

EmiratesGBC Technical Workshop

The Impact of Noise in Society and Typical High-Performance Solutions for Room Acoustic Applications

<u>Facilitator</u>	<u>Company</u>	<u>Date</u>
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Learning Objectives



- Introduction
- Understand the Health-related Impact of Noise
- Understand the Impact of Noise in Certain Architectural Scenarios
- Understand how a Sound Absorbing Material can Improve Room Acoustics
- Best Practice
- Summary

BASF – We create chemistry

- Our chemistry is used in almost all industries
- We combine economic success, social responsibility and environmental protection
- Sales 2018: €62.7 billion
- EBIT before special items 2018: €6.4 billion
- Employees (as of December 31, 2018): 122,404
- 6 Verbund sites and 355 other production sites
- Over 90,000 customers from various sectors in almost every country in the world



BASF's segments



* We are considering the possibility of merging our construction chemicals business with a strong partner, as well as the option of divesting this business. The outcome of this review is open. The Construction Chemicals division will be reported under the Surface Technologies segment until signing of a transaction agreement.

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Acoustics – why be concerned?

Beijing National Aquatics Center, a.k.a. “The Cube”

- Reduce reverberation or background noise
- Reduce overall noise level

Room Acoustic Descriptions

■ Reverberance:

- this deals with speed at which sound energy disappears in a room.
- sound in an auditorium dies away with time as the sound energy is absorbed by multiple interactions with the surfaces of the room.

■ Speech clarity:

- concerns the quality of speech transfer to the listeners.
- so a classroom speech clarity should be very clear, and reverberation time less than 1s.

■ Sound strength:

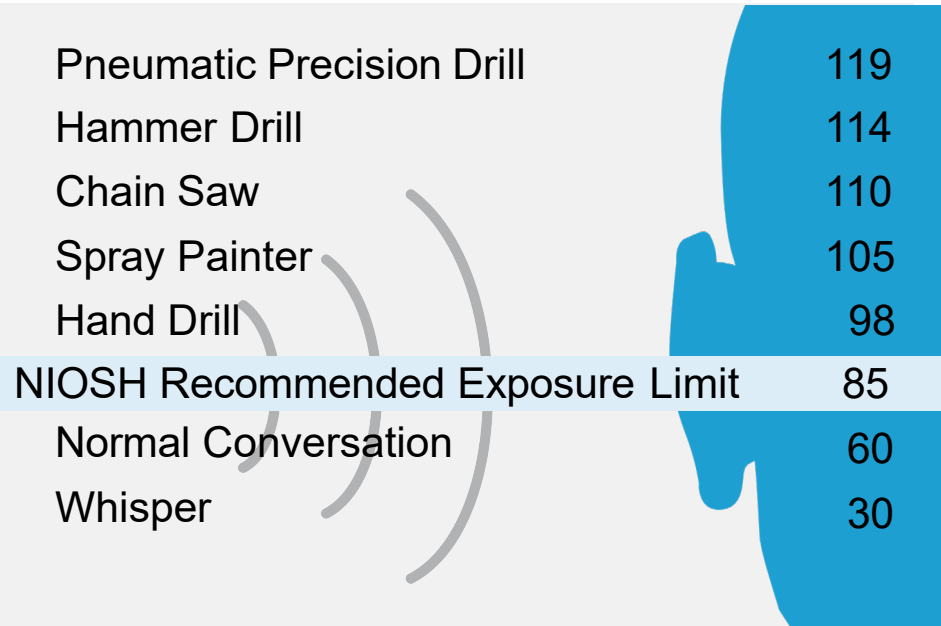
- is the level at which we experience sound
- it is necessary to define a standard reverberation time in terms of the drop in intensity from the original level

- In a very absorbent room, the sound will die away quickly and the room will be described as acoustically 'dead'.
- The optimum reverberation time for a room depends upon their intended use.

Health Effects of Noise

- With sound levels above 85 dB, damage is related to sound pressure (measured in dB) and to time of exposure.
- What is the major cause of hearing loss?
Occupational exposure

Noise levels by decibels



Pneumatic Precision Drill	119
Hammer Drill	114
Chain Saw	110
Spray Painter	105
Hand Drill	98
NIOSH Recommended Exposure Limit	85
Normal Conversation	60
Whisper	30

- Prolonged exposure to road, railway and aircraft traffic noise can cause sleep disturbance and annoyance and lead to serious health effects such as cardiovascular diseases.
- In the European Union, more than 120 million people suffer from noise levels that are considered to have a negative effect on health.

Effects of Noise on Our Health in Our Daily Lives



According to the findings of the WHO

- Noise is the second largest environmental cause of health problems, just after the impact of air quality (particulate matter)*.
- ‘night noise guidelines for Europe’ An annual average night exposure not exceeding 40 decibel (dB) has been recommended in the Guidelines*.
- Study commissioned by DG Environment on the ‘health implication of road, railway and aircraft noise in the European Union’ found that exposure to noise in Europe contributes to*:
 - about 910 thousand additional prevalent cases of hypertension,
 - 43 thousand hospital admissions per year

- The European Union has a target in the 7th Environment Action Programme to significantly decrease noise pollution, moving closer to World Health Organisation (WHO) recommended levels*.

How is Noise Affecting our Children?



It is having impact on such areas as hearing loss which then affects:

- Communication
- Behavior / confidence
- Academic outcomes

Source: Noise Pollution: A Modern Plague, Lisa Goines, RN; Louis Hagler, MD.

