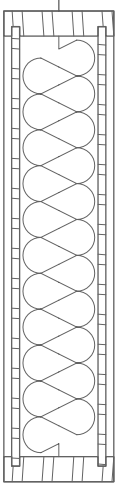
These acoustic solutions, which are intended for retrospective installations, are offered as pre-fabricated system components. However, the freedom of choice in terms of dimensions, perforations and decors also applies to these system solutions.



Elevation



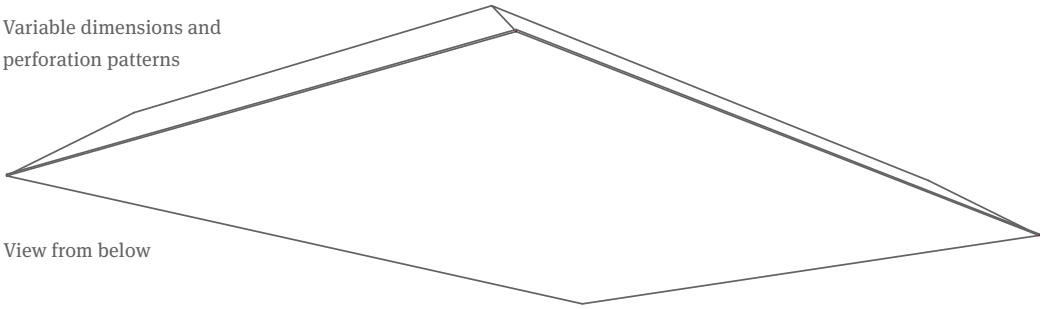
Ceiling baffle
Variable dimensions and perforation patterns



Vertikalschnitt

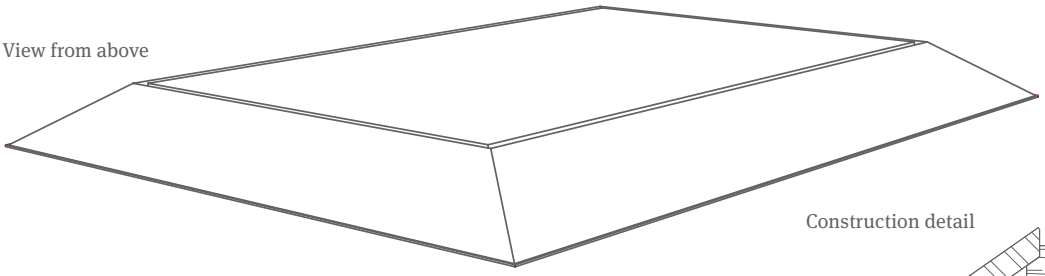
Example 2: Ceiling cloud

Variable dimensions and perforation patterns

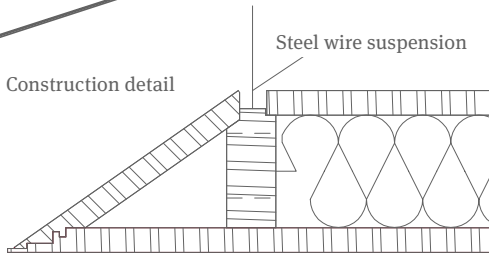


View from below

View from above



Construction detail

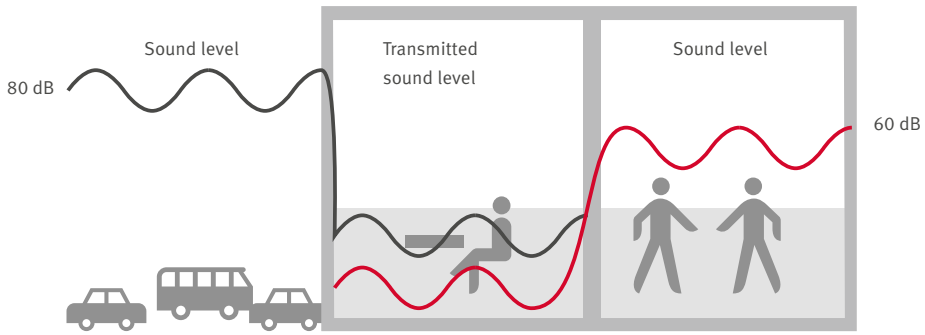


8 THE ABC'S OF ACOUSTICS

8.1 ROOM ACOUSTICS VERSUS BUILDING ACOUSTICS

The difference between the fields of room acoustics and building acoustics becomes obvious only when we take a closer look at acoustical questions. In building acoustics, the question always is: WHAT PORTION OF THE SOUND REACHES THE OTHER SIDE OF THE COMPONENT IN QUESTION? The key property is the sound insulation of the component.

Essentially, it is about the ability of components – walls, ceilings, doors, windows, etc. – to minimise the sound transmission between two rooms. A high degree of sound insulation is usually achieved using solid, heavy components which hinder the propagation of sound.

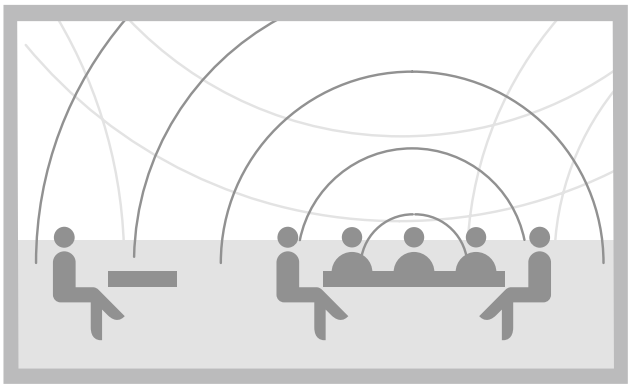


Building acoustics:
Sound transmission
between adjacent rooms

Background noise level

The airborne sound insulation of building components is characterised by the weighted building sound reduction index R'_w, a single number quantity which is calculated with the aid of a rating curve from the frequency-dependent building sound reduction measurement R'. The R'_w rating of an element can be determined "in situ" by measurements or by mathematical model calculations. Sound insulation improvements can be achieved by a variety of different treatments.

In room acoustics, on the other hand, the question is: WHAT SURFACES HELP TO CREATE OPTIMUM LISTENING CONDITIONS IN A ROOM? The key property in this case is the sound absorption provided by the surfaces of the materials used in the room. Sound absorption describes the ability of materials to absorb sound or to convert the incident sound energy into other forms of energy. Sound absorption is achieved by means of sound absorbers.



Room acoustics:
Acoustic quality within a room

Background noise level

The sound absorption of a surface is defined by the frequency-dependent sound absorption coefficient α_s or, alternatively, by a simplified averaged sound absorption coefficient such as α_w. The sound absorption coefficient of acoustically effective surfaces is usually determined by measurements taken in specialised laboratories, referred to as reverberation chambers.

