ECOPHON
ISO 22955 ACOUSTIC QUALITY OF OPEN OFFICES

Ecophon
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The state of office noise

About 70 percent of office workers are dissatisfied with the acoustic conditions in their place of work (1). Unfortunately, this is not a new issue, but a long-standing problem that can be traced all the way back to the very first open offices.

The origins of office noise and its negative effects on workers are well documented, as are the practical solutions. Unfortunately, office noise consistently ranks as one of the leading complaints of office workers all over the world.

There are several likely reasons for the persistence of office noise problems, but one stands out in particular – open offices are very complex sound environments and it has proven hard to design them from an acoustic standpoint. ISO 22955 provides clear instructions and target values for high-quality acoustic design based on a wide range of typical office activities.

WHAT ARE THE BENEFITS OF HIGH-QUALITY ACOUSTIC CONDITIONS IN OPEN OFFICES?

- Increased job satisfaction (2).
- Increased productivity (3).
- Increased well-being, less tiredness (4).
- Fewer errors, increased accuracy (5).
- Reduction in stress hormone levels (6).
- Improve the speed witch which tasks are performed (7).

ISO 22955: ACOUSTIC QUALITY OF OPEN OFFICE

A SIMPLE SUMMARY

ISO 22955 provides technical and methodical guidance on the subject of acoustic quality in open offices. The standard is intended to support design and planning decisions from conception to use. It also provides a solid foundation for communication between the stakeholders involved in the process.

This brochure summarises two of the primary ways ISO 22955 provides clear guidelines on the factors that contribute to acoustic quality in open offices. First, it explains general principles for acoustic treatment, room geometry and space layout; and second, it describes typical work place activities and their acoustic characteristics.

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OBS: Please note that this brochure should not be considered a substitute for the actual contents of ISO 22955. To aid comprehension, this summary differs significantly from the original standard. These differences include, but are not limited to, the order of information, the headings and descriptive accuracy. Please see the original and complete standard for more precise and comprehensive guidance

Basic principles of room acoustic design

GENERAL:

The acoustic treatment of rooms essentially involves covering room surfaces with sound-absorbing materials to limit sound reflections. The more sound that a given material can absorb (i.e., the higher its sound absorption coefficient) and the larger its surface area, the better. Priority should be given to the surfaces that are directly exposed to the sound sources in the room.

[ISO 22955: p. 15 – s. 6.4.1]

CEILING TREATMENT

The ceiling is the most important room surface to treat in open offices and should be as sound-absorbing as possible. A wall-to-wall sound-absorbing ceiling is preferable.

[ISO 22955: p. 16 – s. 6.4.2]

WALL TREATMENT

The wall area tends to be quite small relative to the ceiling area in a typical open office. Wall absorbers are nevertheless still a good way of reducing reverberation time if the open office is sparsely furnished (lacking diffusion). They also minimise flutter echoes and sound reflections for workstations located close to walls, particularly in the corners of open offices. Wall absorbers should be installed at the ear height of the people who use the room.

[ISO 22955: p. 16 – s. 6.4.3]

FLOOR TREATMENT

In general, the effect of acoustic treatment on floor surfaces in open offices is not significant, unless highly specialised solutions such as perforated cavity flooring are installed. Soft flooring only contributes slightly to absorption in the higher frequency ranges. The main room acoustic benefit of carpets is to minimise impact noise from steps and furniture.
When designing office buildings with access flooring, special care should be taken to ensure the structural sound insulation properties of the construction.