Link: http://www.medscape.com/viewarticle/554566_3

Guski: Annoyance and other health effects 2017-04-24 p. 13

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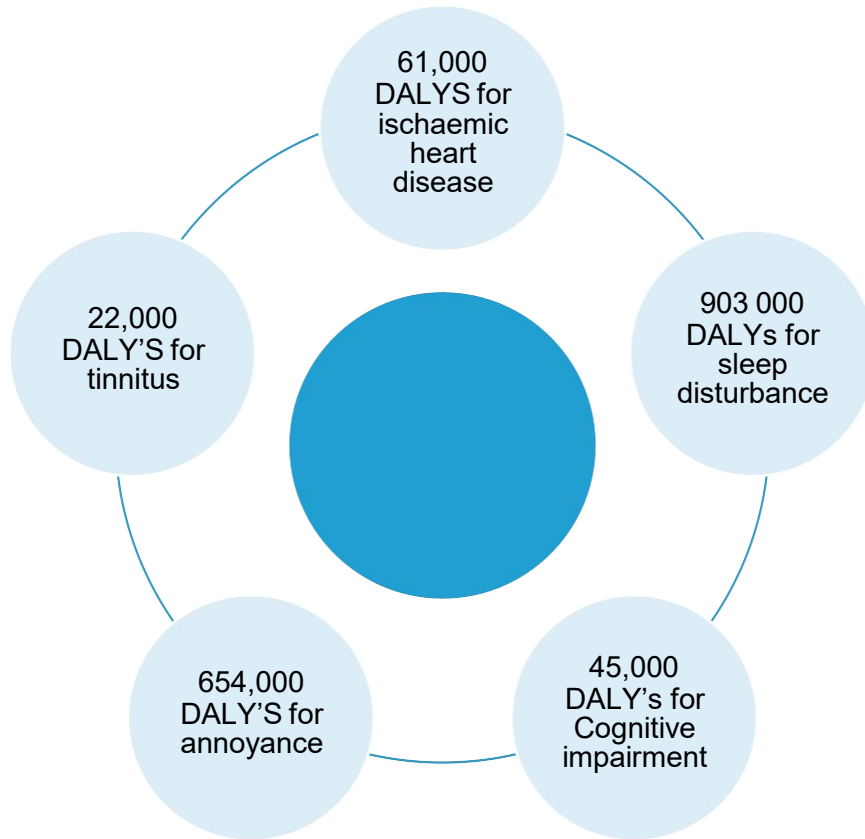


How is Noise Affecting our Children?

Example: NORAH WP 3 (Cognitive development and quality of life of children):

- Found a **statistically highly significant decrease of reading performance of children with increasing aircraft noise levels** (LpAeq,08-16h 40-60dB):
- **a 10 dB increase** of long-term noise levels was followed by one month retardation of reading performance.

Noise Impacts in Cities



1 DALY
("Disability-
adjusted
life years") = **1 year of
"healthy"
life lost**

Continuous noise in excess
of 30 dB disturbs sleep.

- Nearly 70 million Europeans are exposed to noise levels above 55 dB on a daily basis.
- Due to a wide range of health issues related to high noise levels, the European Commission requires that member states map the noise levels in cities and large towns.

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Effect of Noise in Buildings

Healthcare Facilities



- **Recovery rooms should focus on speech clarity by fitting suitable acoustic products**
- **If you achieve this, there will be many benefits for both patients and staff:**
 - Improved quality of sleep
 - Reduced intake of pain medication
 - Improved communication
 - Lowered blood pressure and stress levels
 - Improved patient safety
 - Enhanced staff wellbeing, performance and job satisfaction


Effect of Noise in Buildings

Schools

- **Within education, there are three factors you need to consider in order to succeed:**
 - Reduce the disturbance from background low-frequency noise
 - Make sure the whole school gets the proper acoustic treatment
- **If you achieve this, there will be many benefits for both students and teachers:**
 - Greater understanding of speech / Less voice problems for teachers
 - Better reading ability and test results for students

Sources:

- 1: Tiesler, G., Oberdoerster, M, (2008). Noise – A Stressor?, *Building Acoustics*, 15 (3), 249.
- 2: Siebein, G., (1998). Classroom Acoustics II: Acoustical Conditions in Elementary School Classrooms, *Acoustic Society of America*, 105 (5).
3. (cf.Oberdörster: Acoustic Ergonomics of School).



Learning matters, noise must be tackled to improve children's chances of learning!

Product: Stereo, Texaa

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Basotect

Effect of Noise in Buildings

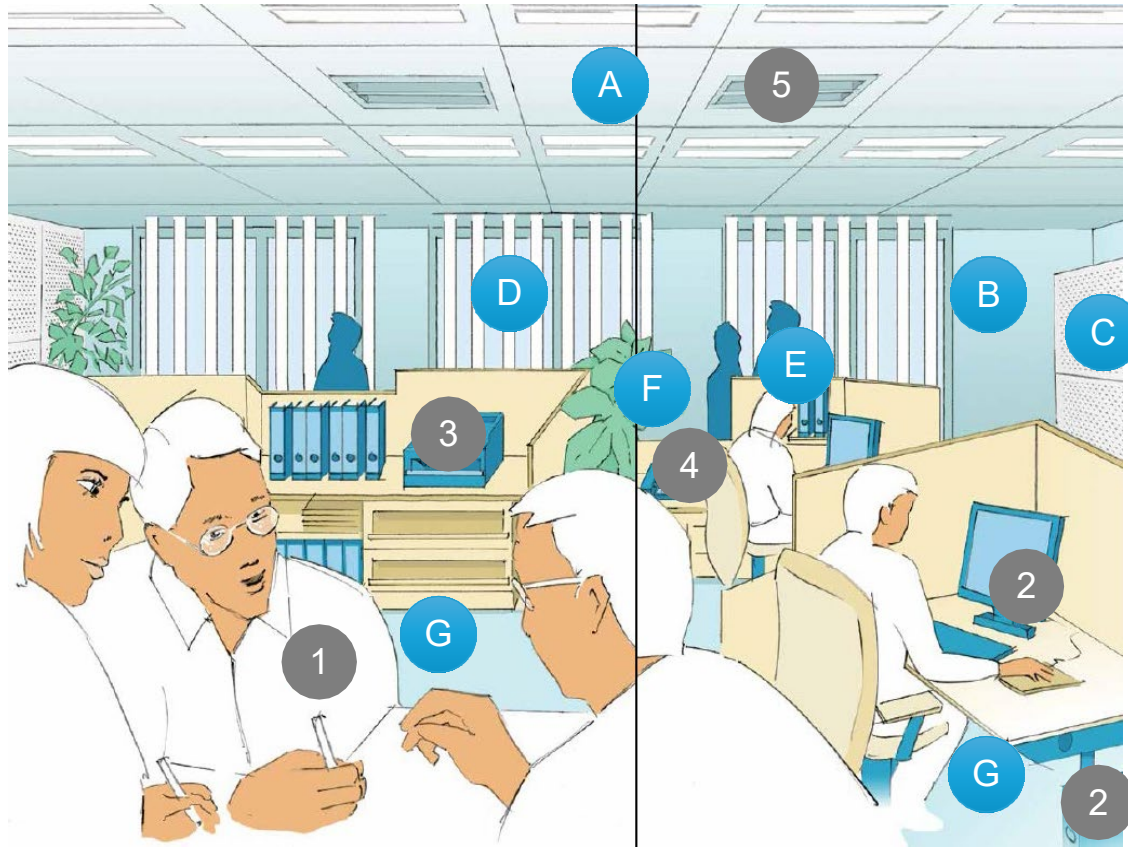
Offices

Sources of noise:

1. Talk of colleagues
2. Computer
3. Printer, copying machine
4. Telephone and telephone talks
5. AC

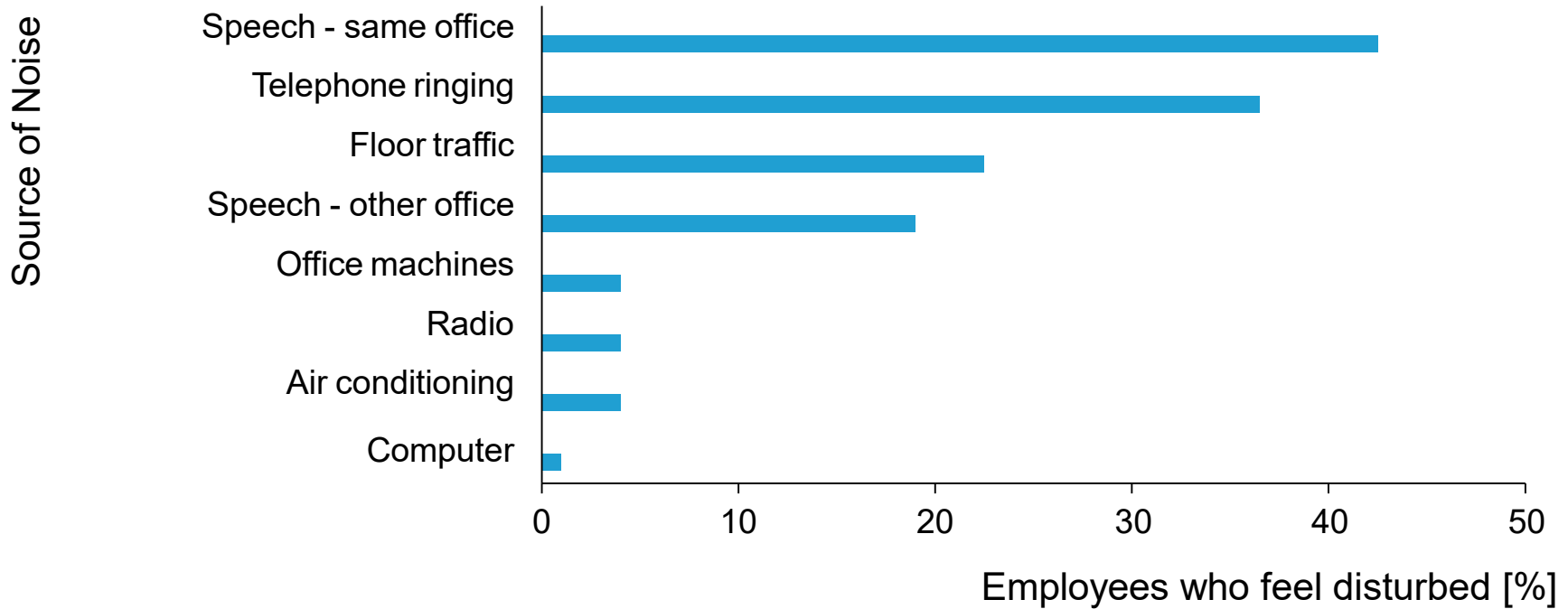
Room acoustic measures:

- | | |
|---------------|------------|
| A - Ceiling | E - Humans |
| B - Walls | F - Plants |
| C - Cupboards | G - Floors |
| D - Windows | |



Effect of Noise in Buildings Offices

Percentage of employees who feel highly/very highly disturbed by noise



Source: Helenius, R., Keskinen, E., Haapakangas, A. & Hongisto, V. (2007). Acoustic environment in Finnish offices – the summary of questionnaire studies. International congress on acoustics. Paper RBA-10-001.

Effect of Noise in Buildings Offices

■ Quiet office: 45-50 dB

- Primarily non-verbal tasks, such as reading, writing and programming
- Here make sure the telephone has been set correctly, are on silence

■ Normal office: 50-55 dB

- Tasks such as reading and writing, but also some conversation with colleagues
- Look at introducing good quality headsets, earphones

■ Noisy office: 55-60 dB

- Look at putting this on the reduce noise agenda
- Improve the office set up. Install acoustic panels and boards

■ All areas can be improved by introducing simple acoustic ceiling tiles or panels

Set Objectives and Goals for the Acoustics in Buildings

- Example: An open office environment might create a more collaborative atmosphere but
 - according to a Cornell University study, if you don't address noise issues, the same environment can increase tension and decrease productivity.
 - and it is important to understand that low-to-moderate noise doesn't just come from machines and equipment, but also from conversations and office chit-chat.
- Adding a simple set of acoustic ceiling panels can absorb sound and make the environment much more pleasant

Think about how the noise will affect the performance of your employees in your room design!



Design your room with care, some simple extra costs at design or modification stage could result in improved performance and health for your staff!