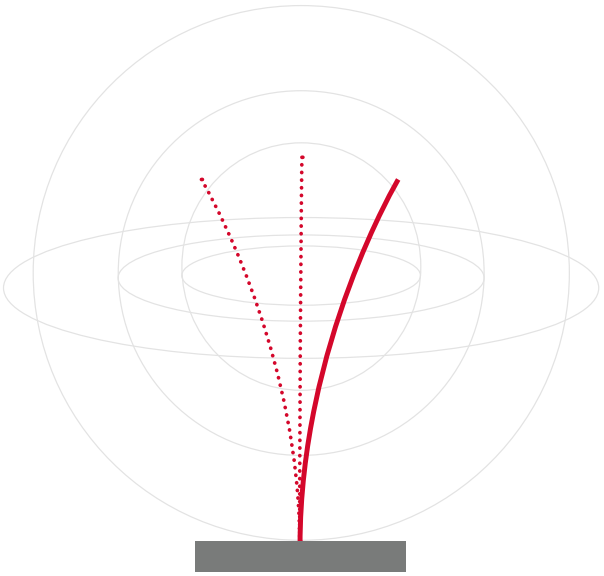
The terms "sound insulation" and "sound absorption" are well-defined and relate to the fields of building acoustics and room acoustics respectively. If we feel annoyed by noise from an adjacent room, increasing the sound insulation of the boundary component essentially helps to improve this situation. In principle, sound absorption in a room can only marginally contribute to increase the level difference between rooms, as part of the sound is already absorbed by the room where the noise is generated and also by the room where the noise is experienced and this has an influencing effect on how the sound level is perceived. Historically, the sound level reduction effect provided by sound absorbing – or acoustically effective – treatments is substantially less than the result that can be achieved with a building acoustical optimisation of the dividing boundary element.

8.2 FUNDAMENTALS OF ACOUSTICS

SOUND

Sound can comprise harmonious tones, music, bangs, noise, crackling, but also spoken words. All of these sound events cause a slight variation in air pressure which propagates within the surroundings of its source. We therefore refer to the sound pressure of a tone, of noise, speech or music. The louder the sound event, the greater is this pressure variation and the higher is the sound pressure. As a rule, sound always propagates into all three directions of space.

With many sound sources the sound radiation depends on the orientation of the source; in most cases it is sufficient, however, to assume roughly a uniform, omnidirectional sound radiation. Sound sources of this type are referred to as omnidirectional sound sources. A sound wave is the recurring temporal and spatial variation of air pressure or its respective density. Sound waves travel though a medium such as air and other gasses, liquids such as water or solid matters, for example stones. For this reason, we differentiate between airborne, fluid-borne and structure noise.
In very general terms, sound can be defined as the propagation of pressure and density variations through an elastic medium: gasses, liquids, solid matters. When sound penetrates through a wall or other construction component, the incident airborne noise is converted into structure noise (vibration of the wall) and subsequently, the airborne noise is reflected on impact with the vibrating wall.

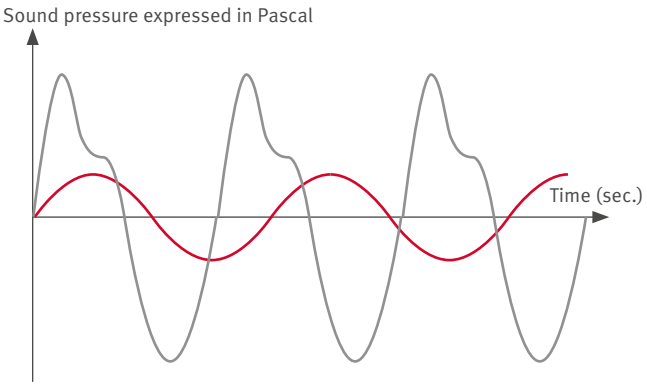


Sounds which are undesired by the recipient are commonly referred to as noise. This definition clearly shows the highly subjective nature of noise perception. Psychoacoustics, a field of acoustics, and noise effect research both study the connection between the subjective human perceptions of sound and the actually present objectively discernible sound signals. They differentiate between wanted sounds – music in a concert or voices during a conversation – and unwanted, annoying sounds – traffic noise or a neighbour's music.

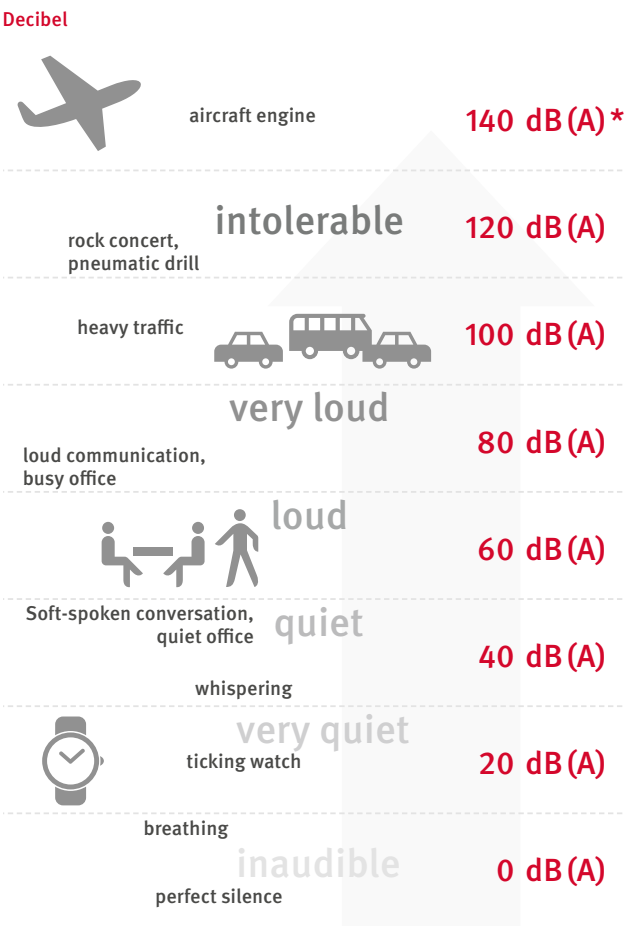
SOUND PRESSURE

Variations in air pressure are referred to as sound pressure. It is therefore possible to determine the respective air pressure of any sound event, whether it be a single tone, a sound, a noise, speech or music. The louder the sound event, the greater are the pressure variations and consequently the higher is the sound pressure.

Minor sound pressure variations are perceived as quiet sounds or noises. The human auditory system is able to perceive a minimal sound pressure of 20 µPa = 0.00002 Pascal. That is a very low value and demonstrates the sensitivity of the human ear. On the other hand, exposure to sound pressures of 20 Pascal, even for a very short period of time only, can lead to permanent damage.



SOUND PRESSURE LEVEL AND DECIBEL SCALE



Sound level, or sound pressure, is usually expressed as sound pressure level, or sound level in short. In the definition of the decibel scale, a sound level of 0 decibels was set as being the threshold of sound pressure perception of the average human auditory system.

The decibel is defined as a logarithmic unit of measurement which expresses the sound pressure level. This provides us with a scale of between 0 decibel (abbr.: dB) and 120 – 140 dB. Exposure over long periods of time to uninterrupted noise from 80 dB onwards, or exposure to 120 dB and higher in instances of very short sound events (a loud bang), can lead to irreversible hearing damage.

* Definition see page 92

8.3 SOUND PRESSURE INCREASE FOR MULTIPLE SOUND SOURCES

SOUND PRESSURE INCREASE FOR IDENTICAL SOUND SOURCES

Example alarm clock	Increase of dB value
1	62 dB
2	62 + 3 = 65 dB
3	62 + 5 = 67 dB
4	62 + 6 = 68 dB
5	62 + 7 = 69 dB
10	62 + 10 = 72 dB
15	62 + 12 = 74 dB
20	62 + 13 = 75 dB
50	62 + 17 = 79 dB
100	62 + 20 = 82 dB

An increase in the number of sound sources by a factor of two always results in an increase of the level by 3 dB, a factor of ten in an increase by 10 dB, and a factor of one hundred in an increase by 20 dB.

