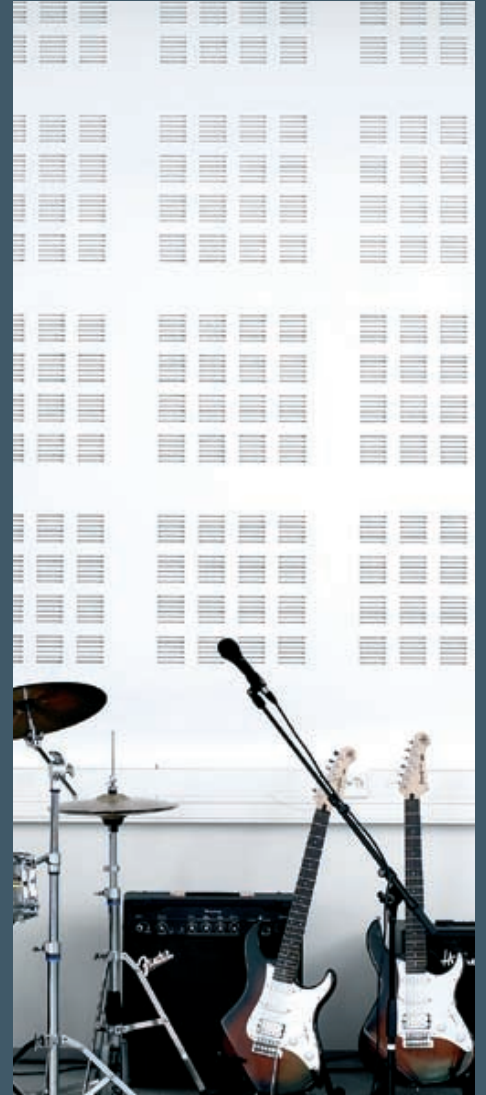


Gyptone ceilings

4.1 Acoustics and sound



Gyptone®

Reflecting everyday life

Acoustics and sound

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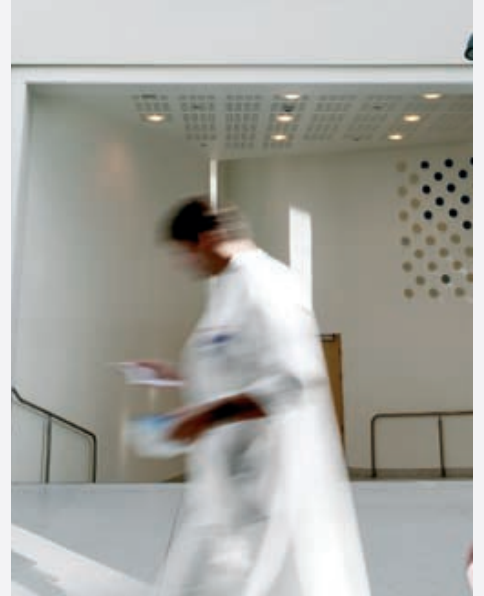
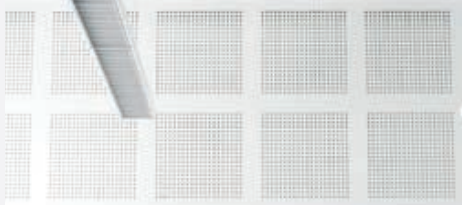
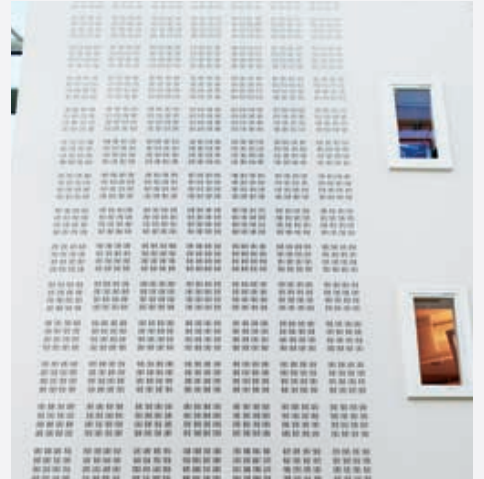
Acoustics is a necessary factor of design just like fire protection or lighting conditions. Acoustics is however starting to become a more and more important parameter of quality for the building environment and the final experience of a good indoor environment.