BASF Offices Turkey

Learning Objectives

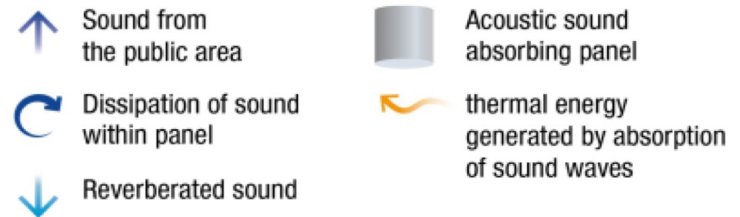
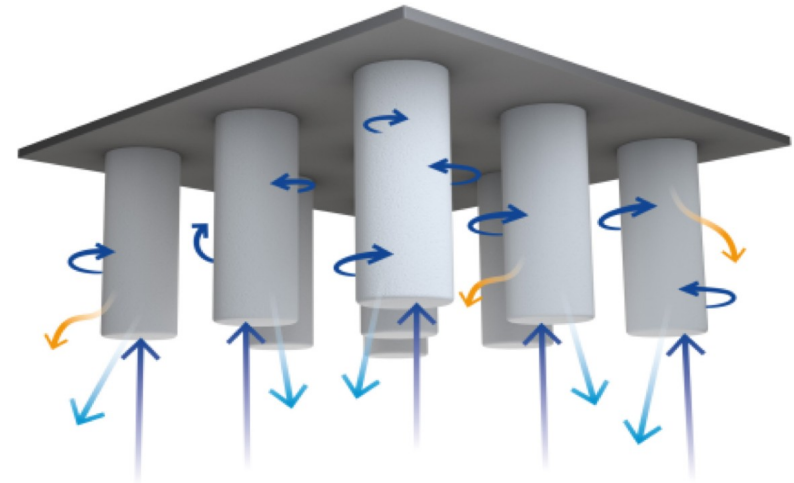


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Sound Absorption Material Choice

Main Considerations

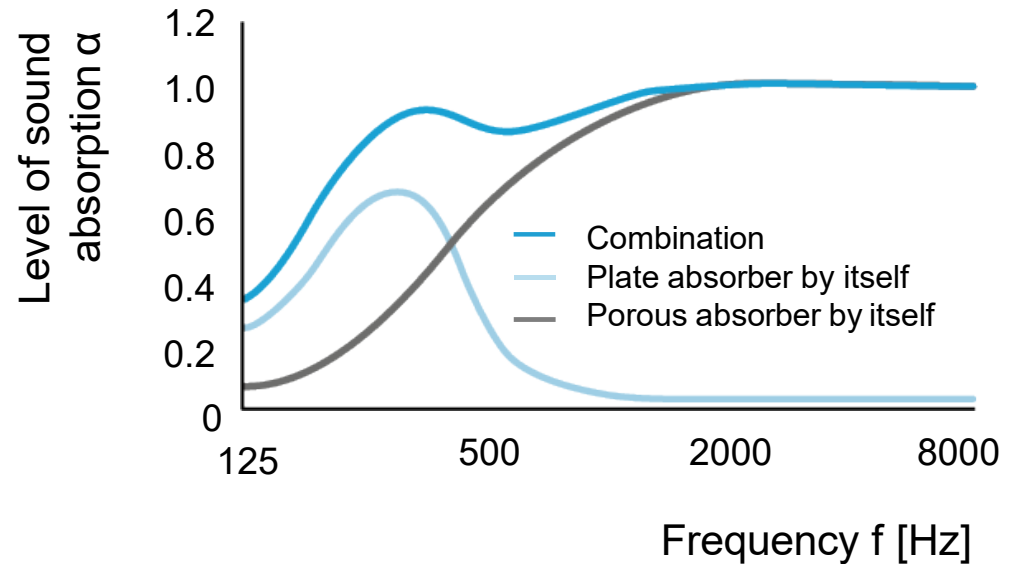
- When we are considering what acoustic quality we desire in our room we have to consider the design, the environment and the rooms purpose.
- Sound from the area – what is the acceptable sound level for our room / office / classroom



Sound Absorption Material Choice

Main Considerations

- Dissipation of sound within a panel – how can we ensure the sound stays within the panels cell structure?
- Reverberation sound – what is the acceptable level of reverberation we will allow?
- Acoustic sound absorbing panel – what is the acceptable level of sound, what fire class should we meet, where and how will the panels be installed, ceiling, walls?



Room Acoustic Considerations for Acoustic Absorbing Materials



Fire Regulation: two main considerations for materials used in building and construction are

■ BS476 Part 6 & 7

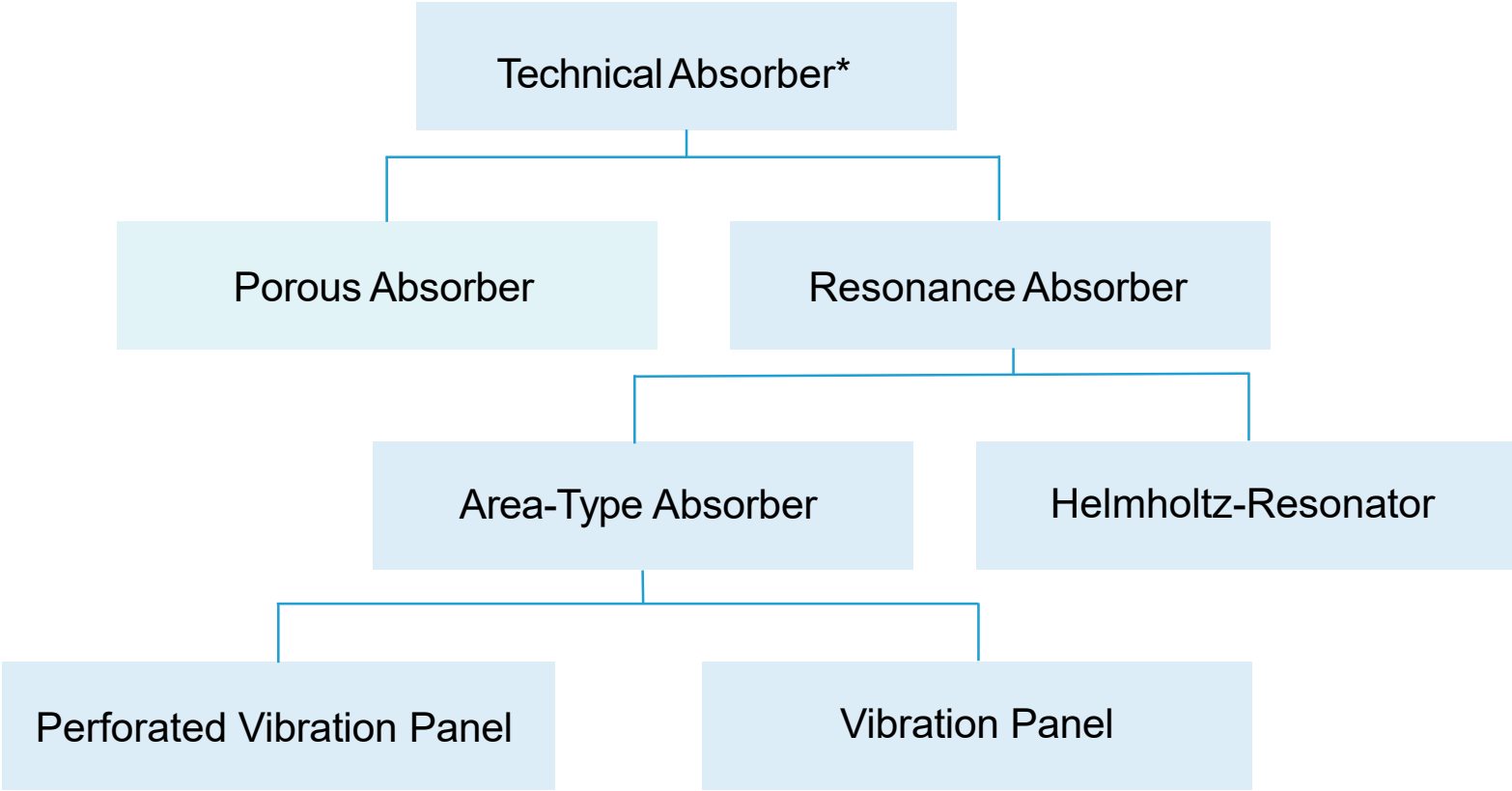
- British standard 476 dictates the appropriate fire tests for these elements of structure/materials and grades the level of fire resistance.
- The test sets out the objective, the sponsor (company) and its opinion, what class it meets.
- BS476 Part 6;1989+A1;2009 = fire propagation. Part 7; 1997 = surface spread of flame