Number of identical sound sources	Acoustic power	Sound pressure	Sound level
	× 100	× 10	+ 20 dB
	× 10	× 3,2	+ 10 dB
	× 4	× 2	+ 6 dB
	× 2	× 1,4	+ 3 dB
	× 1	× 1	0 dB

Increase in sound pressure level by multiplication of number of identical sound sources.

The table below offers a simplified rule of thumb for the addition of two level readings. First of all, the difference between the two levels has to be established.

Level difference between two levels	0 to 1	2 to 3	4 to 9	more than 10
Level increase (to be added to the larger value)	+ 3 dB	+ 2 dB	+ 1 dB	+ 0 dB

EXAMPLE: For two sources of 45 dB and 52 dB respectively, the difference of 7 dB results in an increase by 1 dB, which is added to 52 dB and thus equates to a total level of 53 dB.

8.4 FREQUENCY

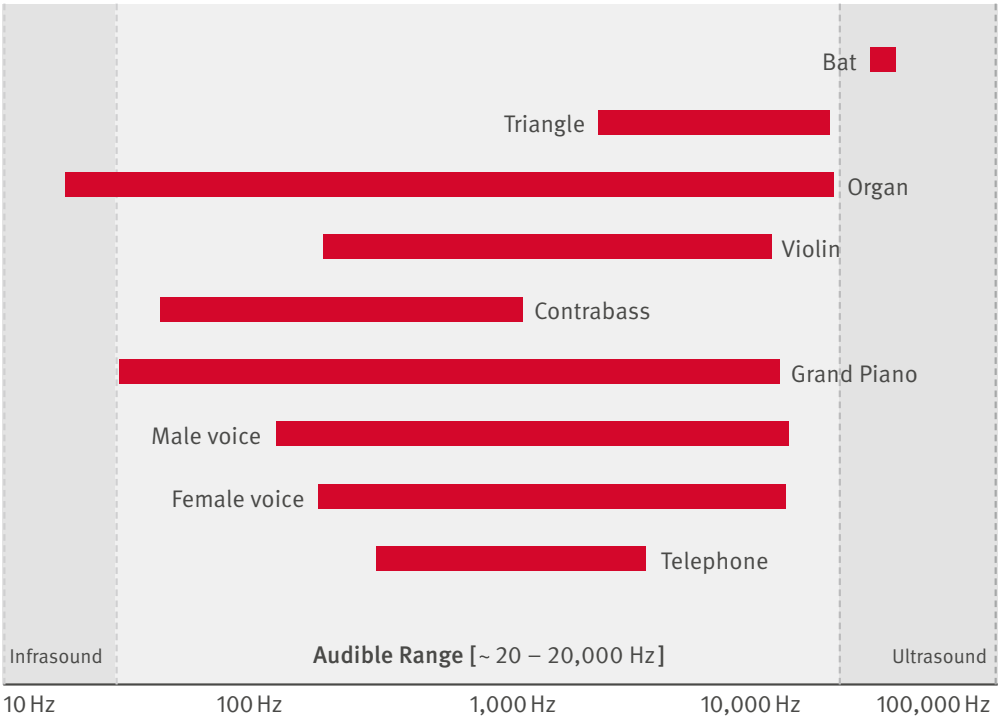
Frequency indicates the number of sound pressure changes or vibrations per second. In formulae, the letter f denotes frequency and Hz the unit Hertz. A frequency of 1000 Hz equates to 1000 vibrations per second. Sound pressure or sound level respectively, is perceived as the volume of sound and therefore represents an important characteristic of sound. Equally important is the frequency composition of the sound, i.e. its spectrum. Pure tones are sound events of a single frequency. The superposition of tones of different frequencies is referred to as noise or sound, depending on the frequency composition.

The sensitivity of the human auditory system is highly dependent on frequency. It is particularly pronounced in the frequency range of human speech between 250 Hz and 2000 Hz. This is very useful when we listen to someone speak, but disruptions in this frequency range are perceived as particularly annoying and can strongly affect communication. With too high or low frequencies, our hearing ability decreases.

A noise loudness rating which meets the demands of the human auditory system needs to take into account the frequency characteristic of the human auditory system. When a total level is accumulated out of the spectrum, the medium frequencies, at which the human auditory system is particularly sensitive, are weighted more heavily than the high and low frequencies. This weighting results in the term dB(A) for sound pressure levels, i.e. the so-called A-weighted sound pressure level.

Nearly all regulations, guidelines, standard values, limit values, recommendations and references to sound pressure levels use values expressed in dB(A).

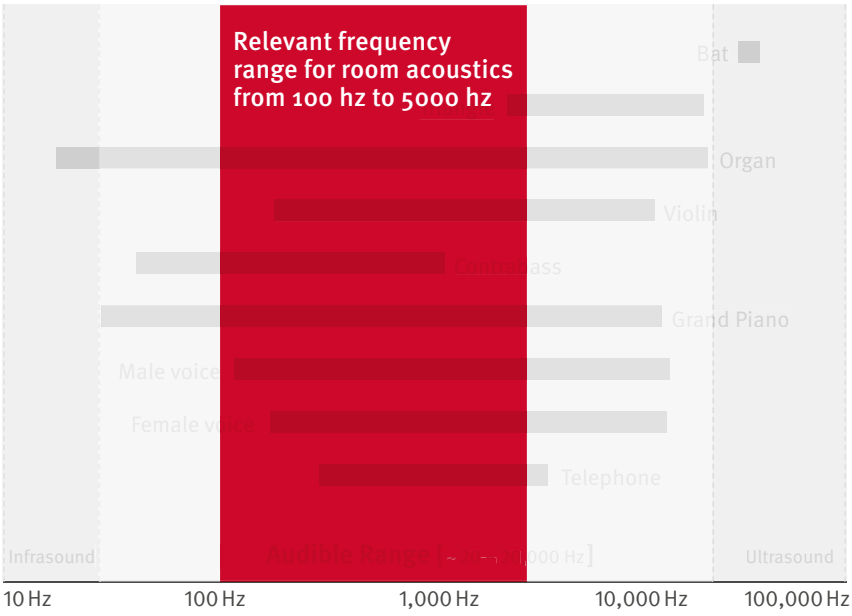
Frequencies measured in Hertz (Hz)



8.5 FREQUENCY RANGES RELEVANT TO ROOM PLANNING

The frequency range to be taken into account when planning a room is based on the human auditory system on the one hand and what is technically sensible and feasible, on the other. Basically, acoustic planning should always consider those frequencies of sound that are relevant to people. Frequencies above 5000 Hz are attenuated by the air to such a degree that it is not sensible to take them into account when planning the acoustics of a room. Below 100 Hz, other physical implications of sound propagation need to be taken into account.
The internationally standardised test methods for determining the sound absorption by particular materials are based on the frequency range from 100 Hz to 5000 Hz. Correspondingly room acoustic planning focuses on this frequency range as a rule.

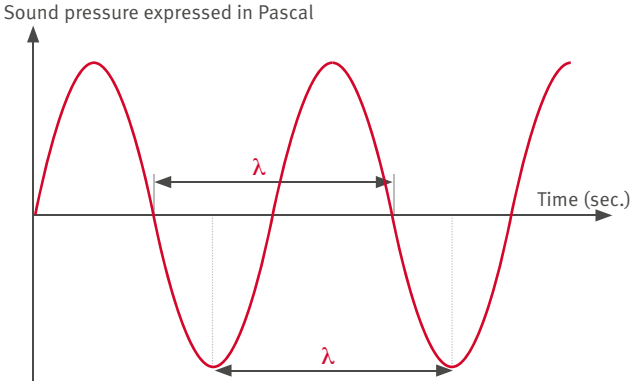
Relevant Frequency Ranges



8.6 WAVELENGTHS OF SOUND

Each frequency of sound is associated with a sound wave of a particular wavelength. In air, a 100 Hz wave has an extension of 3.40 metres, whereas a 5000 Hz wave has an extension of only about 7 centimetres. Accordingly, the sound waves relevant for room acoustics have a length of between 0.07 m and 3.40 m. As we can see, the dimensions of sound waves are well within the range of the dimensions of rooms and furnishings.