[ISO 22955: p. 16 – s. 6.4.4]

ACOUSTIC SCREENS

Acoustic screens improve acoustic privacy and thus reduce distractions in an open office. They do this by minimising the distance that sound spreads. The effect of acoustic screens depends on the quality of the acoustic environment: the fewer sound reflecting surfaces present, the higher the degree of acoustic privacy. The height of acoustic screens should be chosen to block the direct path of speech from workstation to workstation. It should also be noted that acoustic screens that extend above and below desk surfaces provide a higher degree of speech privacy.
Both sound absorption and attenuation

determine the effectiveness of acoustic screens
[ISO 22955: p. 17 – s. 6.5.2]

FURNITURE

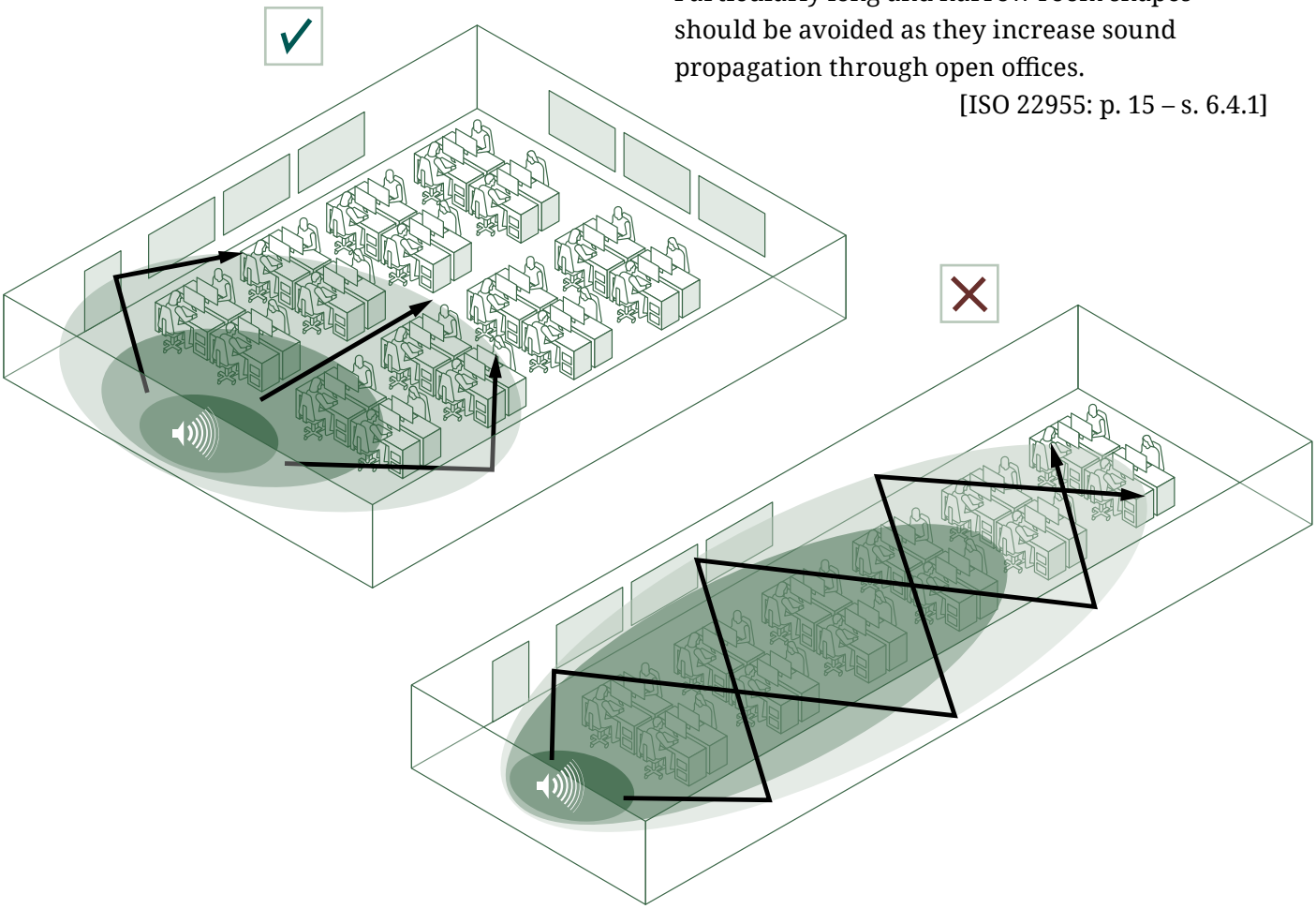
As a rule of thumb, furniture alone will not be sufficient to satisfy the acoustic needs of open office spaces. The first priority for acoustic treatment should instead be to treat room surfaces with sound-absorbing materials.
[ISO 22955: p. 16 – s. 6.5.1]

