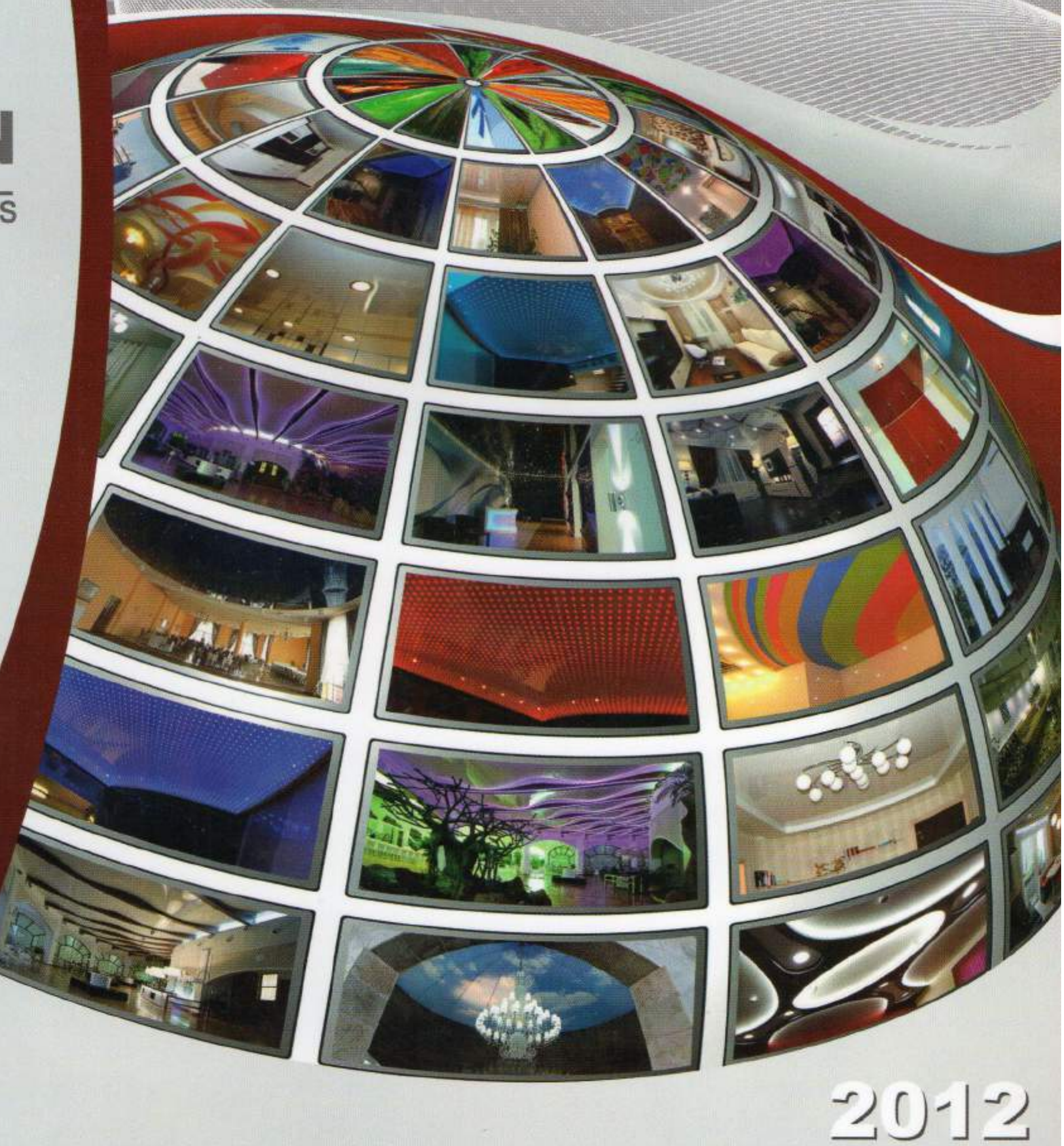
COMFORT
TECHNOLOGY
PREMIUM
ART

SAROS DESIGN
STRETCH CEILINGS

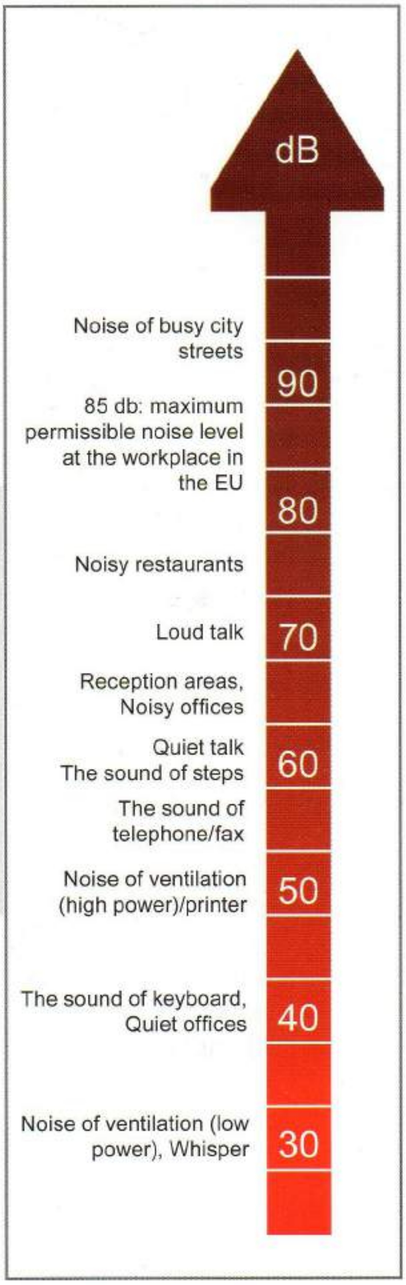


2012

COMFORT COLLECTION

The problem of noise pollution

Noise (acoustic) pollution is one of the major problems of the modern urban dweller. People face the problems of noise pollution not only in public places with traditionally high noise level (shopping centers, offices, restaurants, nightclubs), but also at home. The intensive use of household appliances breaks the silence in our houses and apartments. The high level of noise, in human's surrounding area, frequently turns into chronic fatigue and stress source and negatively affects human's physical and mental health.