Wavelength λ

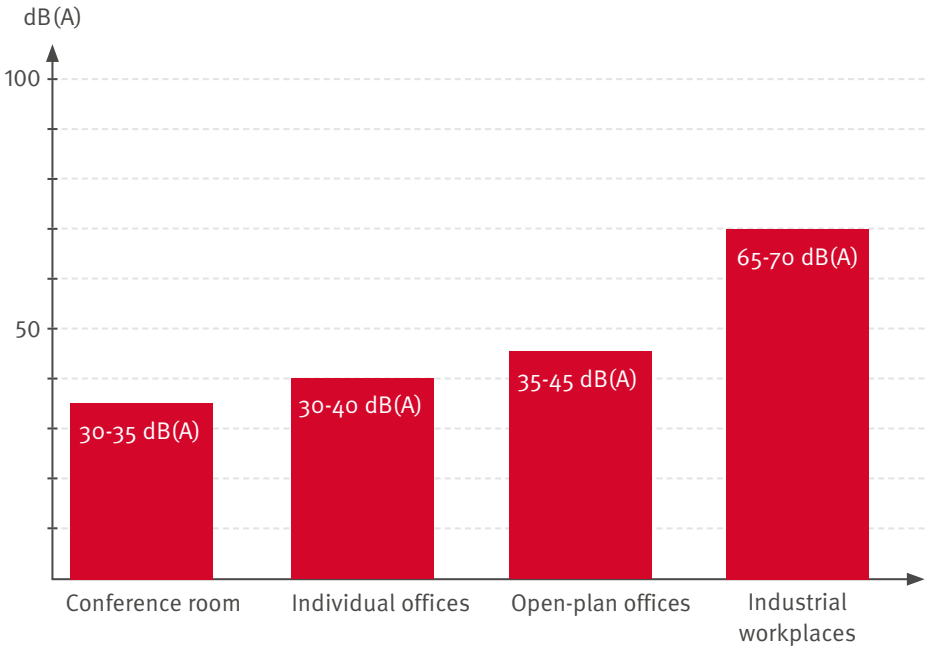


8.7 LEVEL VALUES

The relevant parameter for an objective assessment of the noise impact at a work station is the so-called rating level, which consists, on the one hand, of the measured, time-averaged sound pressure level in a room and, on the other hand, of adjustments in accordance with the characteristic of the noise as well as its duration of impact.

The rating level is usually based on a rating period of 8 hours during which it is normally sufficient to capture short, representative periods of time. High background noise levels impair concentration and affect the intellectual efficiency. For this reason, several regulations and standards contain recommendations in terms of maximum permissible background noise level.

The following table shows the recommended background noise level values in accordance with EN ISO 11690:



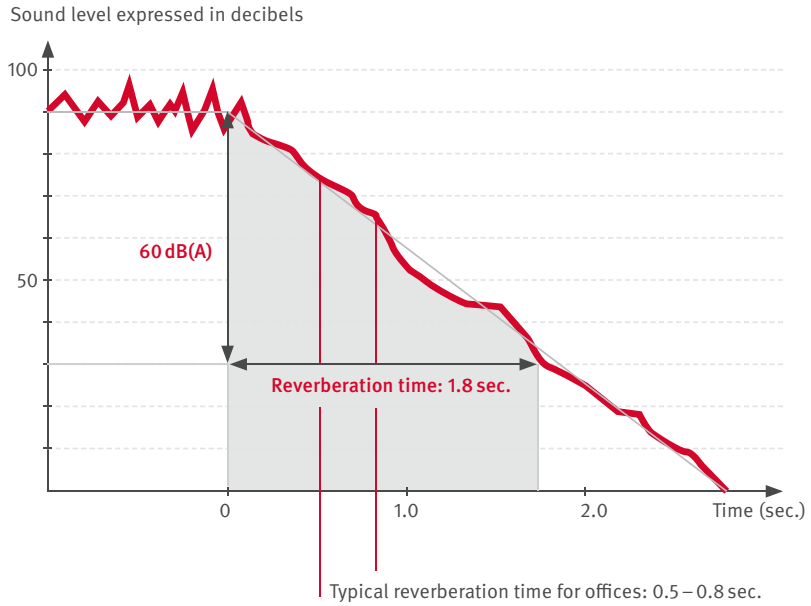
8.8 ROOM ACOUSTIC PARAMETERS

REVERBERATION TIME

The reverberation time forms the basis of rating room acoustic conditions in a room. Put simply, the reverberation time indicates the period of time it takes for a sound event to become inaudible. In technical terms, the reverberation time T has been defined as the time required for the sound pressure level in space to decay by 60 dB.

This means that, if a room is excited with a bang of 95 dB, the reverberation time indicates the period of time within which the noise level drops to 35 dB. This can be a few tenths of a second up to several seconds. The reverberation time can be determined for each enclosed space.

Reverberation Time



As reverberation time can be measured objectively, it is possible to compare a large variety of rooms and to evaluate their room acoustical quality.

THE FOLLOWING ARE TYPICAL REVERBERATION TIMES FOR DIFFERENT TYPES OF ROOM:

Type of room	Reverberation time (example)
Church	approx. 4 – 8 seconds
Medium sized class room	0.6 seconds
Office – depending on size	0.5 – 0.8 seconds
Concert hall for classical music	approx. 1.5 seconds

The reverberation time directly influences intelligibility within a room. In general terms, intelligibility within a room deteriorates as reverberation time increases. This, however, does not mean that the shortest reverberation time is also the best reverberation time. As a rule, a very poor intelligibility would indicate that the reverberation time is too long. The subjective impression of the sound quality of a room allows even a layperson to draw conclusions as to how the reverberation time progresses within the different frequency ranges.

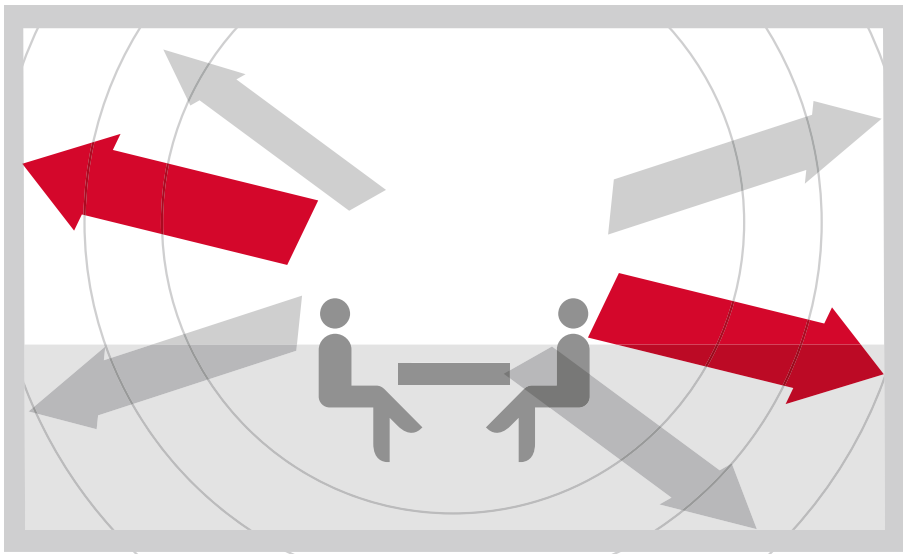
For this task, the following table will prove to be of assistance. If, for example, speech in a room sounds blurred and if it is very difficult to understand each other, it can be assumed that the reverberation time is too long. Acoustically "dry" in this context means that the sound is absorbed unnaturally fast. If this happens only at high frequencies, the room sounds "hollow" or "booming", whereas at low frequencies it sounds "piercing" and "sharp".