SPACE LAYOUT

Workstations should be grouped together according to levels of collaboration. Likewise, the routes to support areas should be kept as short as possible for the groups that use these support areas most frequently. Where possible, support areas should be located in adjacent rooms with doors that isolate noise acoustically.
[ISO 22955: p. 14 – s. 6]

ROOM GEOMETRY

Open offices generally have a relatively low ceiling height relative to their floor area. Normal ceiling heights help to improve speech privacy in office spaces with large floor areas. i.e. ceilings that are higher than normal are best avoided.
Particularly long and narrow room shapes should be avoided as they increase sound propagation through open offices.
[ISO 22955: p. 15 – s. 6.4.1]



1 Space type 1: – activity still unknown

In some cases, choices must be made in the design of an office space before it is known what activity will take place in the office. This includes projects under tight time constraints or when designing spaces that are intended to be rented out to third parties, etc.

In such cases, it should be emphasised that the basic design, including materials and geometry, is the fundamental factor that affects the acoustic quality of any room. The flexibility, use and effectiveness of the layout or interior design of any open office depend on ensuring that the basic design delivers the essential acoustic qualities right from the start – regardless of the activities that are to be carried out in the space.

No normative target values are provided by ISO 22955, but an informative annex does provide recommendations in terms of absorption area.

Equivalent Absorption Area*

$$\frac{A}{S_{floor}} \geq 0.9$$

* Not normative [Annex G, p. 37]

Space type 2: Tele- and video communication

FUNCTIONS:

Technical support, sales, information services, prospecting, consultation, tele-medicine, etc.

TYPICAL DENOMINATIONS:

Call centres, contact centres, support centres, etc.

SOUND ENVIRONMENT:

High noise levels are typical in spaces used for tele- and video communication. Colleagues talking to each other and through communication equipment can cause noise levels to escalate.

CHALLENGES:

High noise levels as well as “irrelevant speech” are known to increase stress, vocal strain and reduce productivity and communication quality. Acoustics should therefore support concentration and mental clarity, by mitigating noise levels and supporting speech privacy through the space.

Attenuation of speech
between workstations
$D_{A,S} \geq 6$ dB

Reverberation time
$T \leq 0.5$ s.
$T_{125Hz} \leq 0.8$ s.

Spatial decay rate of speech
$D_{2,s} \geq 7$ dB

Space type 3: Primarily collaborative work

FUNCTIONS:

Consulting, advertising, design, marketing etc

SOUND ENVIRONMENT:

Noise levels tend to fluctuate in spaces for collaboration. Activities involve an interplay between individual mental tasks and a high degree of verbal communication. This facilitates a lively and dynamic sound environment.

CHALLENGES:

Simultaneous conversations can result in escalating noise levels due to the Lombard effect. The acoustic environment should therefore mitigate noise levels and ensure that colleagues can carry on a conversation at short range while not disturbing others at a distance. Dampening of speech propagation through the space is therefore a priority.

Attenuation of speech
between workstations
$D_{A,S} \geq 6$ dB

Reverberation time
$T \leq 0.5$ s.
$T_{125Hz} \leq 0.8$ s.

Spatial decay rate of speech
$D_{2,s} \geq 7$ dB

Space type 4: Sporadic collaborative work

Attenuation of speech
between workstations
$D_{A,S} \geq 6$ dB

Reverberation time
$T \leq 0.5$ s.
$T_{125Hz} \leq 0.8$ s.