■ DIN EN13501

- European Fire classification of construction products and building elements Part 1
- The test will produce the result and class, including the fire behaviour, smoke production, and burning droplets

Sound Absorbing Materials in Room Acoustics

Type of Absorber



*Other technical absorber: Acoustic plaster, micro-perforated panels, textiles

Sound Absorbing Materials in Room Acoustics

Porous Absorbers



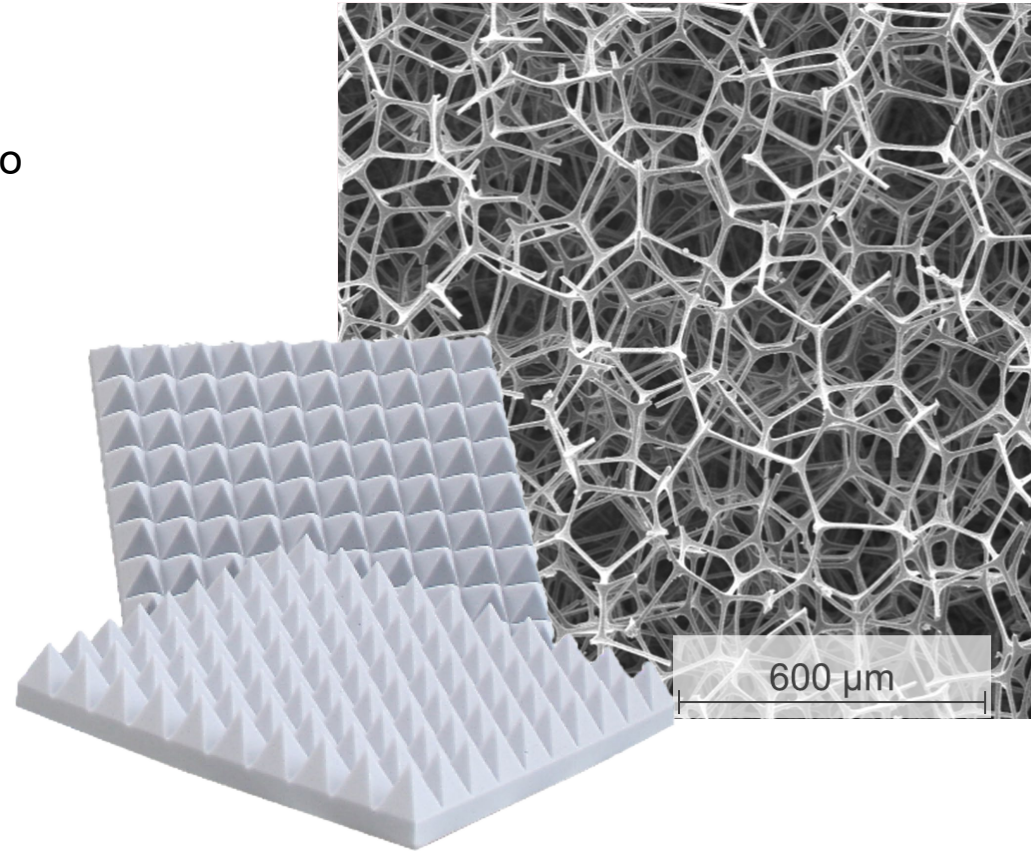
Here you could look at the following:

- Melamine Foam
- Glass Mineral Fiber / Wool
- Polyester Fleece
- Wood wool
- Sheep wool
- Hemp fibers

Sound Absorbing Materials in Room Acoustics

Porous Absorbers: Melamine Foam

- Flexible thermoset polymer foam based on melamine resin
- Excellent sound absorption in medium to high frequencies
- Meets EN13501 Class B/C and BS 476 Part 6 & 7 Class 0 (depending on material thickness; further information upon request)
- Without additional flame retardants at certain thicknesses
- Low density with high air permeability (100% open-cells)
- Design freedom with high stiffness