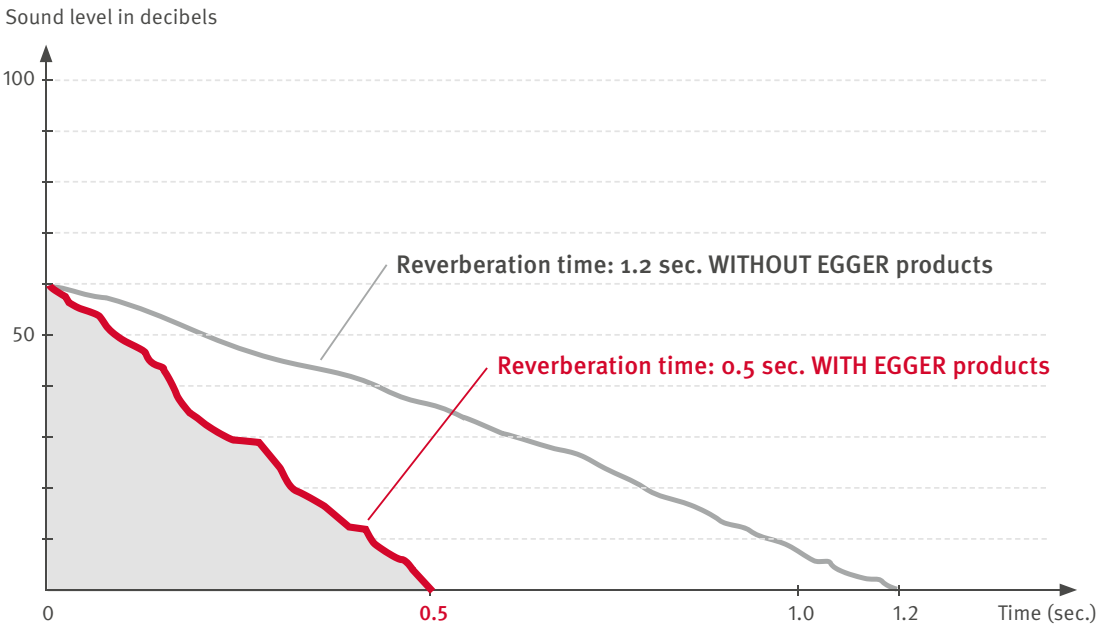
Event	Reverberation time at low tones	Reverberation time at high tones	Subjective Impression
Speech	too long	too long	blurred, difficult to understand
	too long	too short	hollow, but easy to understand
	too short	too long	piercing, sharp, possibly hissing noises, difficult to understand
	too short	too short	dry, but easy to understand
Music	too long	too long	blurred, "wavy"
	too long	too short	unnaturally hollow, possibly booming
	too short	too long	blaring to piercing
	too short	too short	dry, wishy-washy

The reverberation time depends mainly on three factors: the volume of the room, the surfaces and the furniture and fixtures in the room.
Basically, the following applies:

- The larger the room, the longer is usually the reverberation time.
- The more absorption there is in a room, the shorter is the reverberation time.

A room usually becomes more reverberant with increasing height. Absorbing surfaces – such as carpets, curtains and sound absorbing ceilings, but also furniture or people present in the room – reduce the reverberation time.

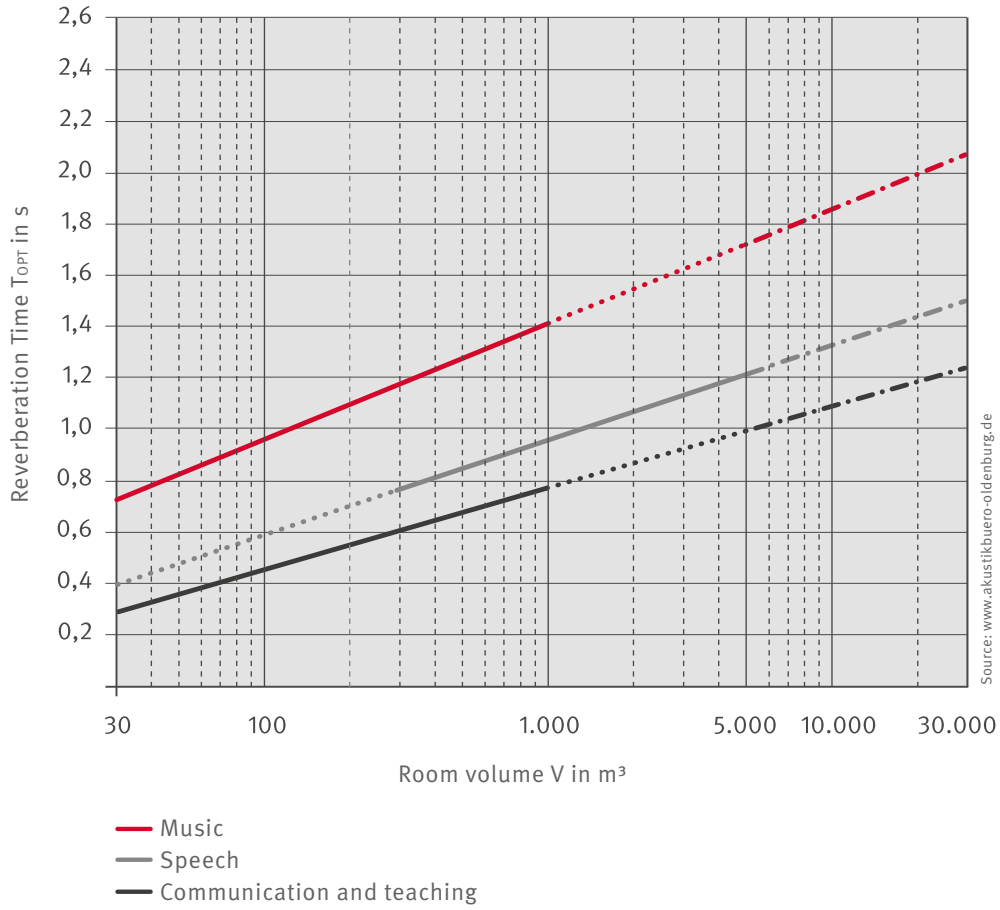




A fundamental task of room acoustic planning is to achieve a good balance between the two quantities volume and absorption area. The second step involves the optimum positioning of reflecting and absorbing surfaces in the room.

The shape of a room is usually of minor importance in terms of reverberation time. Only if the room acoustic requirements are very high (e.g. in concert halls) or if the shape is very unusual, e.g. vaulted surfaces, or if there are significantly varying room heights, does shape become an essential factor.

The recommendations and directions given in DIN 18041 should always form the basis of any room acoustic planning. In terms of optimum reverberation time, DIN 18041 distinguishes between three different room categories: "music", "speech" and "communication and teaching". Communication intensive areas such as meeting rooms, conference rooms or multiple occupancy offices should be treated in accordance with category "Communication and teaching".