Standards and guidelines have been made in the Nordic countries which specify the minimum requirements for acoustics, different materials' acoustic standards and now most recently the categorisation of the building environment in different classes of acoustic quality.

In this brochure we treat acoustics as general information.

In you will find concrete acoustic information about Gyptone ceiling and wall product in the product brochures. This can also be found on www.gyptone.com, where PDF files can be downloaded and printed.

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- Frequency
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Basis for sound

"The science of sound," is what acoustics is called – a word which stems from the Greek akoustos, which means "listen". If we in a study of mechanical vibrations (and radiation of these vibrations through mechanical waves) start with the origins, acoustics has had important applications of use in all areas of life.

Acoustics is on the one hand part of classical physics, but on the other hand in certain circumstances its effect is more related to psychology than physics. Just as is the case for other parts of the science of physics, most acoustic relationships are measurable. The interpretation of the measurements are however not so straight forward.

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The problem is however that there is still some confusion about good acoustics. The desired effect of acoustics will naturally always depend on the function or the purpose of a room. Acoustics which meet the requirement for a concert hall are not suitable for a classroom. All acoustic requirements are expressed as physical, measurable amounts, for e.g. reverberation time. The problem is that even if these requirements are fulfilled it does not necessarily mean there is good acoustics. We can easily define building acoustic requirements as minimum sound insulation or acceptable noise levels. But for the acoustics of a room the situation is more complicated. We can specify reverberation times, but we can not specify that the room must sound natural.

The purpose of this assessment of acoustics is not to provide a complete course in acoustic design, but to focus on the aspects of a room's acoustics and the properties of materials for different jobs.





Sound level

A sound wave is an expression of a change in air pressure, where the source of sound is the deciding factor for how big the pressure changes are. A split of the audible area cannot be done as a rule.

A small increase in a pressure change by a little volume of sound results in a significant audible difference. In contrast, a small increase in a pressure change by a lot of volume of sound does not result in the same audible impression. The reason for this is that the ear only registers a change in relation to the original strength.

Therefore a scale of strength with intervals which grow proportionately with the strength is used. This is known as the decibel scale. (dB).

A decibel is a proportional measurement of energy or force and it is organised logarithmically. The choice of a logarithmic scale overcomes several problems and is roughly equivalent to the sound level that is characteristic for the ear. As an example, the doubling of a perceived sound level is the equivalent to a 10dB change.

Frequency

Frequency (f) has an influence on all aspects of acoustics. A clear tone has a single related frequency. All musical instruments however, produce complex sounds made by different frequencies, while the lowest of these normally determines the pitch, the name of the perceived frequency.

Frequency is referred to in Hertz (Hz). The ear can register frequencies between 20 Hz and 20,000 Hz, but the top limit decreases with age. The ear can also grasp the frequency logarithmically; but no new logarithmic measuring system is used.

The fundamental musical interval is the octave, which is the equivalent of a doubling of the frequency. Acoustic measuring methods are also traditionally based on the octave intervals with the centre frequency at 125, 250, 500, 1000 Hz etc.



Room acoustics

The acoustics of a room is generally linked to a term which describes the room's actual acoustic properties in relation to the use of the room. The general perception is that it is the room's reverberation time which theoretically can be calculated or measured on spot which is essential for how one perceives a single room's acoustics. This is not always right as in many instances other terms can be used like for e.g. speech intelligibility, which can be measured with the aid of STI (Speech Transmission Index) or RASTI (RAPid Speech Transmission Index).