Spatial decay rate of speech
$D_{2,s} \geq 7$ dB

FUNCTIONS:

HR, accounting, engineering, programming, etc.

SOUND ENVIRONMENT:

When managed properly, spaces of this type tend to be relatively quiet and stable. Work activities are centred around concentration and mentally demanding tasks that generate little noise. Conversations tend to be brief and infrequent in nature, while longer interactions are relegated to external or acoustically screened-off areas.

CHALLENGES:

As noise levels will generally be quite low, this space is less acoustically demanding (except for work involving noisy manual or mechanical devices). Design priority should be placed on reducing reverberation to a suitable level, ensuring adequate speech intelligibility and reducing sound propagation. Especially in larger offices it is important to take special care to reduce distraction between teams/ groups by managing sound propagation.

Space type 5: Receiving the public

5

FUNCTIONS:

Hotels, public organisations, travel agencies, retailers, etc.

DENOMINATIONS:

Reception, lobby, store, municipality, customer service, store, etc.

SOUND ENVIRONMENT:

This type of space often contains various sound sources such as office equipment and printers, and integrated loudspeakers and continuous music are not uncommon. Noise levels from other sources such as conversations, internal and external traffic or impromptu conversations may vary greatly, creating quite a lively sound environment.

CHALLENGES:

Receiving the public entails continuous interactions with visitors, but staff are usually also stationed at a work space suitable for more mentally demanding tasks. Interactions can often potentially involve sensitive information such as personal issues or business. The acoustic environment should, as a rule of thumb, be designed for the most demanding activity that the space may be used for. Design priority should ensure acceptable noise levels and provide excellent speech intelligibility at interaction points between staff and visitors. Depending on the space, affording a high degree of privacy between such areas and other spaces, including waiting areas, can be very important.

Attenuation of speech
- between workstations
$D_{A,S} \geq 6$ dB

Reverberation time
$T \leq 0{,}5$ s
$T_{125Hz} \leq 0{,}8$ s

Spatial Decay Rate of speech
$D_{2,s} \geq 7$ dB

Space type 6: Mixed Activities

Due to the nature of their use, it is not possible to define an exhaustive list of potential activities that may take place in these spaces. Typical activities include:

- Concentration work in special areas designed to dampen noise.
- Desk work at workstations for sporadic collaboration/discussion.
- Tele- and video communication.
- Informal meetings and collaboration without acoustic screening.
- Recreational activities such as resting, refreshments, recuperation.
- Formal meetings in spaces that are not screened off acoustically.
- Formal meetings in spaces that are sectioned or screened off from surrounding areas to provide higher degrees of privacy, often with walls that extend to the height of the suspended or structural ceiling.

Accommodating several activities in one space necessitates strict demands on acoustic design – the greater the variation in activities present, the higher the demands.

It is therefore not generally useful to give general target values for the entire space. Instead, ISO 22955 specifies the necessary values of $D_{A,S}$ between working areas, provided that sufficiently low background noise levels are achieved for the given activity type.

Table 1 - Potential $D_{A,S}$ ratings between different types of spaces

Source/receiver space type	Informal meetings (open plan)	Outside of the room communication (phone)	Collaborative	Non-collaborative	Focused phone	Focused individual work
Social and welfare	15	15	18	24	27	32
Informal meetings (open plan)	15	12	15	21	24	29
Outside of the room communication (phone)			12	18	21	26
Collaborative				18	21	26
Non-collaborative					18	23
Focused phone					21	26

NOTE 1: In order to keep the noise level within the social and welfare space under control and avoid the Lombard effect, a certain amount of absorption is needed. It is recommended to have an absorption area of at least 90% of the floor surface.
$A/S_{floor} \geq 0.9$.

NOTE 2: These values are derived based on assumptions regarding background sound levels, source vocal effort, and proposed signal-to-noise ratios. These values may vary depending on the context.