TWO EXAMPLES

Example 1

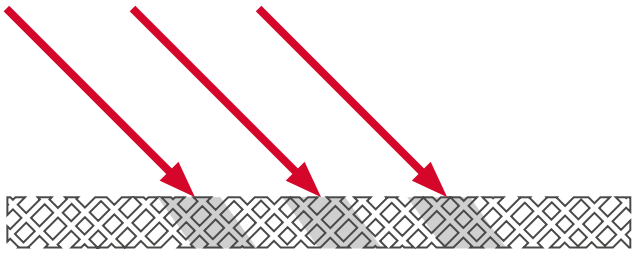
A conference room (usage type: "communication and teaching") with a volume of 250 m³ should have a reverberation time of 0.6 s.

Example 2

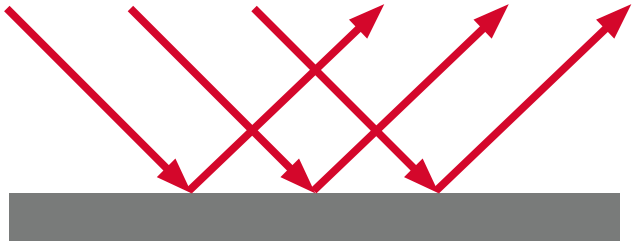
A chamber music hall (usage type: "music") with a volume of 550 m³ should have a reverberation time of 1.3 s.

8.9 SOUND ABSORPTION

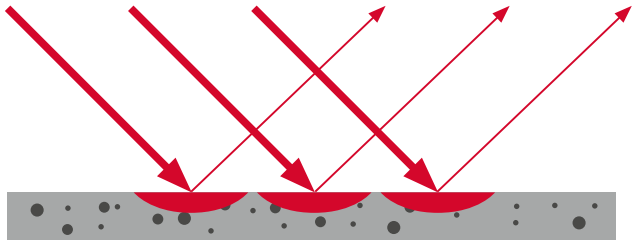
The sound absorption coefficient α describes the property of a material to convert incident sound into other forms of energy – e.g. thermal or kinetic energy – and thus to absorb it.



SOUND COMPLETELY ABSORBED AND NO REFLECTION
– sound absorption coefficient α = 1



The other extreme is where SOUND IS COMPLETELY REFLECTED. The incident sound is reflected by a wall, for example, and prevented from propagation. Sound completely reflected – sound absorption coefficient α = 0

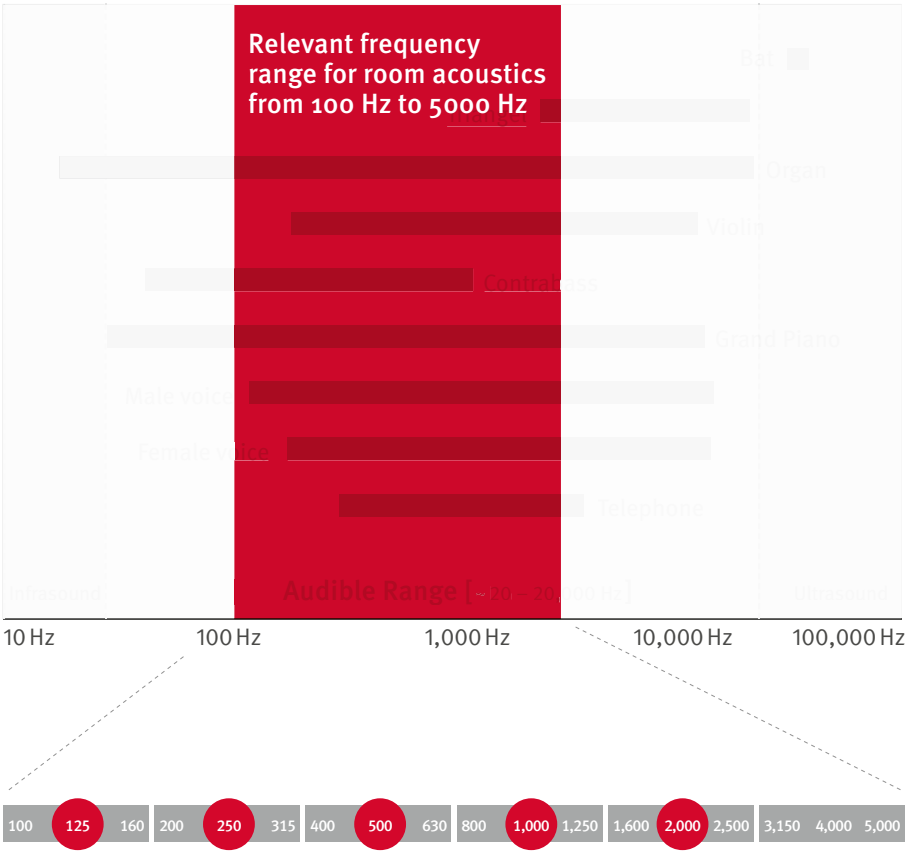


PARTIAL SOUND ABSORPTION
– sound absorption coefficient α = between 0 and 1

The sound absorption coefficient α of a material is highly dependent on frequency. It is therefore necessary to also view the absorption effect of materials as being frequency-dependant. The frequency-dependent sound absorption coefficient of a material is determined by means of a special acoustic material test – the so-called reverberation room method. For this test, a material sample is placed into the reverberation room, whose reverberation time has been determined previously without the sample. From the change in the reverberation time with the sample present in the room, the sound absorption coefficient α_S ("Alpha Sabine") can be determined for each one-third-octave between 100 Hz and 5000 Hz.

This yields 18 one-third-octave values which uniquely describe the absorption behaviour of the material, i.e. to what extent and at what frequencies the material absorbs the sound. When solving room acoustic problems with the aid of metrological methods, a resolution in one-third-octave intervals should always be chosen, as many acoustic problems occur within small frequency ranges and, accordingly, require precisely tailored solutions.

One-third-octave and octave centre frequencies



One-third-octave and octave centre frequencies (Hz), Sequence of one-third-octave centre frequencies

However, it is not only the choice of material that is responsible for the sound absorption in a room. The decisive factor is the total area of this material present in the room. The quantity equivalent sound absorption area was introduced to provide a measure for the sound absorbing performance of a sound absorber.

It is defined as the product of the sound absorption coefficient α_s of a material and the surface of this material. The equivalent sound absorption area can be calculated by multiplication of the sound absorption coefficient by the surface area of the material in question. If this surface area is doubled, then the sound absorption coefficient doubles as well.

Calculation of the equivalent sound absorption of surfaces in a room:

$A = s_1 \alpha_1 + s_2 \alpha_2 + s_3 \alpha_3 + \ldots + s_n + \alpha_n + A_1 + A_2 + \ldots + A_n$

A – total equivalent sound absorption area in a room

s_1 – size of surface area of material 1, e.g. acoustic ceiling

α_1 – sound absorption coefficient of material 1

s_2 – size of surface area of material 2, e.g. fitted carpet

α_2 – sound absorption coefficient of material 2 …

A_1, A_2, … equivalent sound absorption coefficient of fixtures and fittings (such as chairs, tables, cabinets ….)

8.10 SOUND ABSORPTION AND REVERBERATION TIME

In a fully furnished room with different surfaces, each material (e.g. carpets, plaster, acoustic ceiling, curtains, windows, shelves, etc.) can be allocated a sound absorption coefficient and by multiplying this coefficient by the actual surface area of this material, the equivalent sound absorption area can be calculated. The equivalent sound absorption areas of all materials are then added to determine the total equivalent sound absorption area of the room. If the room volume is known, the reverberation time can be calculated very quickly with the so-called Sabine reverberation equation which provides a formula that is based on three parameters only: the equivalent sound absorption area, the room volume and the reverberation time.