Speech intelligibility can be simply described as how clearly information from the sender can be heard/recognised by the receiver.

If a large room's reverberation time is reduced because of an absorbent enclosure and the room is used for e.g. teaching, meetings, conferences or similar, there can be problems with understanding the information a sender passes on to a receiver. This phenomenon can be described by rating with RASTI values.

Perforated plaster products, which are a combination of absorption (holes) and reflection (the smooth plastered areas), will in many cases provide good speech intelligibility.





Reflection of sound

When a sound wave hits a surface it is reflected, absorbed or spread or even a combination of this.

The strength of an individual reflection is determined by the acoustic properties in the surface, from which it is reflected, as well as the distance it has covered.

When a sound wave hits a completely even surface it is reflected as a mirror image. All irregularities in the reflecting surface will influence the reflection.

If a reflecting surface has absorbing properties some of the energy will be absorbed but the pattern of reverberation will also be affected by the angle the sound wave comes from. This especially applies to reverberations from a thin board which begins to vibrate because of a sound wave so that the reverberation angle fluctuates.

Surfaces which are not even spread the energy of the sound wave. A diffuse surface can be regular for e.g. curved or irregular, for e.g. like diffuse surfaces which are used

in studios. From a design point of view it is important to remember that all diffusion from surfaces is to a certain extent dependant on frequency. This means that the size of the inconsistencies must be in a certain ratio to the wave length of the sound wave. This also results in the surface, which spreads in one frequency scale, to create focused or very strong reflective reverberations in another frequency scale.

Sound absorption

When a wave hits a surface, part of the energy is absorbed by the surface. Put simply, one can say that all the materials have an absorption factor and are thereby absorbent.

The absorption factor for different materials denotes how much energy remains in the material. The factor is rated in percent and is weighted from 0 to 1. The actual unit of absorption is Sabine (Sa). A Sabine is the equivalent to one square metre of 100% absorption.

Typical resonant base structures are perforated Gyptone plasterboards.

Both the boards and the resonant base structures have a resonance frequency and will absorb around this frequency. Typical membranes are normal plasterboard walls as well as tightly sealed surfaces.

The membrane's resonant frequency will primarily depend on the surface's weight and to a certain degree surface tension.

Cavity absorbents are based on resonant base structures, which are surfaces with holes or gaps with a cavity behind them. The cavity can either be empty or filled with porous material. Perforated plasterboards like Gyptone BIG are typical cavity absorbents.

The actual absorption properties depend on both the degree of perforation and the size of the cavity or more precisely on the cavity's impedance.

All of the building parts/materials have a more or less absorbing effect and are thereby a decisive factor in the room's total absorption. Some building parts/materials provide an absorbing contribution to the low frequencies and to the medium and high frequencies. Therefore in many cases it would be an advantage to use an absorbing product which has broad absorption that is reasonably spread throughout the frequency range from 125 – 4000 Hz.



Acoustics for music

While good acoustics for talking can be relatively easily established, good acoustics for music is much more complicated.

Good acoustics depends, first and foremost, on which type of music is intended for the room and its size.

Projects which comprise "serious" music acoustics will normally have an acoustic engineer involved.



Background noise

The best known reason for poor speaking reception is bad signals due to noise conditions, that is to say exceptionally loud background noise.

Even though it is only proven for serious cases of noise existence it is logical that this has a direct influence on speech reception even in the case of low levels of background noise.

A speaker's normal speech level is approx. 60 dB, measured at a distance of one metre, even though literature in some cases suggests that teachers talk with raised voices at approx. 70 dB.

It is obvious that to achieve reasonable noise conditions, even in small classrooms, background noise must be low.



www.gyptone.com

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Gyproc A/S
Hareskovvej 12
DK-4400 Kalundborg
Denmark
Tel.: +45 59 57 03 30
Fax: +45 59 57 03 01
e-mail: info@gyproc.com
www.gyptone.com

October 2007