Dampening of speech between workstations

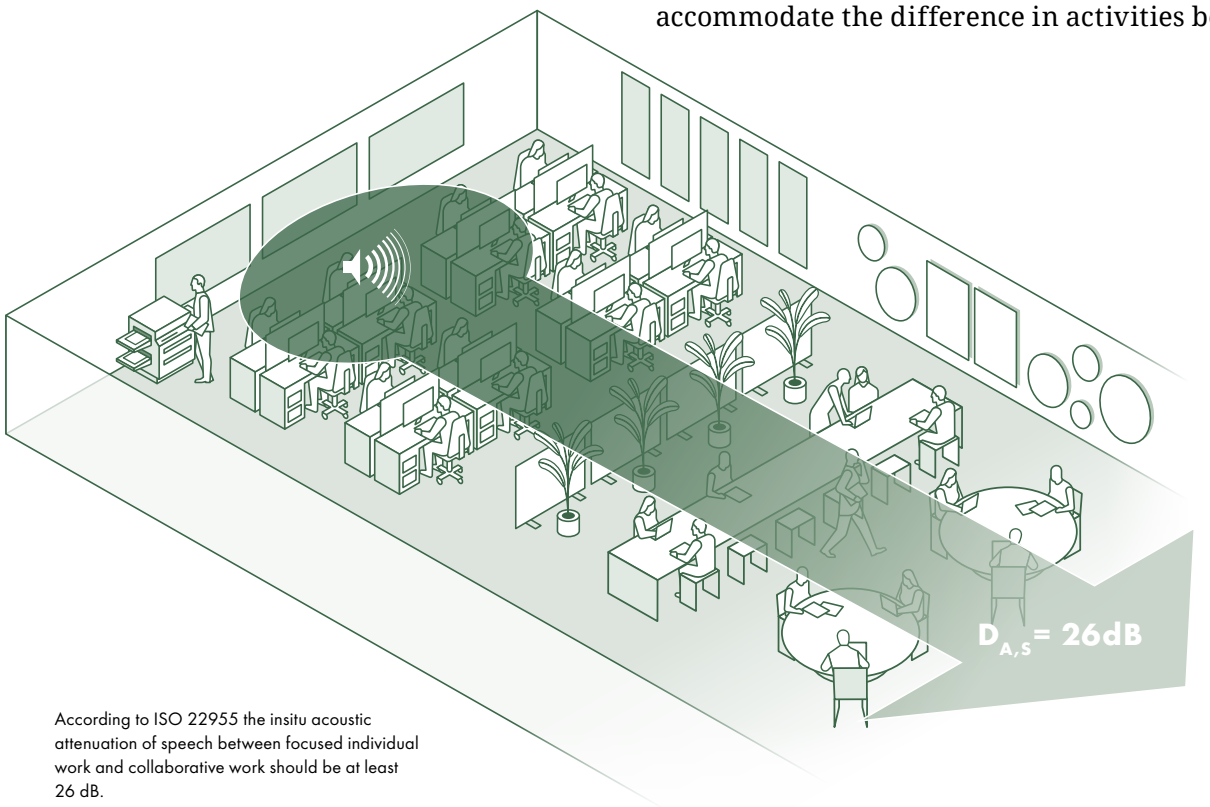
$D_{A,S}$: IN SITU ACOUSTIC ATTENUATION OF SPEECH

ISO 22955 introduces a new parameter for evaluating the acoustic quality of offices. Unlike many other room-acoustic descriptors, $D_{A,S}$ denotes a difference in sound level between a sound source and a receiver. Several $D_{A,S}$ values could therefore be relevant to evaluate in most open offices.

The precise definition from ISO 22955 is as follows:

"The difference, in decibels, between an A-weighted speech source spectrum at 1 m from an omni-directional source in the free field and the A-weighted sound pressure level at a reception point."

As shown in Table 1, this descriptor provides acoustic designers with a tool to evaluate whether activities are separated by a satisfactory degree of acoustic dampening. Evaluation of acoustic design through this parameter can be used to specifically accommodate the difference in activities between



According to ISO 22955 the insitu acoustic attenuation of speech between focused individual work and collaborative work should be at least 26 dB.