SABINE FORMULA:

$$T = 0.163 \times \frac{V}{A}$$

T – Reverberation time
V – Volume of the room
A – Total equivalent sound absorption area in the room

Even a sound absorber with a high sound absorption coefficient does not achieve the desired effect in the room unless a certain surface area is constructed of it. On the other hand, a sound absorber with a relatively low absorption coefficient can also achieve the desired effect, as long as the surface area selected is large enough. Essentially, room dampening can be achieved with either a single sound absorber or even a combination of many different sound absorbers. The decisive factor for the reverberation time of a room is always the total sum of all equivalent sound absorption areas.

8.11 RATING OF SOUND ABSORPTION

Statements are available on the basic suitability of sound absorbers for particular applications and provide simplified single number ratings in terms of sound absorption coefficient. Whilst they may not permit differentiated planning, they do allow rough comparisons to be made between different sound absorbers. Such ratings also enable the simplified planning of rooms with low requirements in terms of acoustical quality. Against this backdrop, single values of sound absorption have been defined in Europe and the US which differ slightly. The most common single number value of sound absorption in Europe is the so-called weighted sound absorption coefficient α_w, whereas in the English-speaking world it is the Noise Reduction Coefficient (NRC) or the Sound Absorption Average (SAA). All methods used for the determination of the single number value are based on the one-third-octave values of the sound absorption coefficient α_s, which is measured in a reverberation chamber. The methods involved in the determination of the single number values NRC, SAA and α_w are described below.

Weighted sound absorption coefficient α_w (EN ISO 11654): In order to determine the weighted sound absorption coefficient α_w, the mean value for the octave centre frequency between 125 Hz and 4000 Hz is identified from three one-third-octave values. 18 one-third-octave values are thus converted into 6 octave values. The mean value of the respective octave is then rounded to the nearest 0.05 and is referred to as the practical sound absorption coefficient α_p. The practical sound absorption coefficient α_p between 250 Hz and 4000 Hz is then compared to the reference curve given in EN 11654. The reading of this comparison is the single number value of the weighted sound absorption coefficient α_w.

Deviations by more than 0.25 between the curve and the reference curve are indicated by means of the shape indicators L, M or H, depending on whether they occur at 250 Hz (L), at 500 Hz or 1000 Hz (M), or at 2000 Hz or 4000 Hz (H).

The resulting values are, for example, $\alpha_w = 0.65$ (H), $\alpha_w = 0.20$ or $\alpha_w = 0.80$ (LM).

Based on the α_w value, sound absorbers can be classified into different sound absorber classes. α_w values of more than 0.90, for example, belong to sound absorber class A, values of between 0.15 and 0.25 belong to class E.

Sound absorber class	α_w- value range
A	0,90 – 1,00
B	0,80 – 0,85
C	0,60 – 0,75
D	0,30 – 0,55
E	0,15 – 0,25
Not classified	0,00 – 0,10

Apart from the widely used European weighted sound absorption coefficient α_w (EN ISO 11654), the most common single number ratings in the US are NCR and SAA (ATMS 423). The NRC (Noise Reduction Coefficient) is determined by calculating the mean value from four one-third-octave values of the sound absorption coefficient (250 Hz, 500 Hz, 1000 Hz and 2000 Hz). The result is then rounded-up exactly to the nearest 0.05. The SAA (Sound Absorption Average) is determined by calculating the mean value from twelve one-third-octave values of the sound absorption coefficient between 200 Hz and 2500 Hz. The result is then rounded-up exactly to the nearest 0.01.

Advantage of single-number values:

Sound absorbers can be roughly classified and therefore compared with one another. For room situations where requirements are low, for example corridors or sales floors, it is perfectly acceptable to consult single-numbered values in order to estimate the required absorber surface.

Disadvantage of single-number values:

A single-number sound absorption value always represents an extremely simplified value. Sound absorbers with very different absorption spectra can have identical single-number values. This may sometimes result in the use of a sound absorber which is not suitable for the existing conditions. Frequencies below 200 Hz are not taken into account. Consequently it would be possible to choose a sound absorber, whose sound absorption below 200 Hz is so minimal, that the room has a 'booming' acoustic pattern on completion.

8.12 INDEX

ACOUSTIC QUALITY

The acoustic quality of a room refers to its suitability for a particular use. It is influenced by the properties of the boundary surfaces (walls, ceiling, floor), the fixtures and fittings and by persons present in the room.

AURALISATION (PROCESS OF RENDERING AUDIBLE)

Auralisation is a method for simulating the acoustic properties of a room. With this method, the effects of certain acoustic treatments can be "auralised" as early as during the design stage. Room acoustic auralisations can be based on either simulated calculations of a computer generated virtual room model or on measurements taken in a real room. The process demonstrates, in advance, auditory conditions in a room and offers a more direct comparison between different planning models than could otherwise be achieved by comparing parameter values.

A-WEIGHTED SOUND PRESSURE LEVEL – dB(A)

The A-weighted sound pressure level is the weighted average value of the sound pressure level (dB) as a function of the frequency of a sound. The weighting takes into account the ability of the human auditory system to perceive sound pressure levels or tones of different frequencies to a different degree. This sensitivity is particularly pronounced in the medium frequency range, i.e. the range of human speech. Nearly all regulations and guidelines indicate values expressed in dB(A).

BACKGROUND NOISE LEVEL

Usually, sounds which do not contain any meaningful information are referred to as background noise (e.g. noise from air conditioning or traffic). The background noise level is measured in dB or, by weighting its frequencies in accordance with the human auditory system, in dB(A). The background noise level indicates the sound pressure level which has been exceeded during 95 % of the measurement period. It has a direct effect on speech intelligibility.

BUILDING ACOUSTICS

Building acoustics is a branch of building physics, or acoustics, which deals with the effect of the structural conditions on the propagation of sound between the rooms of a building or between the interior of a room and the outside of the building.

DECIBEL (dB)

A logarithmically defined unit of measurement which expresses the sound pressure level. The relevant scale for human beings is 0 dB to 140 dB. 0 dB refers to a sound pressure of 20 µPa.

EQUIVALENT SOUND ABSORPTION AREA

The equivalent sound absorption area A is defined as the product of the sound absorption coefficient α of a material and the surface S of this material.

FREQUENCY

Frequency indicates the number of sound pressure changes per second. Sound events with a high frequency are perceived by the human ear as high-pitched tones, sound events with a low frequency as low-pitched tones. Sounds such as noise, road traffic, etc., normally comprise a great number of frequencies. The measurement unit of frequency is hertz (Hz), 1 Hz = 1 / s. Human speech is in the range between 250 Hz and 2000 Hz. The audible range of human beings is between 20 Hz and 20000 Hz.

NOISE

Noise comprises all sounds which, due to their loudness and structure, are considered as harmful or annoying or stressful for human beings and the environment. It depends on the condition, preferences and mood of a person whether sounds are perceived as noise or not. The perception of sounds as noise and the way in which people are affected by it depend, on the one hand, on physically measurable quantities such as the sound pressure level, pitch of a tone, tonality and impulsiveness. On the other hand, certain subjective factors also play a role: at bedtime noise is perceived as extremely annoying.