Design Capabilities of Melamine Foam

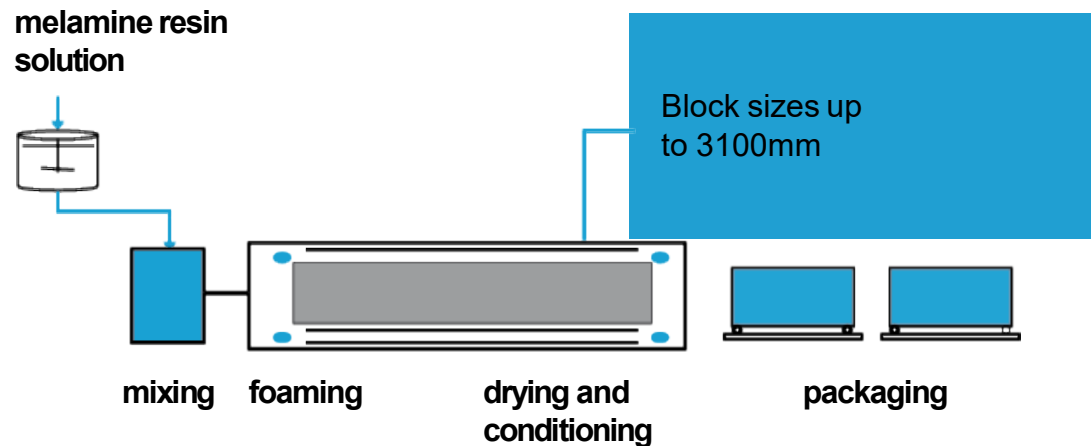
Processing and Conversion

Mechanical treatment

- **Splitting**
Cutting of sheets
- **Contour or profile cutting**
3D geometries
- **Die cutting**
Flat parts

Post-treatment

- **Dying/Coating**
Decorative colored surfaces
- **Laminating**
(fabrics, non-wovens, foils, PSAs)



Design Capabilities of Melamine Foam Hanging Baffles and their Design Aspects

- Natural
- Coated
- Behind textiles
- Cut to any shape
- Coated to any color
- Integrated into lighting

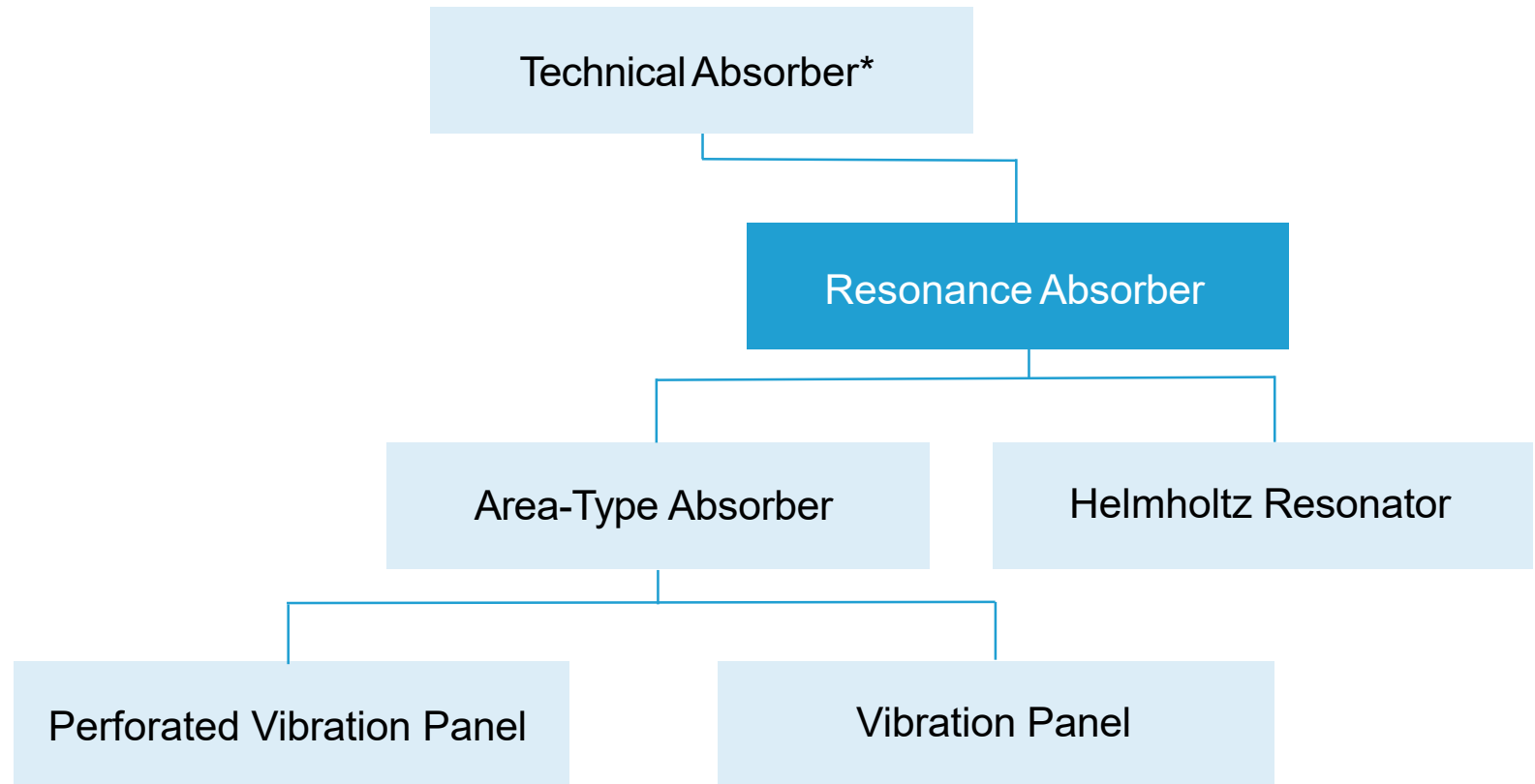
Scoring Comparison of Different Acoustic Absorbing Materials

Properties	Melamine Foam	Glass Wool	Stone Wool	Wood Wool	Expanded Glass Granules
Sound Absorption EN ISO 354	8	9	9	6	5
Fire Protection EN ISO 13501-1 and DIN 4102-1	8	9	10	8	10
Weight EN ISO 845	10	8	7	5	2
Stability of Long-Term Temperatures EN ISO 2578 and EN ISO 3386-2	9	7	7	10	10
Processing / Assembly	8	5	3	5	2
Design Flexibility	10	6	6	4	4
Results	53	43	42	38	33