Glossary

two working areas.

• Background noise level

The mean overall sound-pressure level of an environment is referred to as the background noise level or ambient sound level and can be evaluated by different descriptors and target values. ISO 22955 suggests target values for noise levels measured at individual workstation through the descriptor $L_{Aeq,T}$. Noise levels are affected by both sound sources and the acoustic characteristics of a space, including reverberation time.

• Reverberation time, T (ISO 3382-1+2 & 12354-6)

This basic room acoustic descriptor specifies the time it takes for sound energy to decrease in an enclosed space in seconds. Roughly speaking, the longer the reverberation time, the noisier a room will be. Reverberation time is specified for several frequency bands as materials interact differently with sound at different frequencies.
For several reasons, special target values are often prescribed for reverberation at the 125 Hz frequency band ($T_{125\ Hz}$)

• Spatial decay rate of speech, $D_{2,s}$ (ISO 3382-3)

This descriptor is very important in open offices as it describes the relation between the dampening of speech as the distance from the sound source increases. It specifies the reduction in A-weighted sound pressure level when the distance to the source is doubled. So the higher the $D_{2,s}$ value of an open office space, the better.

• Flutter echo

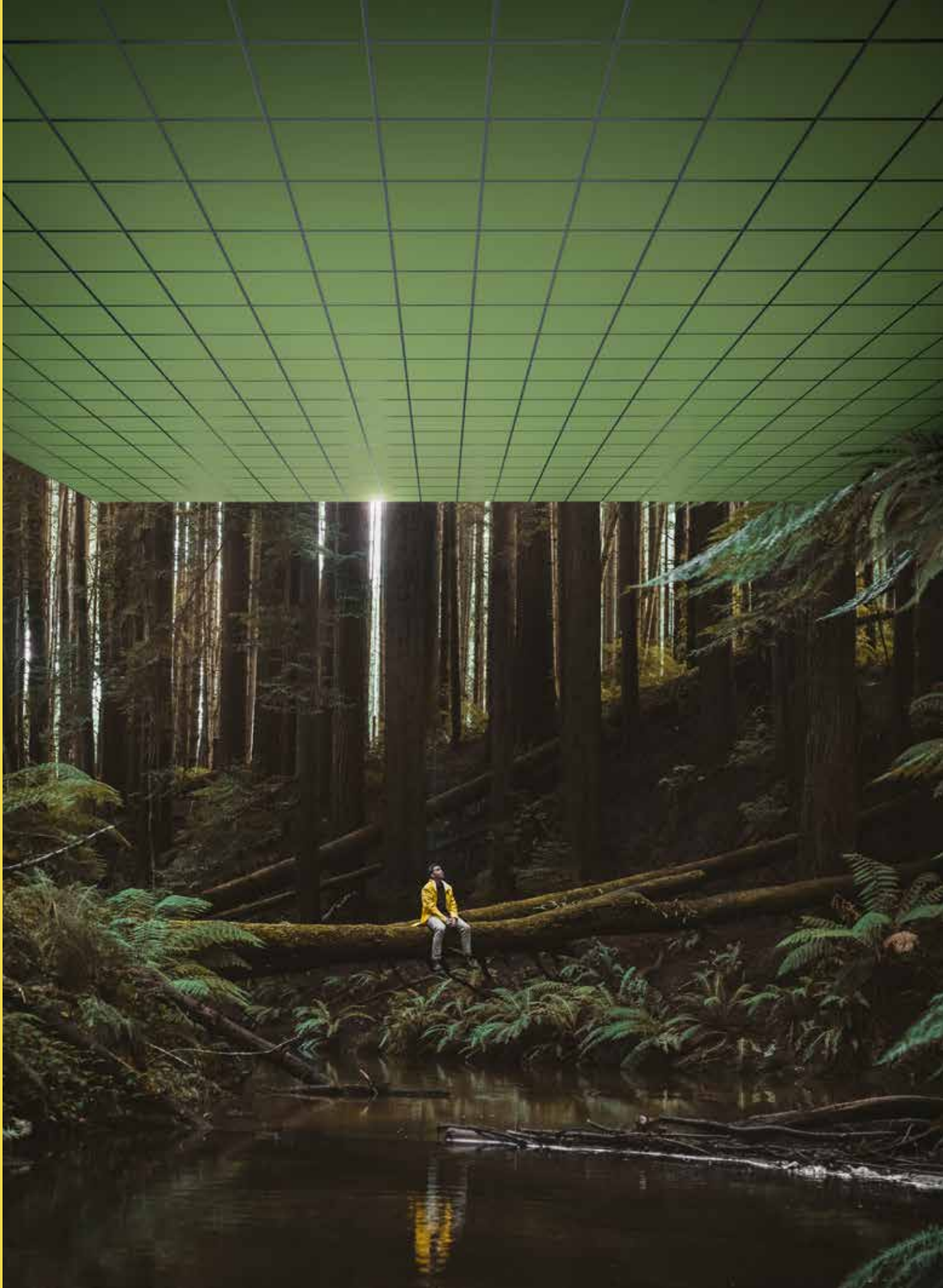
The physical phenomenon of sound waves as they are reflected between parallel hard surfaces over a short time span. This can create a very rapid echo that can cause discomfort and fatigue over the course of a working day.