The same is true for activities which require a high level of concentration. If we like certain sounds, we will not perceive them as annoying even at high volumes; sounds which we do not like are annoying to us even at low volumes (e.g. certain types of music). Furthermore, how we feel at a particular time also influences our sensitivity to noise. If an activity is disrupted or disturbed by one or more sounds, this is referred to as noise pollution. We are particularly sensitive to noise if verbal communication is affected, e.g. if a loud conversation at the neighbouring table makes it difficult for us to listen, and if we have to concentrate or want to sleep.

OCTAVE BANDS

Acoustic parameters such as the sound pressure level or the sound absorption coefficient are usually expressed in increments of octaves and one-third-octaves. The precise knowledge of acoustic properties in the smallest possible frequency steps of sound is a prerequisite for a detailed acoustic design. For room acoustics the relevant octave frequencies are 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. The octave increments are obtained by doubling the previous frequency. Each octave comprises three one-third-octave values (see also "single values").

POROUS ABSORBERS

Porous absorbers comprise, for example, mineral fibres, foams, carpets, fabrics, etc. The effect of the porous absorbers is due to the fact that sound is able to enter the open structures of the material where, by the friction of air particles, the sound energy is converted into thermal energy at the surface of the pores. Porous absorbers achieve their best effect at medium and high frequencies.

PSYCHOACOUSTICS

A branch of acoustics or noise effect research which deals with the subjective perception of objectively present sound signals. Furthermore, psychoacoustics studies the influence of a listener's personal attitudes and expectations on the perception of sound events.

RATING LEVEL (L_r)

The rating level L_r (L for "level", r for "rating") is the relevant parameter for objectively assessing the noise impact at a workplace. Apart from weighting the sound pressure level as a function of the frequency (see A-weighted sound pressure level), a determination of the sound pressure level takes into account certain adjustments which depend on the characteristic of the sound (e.g. impulsiveness or clear prominence of individual tones) and its duration of impact. The rating level is also expressed in dB(A).

RESONANCE ABSORBER

This term comprises all types of absorbers using a resonance mechanism such as an enclosed air volume or a vibrating surface. Resonance absorbers are mainly suitable for absorbing sound of medium to low frequencies. The maximum effect of resonance absorbers is usually restricted to a certain frequency range (see also "porous absorbers").

REVERBERATION ROOM

Reverberation rooms are special laboratory rooms with walls which reflect the incident sound waves to a very high degree. Reverberation rooms have particularly long reverberation times across the entire frequency range.

REVERBERATION ROOM METHOD

The reverberation room method is used for determining the frequency-dependent sound absorption coefficient. A sample of the material to be tested is placed into the reverberation room. The sound absorption of a material can then be calculated from the change in the reverberation time of the room.

REVERBERATION TIME

Put simply, the reverberation time indicates the period of time it takes for a sound event to become inaudible. In technical terms, the reverberation time T has been defined as the time required for the sound pressure level in space to decay by 60 dB.

SABINE FORMULA

If the volume and the total equivalent sound absorption area of a room are known, the reverberation time can be estimated using the Sabine formula, where "T" is the reverberation time, "V" is the volume of the room and "A" is the total equivalent sound absorption area. The close relationship between the volume of a room, the sound absorption of the surfaces of this room, and the reverberation time was discovered by the physicist Wallace Clement Sabine (1868 – 1919). He uncovered that the reverberation time T is proportional to the room volume V and inversely proportional to the equivalent sound absorption area A:

$T = 0{,}163 \times V / A$

The equivalent sound absorption area A is the sum of all surfaces S present in the room, each multiplied by its corresponding sound absorption coefficient α:

$A = \alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \ldots + \alpha_n S_n$

SINGLE-NUMBER VALUES OF SOUND ABSORPTION

So-called "single-number values" are used for a simplified representation of the frequency-dependent parameter of the sound absorption coefficient, as well as for a rough comparison of different sound absorbers. In Europe, the "weighted sound absorption coefficient" α_w in accordance with EN ISO 11654 is commonly used. In the US, the NRC and SAA values are widely used. All of the above values are based on measurements of the sound absorption in one third octave and octave increments. For a detailed acoustic planning of a room it is, however, necessary to know these sound absorption values precisely in one-third-octave or at least in octave increments (see "octaves").

SOUND ABSORBERS

Sound absorbers are materials which attenuate incident sound or convert it into other forms of energy. A distinction has to be made between porous absorbers and resonance absorbers or combinations of these absorber types.

SOUND ABSORPTION COEFFICIENT α

The sound absorption coefficient α of a material indicates the amount of the absorbed portion of the total incident sound. α = 0 means that no absorption occurs; the entire incident sound is reflected. If α = 0.5, 50 % of the sound energy is absorbed and 50 % is reflected. If α = 1, the entire incident sound is absorbed, there is no longer any reflection.

SOUND ATTENUATION

Sound attenuation describes the ability of materials to absorb sound or to convert the sound energy present into other forms of energy, i.e. ultimately into thermal energy (see also "sound insulation").

SOUND EVENTS

General term for tones, music, bangs, noise, crackling, etc.

SOUND INSULATION

Sound insulation refers to the restriction of the propagation of sound through the boundaries of a room. Sound insulation is, therefore, a measure to separate rooms acoustically from unwanted sound from adjacent rooms or the outside. This has nothing to do, however, with the required acoustic sound attenuation within a room (see also "sound absorption"). Sound insulation is a fundamental parameter of building acoustics. A distinction has to be made between airborne sound insulation and impact sound insulation. Airborne sound is created by sound sources present in the room which are not immediately connected to the boundary surfaces, e.g. people who are talking. Impact sound, on the other hand, results from structure-borne sound (footfalls, knocking), which in turn excites the walls or ceilings to radiate airborne sound. Airborne sound insulation and impact sound insulation both have to fulfil the requirements established in relevant building laws.

SOUND MASKING

Sound masking specifically uses sounds, either natural (e.g. birds' twittering) or artificial (e.g. noise) in order to blanket other sounds. This method can be used, for example, to drown out information-containing sounds if the other background noise is too weak to mask them.

SOUND PRESSURE

All sound events have in common the fact that they cause slight variations in air pressure which can propagate in elastic media such as air or water. We therefore refer to the sound pressure of a tone. The heavier the pressure variations are, the louder is the sound event. The faster the variations occur, the higher is the frequency.

SOUND PRESSURE LEVEL (L_p)

The sound pressure level (L for level and p for pressure) is a logarithmic quantity for describing the intensity of a sound event. The sound pressure level is often also referred to as "sound level", which is actually not quite correct. The sound pressure level is expressed in decibels (abbreviated as dB). Sound pressures are measured using microphones. The measurable level range starts at just below 0 dB and ends at approximately 150 to 160 dB.

SOUND SHIELDING

A sound shield is basically an obstacle which interrupts the direct propagation of sound from a source to a receiver. It can consist of a movable partition or an attachment to be placed on top of a desk. Cabinets and other large-surface pieces of furniture can also function as sound shields. Sound shields can be provided with a sound absorbing surface which additionally reduces the propagation of sound.

SOUND SPECTRUM

The sound spectrum describes the frequency composition of the sound. Pure tones are sound events of a single frequency. A superposition of tones of different frequencies is referred to as noise or sound.

SOUND WAVES

Variations in air pressure which are caused by sound events are referred to as sound waves. The length of the sound waves defines the frequency and their height defines the level. Long sound waves have a low frequency and are perceived as low-pitched tones. Short sound waves have a high frequency and are perceived as high-pitched tones. In air, a 100 Hz wave has an extension of 340 metres, whereas a 5000 Hz wave has an extension of approximately 7 centimetres.

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