Source: Table 1: Acoustic ceiling systems made of Basotect® compared with systems consisting of other porous absorption materials

Sound Absorbing Materials in Room Acoustics

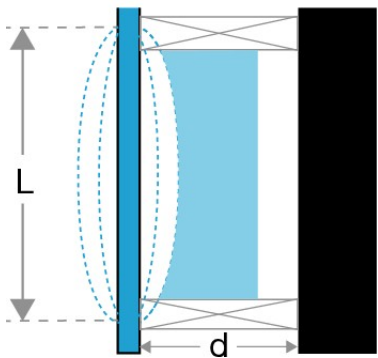
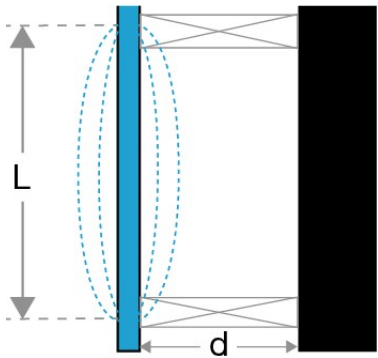
Type of Absorber



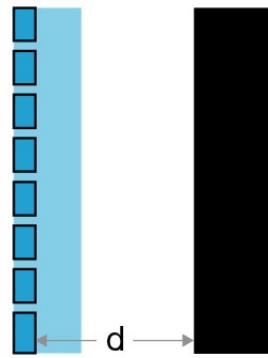
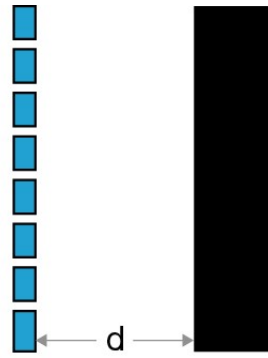
*Other technical absorber: Acoustic plaster, micro-perforated panels, textiles

Sound Absorbing Materials in Room Acoustics

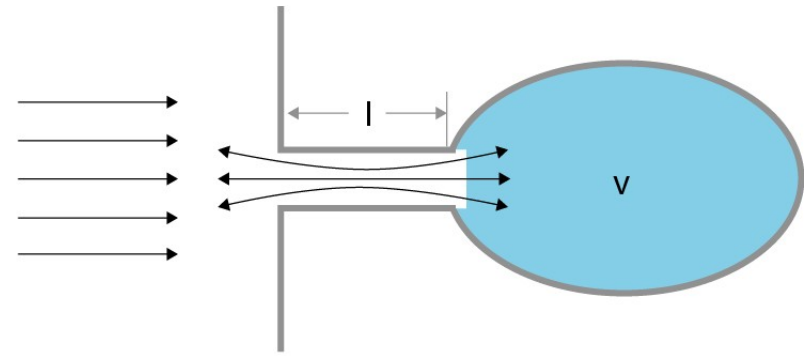
Resonance Absorbers



Vibration Panel



Perforated Vibration Panel



Helmholtz Resonator

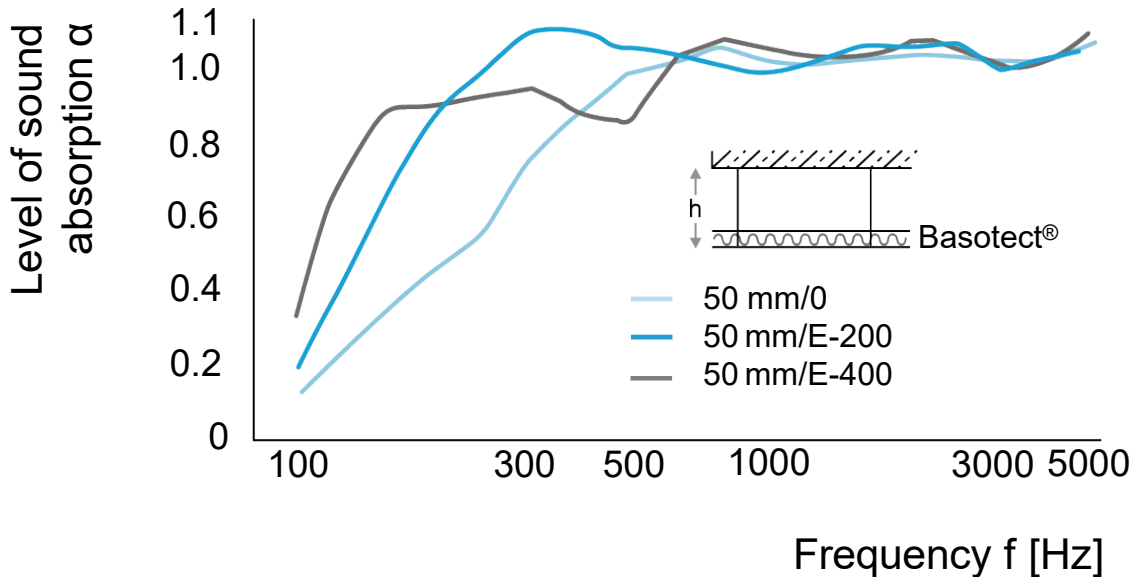
- Air in V works as a spring
- Air in the bottle neck works as mass
- Inserted absorption material or fleece in the bottle neck cause resonance dampening

Sound Absorbing Materials in Room Acoustics

Use of Air Space

Typical Combination:

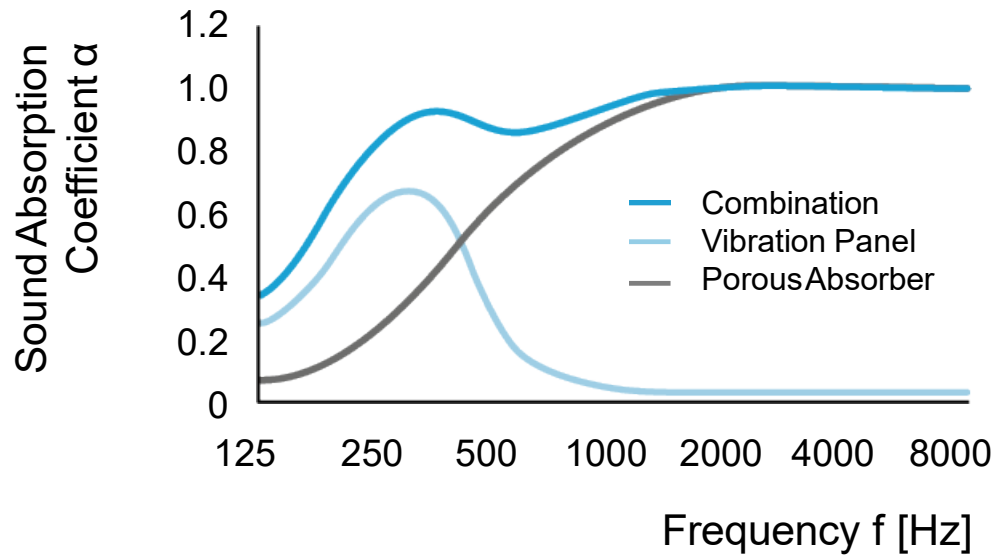
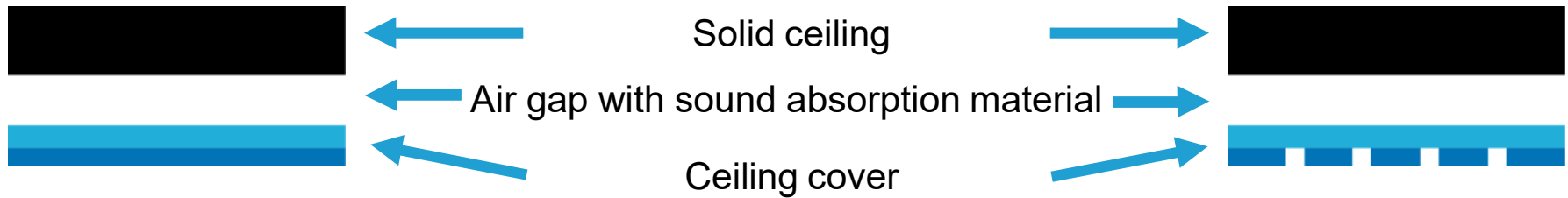
- Smooth, perforated, or grooved panels made of gypsum board or wood are frequently used.
- These panels may be combined with a fleece layer behind the xopenings and an additional sound-absorbing layer of Melamine Foam to improve their acoustic performance.



Sound absorption of 50 mm porous absorber with 200 and 400 mm gap.

Sound Absorbing Materials

Combination of Absorbers



Environmental and Sustainability Considerations of Acoustic Absorbing Materials



- Buildings use resources (energy, water, raw materials, etc.), generate waste (occupant, construction, and demolition), emit potentially harmful atmospheric emissions, and fundamentally change the function of land, and the ability of that land to absorb and capture water into the ground. Building owners, designers, and builders each face unique challenges to meet demands for new and renovated facilities that are accessible, secure, healthy and productive, while minimizing any negative impacts upon society, the environment, and the economy.
- A sustainable building is designed and operated to use and reuse materials in the most productive and sustainable way across its entire life cycle, and is adaptable for reuse during its life cycle

Environmental and Sustainability Considerations of Acoustic Absorbing Materials



- The indoor environmental quality (IEQ) of a building has a significant impact on occupant health, comfort, and productivity.
- Among other attributes, a sustainable building maximizes daylighting, has appropriate ventilation and moisture control, optimizes acoustic performance, and avoids the use of materials with high-Volatile Organic Compounds (VOC) emissions, ISO 16000-6:2011. Principles of IEQ also emphasize occupant control over systems such as lighting and temperature.
- Acoustic material choice plays a part in areas of VOC emissions and light reflectance alike. There are acoustic materials available which can help meet the IEQ principles including those with VOC emissions approval to ISO 16000-6:2011. Also materials which can be white, coated white, or spray painted white can give a good light reflectance. An example here could be a Melamine foam in white has a “light reflection factor” of 79 % vs 57% of Melamine foam grey acc to DIN 5036-3

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Suspended Ceiling

Conference Room BASF, Ludwigshafen

Important Project Properties	Values
Low Weight	9 kg/m ³
High Sound Absorption	$\alpha_s \geq 0.90$ (2000 Hz, t=50 mm)
Low Thermal Conductivity	
High Temperature Resistance	
Excellent Fire Behavior	B/C (EN 13501)
Good Environmental Behavior	Mineral Fiber Free
Design Freedom	Shaped Sheets
Easy Mounting and Fixing	Suspended

Product: Basotect®

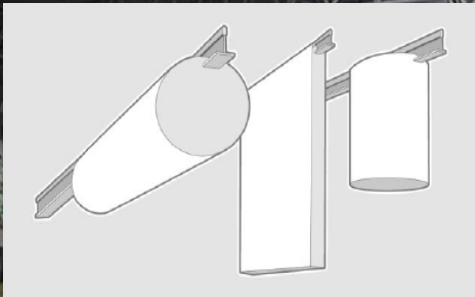
Design Capabilities of Melamine Foam Halls – Best Practices (ceilings)

- Patterns cut into the surface
- Integrated with lighting
- Intricate pieces worked together
- Easily worked around hardware, sprinklers, etc...
- White products give high light reflection



Design Capabilities of Melamine Foam Sports Facilities – Best Practices

- Resistance to moisture and microorganisms
- Low weight allows for ease of installation



Ordos stadium, Entech



rondo, pinta acoustics inc

Design Capabilities of Melamine Foam: Baffles

DUI Restaurant, São Paulo

Important Project Properties

Low Weight

High Sound Absorption

Low Thermal Conductivity

High Temperature Resistance

Excellent Fire Behavior

Good Environmental Behavior

Design Freedom

Easy Mounting and Fixing

Values

9 kg/m³

$\alpha_s \geq 0,75$
(2000Hz, air gap 200mm, t=20mm)

B/C
(EN 13501)

Mineral Fiber Free

Insert Sheets

Suspended

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BASF Product Offering

Basotect® Melamine Foam Grades B and G + for Room Acoustic Solutions

- High sound absorption capacity
- Easy to work with and design freedom
- Low flammability without additional flame retardants
- Low weight ($\sim 9 \text{ kg/m}^3$)
- No fibers
- High light reflectance
- High colour stability
- Resistant to static charging

Thank You