• Diffusion

Furniture and rough or uneven room surfaces can improve acoustic conditions when used in conjunction with highly absorbing materials. They scatter the sound reflections and thereby prevent reoccurring reflections between hard parallel surfaces. This creates a more diffuse sound field, also sometimes referred to as “adding diffusion” to the room.

• Equivalent absorption area

A room’s equivalent absorption area (A) denotes the total amount of sound absorption that a given space contains. The larger the absorption area, the fewer sound reflections, the better the sound environment. The best way of increasing the equivalent absorption area of a space is by adding acoustic materials.
When choosing acoustic materials, it is important to keep in mind that their actual area is not necessarily equal to their absorption area.
Their contribution depends on the quality of the materials. You should therefore always ask or look for the absorption classes of acoustic products, which are listed from class A and lower. The higher the quality of acoustic material used, the fewer square meters of acoustic material is needed.



References:

1. Leesman Index – Global Workplace Survey, 2020

2. Fried, Yitzhak et al. (2002).”The joint effects of noise, job complexity and gender on employee sickness absence”. Journal of Occupational and Organizational Psychology, 75, 131-144.

3. Weinstein, University of California, Berkeley, 1974, “Effect of noise on intellectual performance”, Journal of Applied Psychology 1974, vol. 59, no 5, 548–554.

4. Olson, J. (2002): ”Research about office workplace activities important to US businesses - and how to support them” Journal of Facilities Management, 1(1), 31-47.

5. Weinstein, University of California, Berkeley, 1974, “Effect of noise on intellectual performance”, Journal of Applied Psychology 1974, vol. 59, no 5, 548–554.

6. Evans, Johnson, Cornell university, “Stress and open office noise”, Journal of Applied Psychology, 2000, vol. 85, no. 5, 779–783.

7. David M. Sykes, ”Productivity: How Acoustics Affect Workers’ Performance in Offices & Open Areas.” Palgrave Dictionary of Economics, 2004.

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Ecophon is the leading supplier of indoor acoustic solutions that improve working performance and quality of life. We believe in the difference sound can make to our everyday lives, and are passionate advocates for the importance of room acoustics to people's wellbeing – whatever the space, activity or need.

Having a sound effect on people is the principle that guides all we do. We're proud of the Swedish heritage and human approach that promise is founded on.

Our uncompromising commitment to transparent sustainable practice. And, as members of the Saint-Gobain Group, to be doing our part in making the world a better home.

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