Facts: The European directive of June 25, 2002 defines noise pollution as a serious problem of the modern world. The research of public opinion shows that noise is the key irritant in our daily life. For example, the research carried out by INSEE in October 2002 showed that more than 50% of Europeans consider the problem of noise pollution to be very serious. The same situation is observed in all countries with high urbanization level.

Nowadays there are developed many techniques which allow to reduce or eliminate some noise. The leading architects and designers project modern buildings with the requirements of acoustic comfort. The modern construction technologies effectively fight against noise penetration in the room (the soundproof technologies) and provide good sound insulation inside the room (the use of sound insulation materials).

Noise is a random combination of sounds of different intensity and frequency. In terms of human perception, noise is any sound perceived as negative.

Ceiling as the acoustically functional element

Creation of comfortable acoustic environment in the room gives the solution of two interrelated problems: protection from external sounds (sound insulation) and provision with high-quality spread of useful sounds in this room (noise absorption).

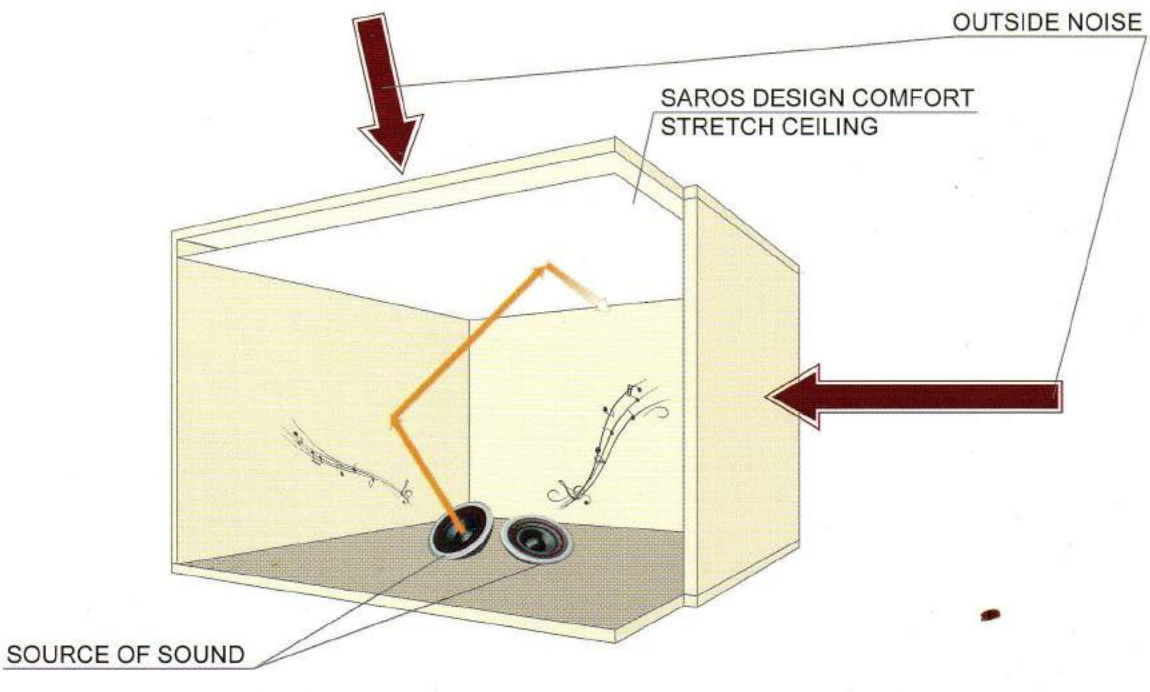
The satisfactory sound insulation from the outside noise can be achieved using the materials with superior sound-insulating properties or by the simple expansion of walls and ceiling thickness.

The case concerning noise absorption is somewhat different. Usage of the sound-absorbing materials can help to cope with echo inside the room. Usually there are carpets on the walls and on the floors, upholstered furniture. There are special acoustic panels in the "advanced", according to the acoustic properties, rooms.

At the same time there is a contradiction between the desired room appearance and acoustic requirements. You may agree that not in every interior carpets on the walls, heavy curtains and carpet on the floor will be appropriate. So, what to do? What to choose – functionality or beauty? There is a way out of this contradiction.

There is a free surface in every room - the ceiling. If we make the ceiling with different level of sound absorption, then we can make the room acoustically balanced, maintaining its appearance. Such opportunity can be achieved using our new perforated stretch ceiling brand – SAROS DESIGN COMFORT.

Facts: The theory of sound absorption by porous materials was developed more than 100 years ago by J.W. Strutt. It is based on the fact that there are viscous forces in porous materials which prevent air percolation through the pores, due to that the substance takes away the part of the kinetic energy from the vibrating particles of air turning it into heat. According to this theory, absorbing properties of porous materials depend on viscosity and density of air, radius and the number of pores per unit area, by using it as a coating material for the solid wall – from the layer thickness, or to be more exactly from the distance between it and the solid wall. The smaller pores' radius and more of them, the better high frequencies are absorbed.



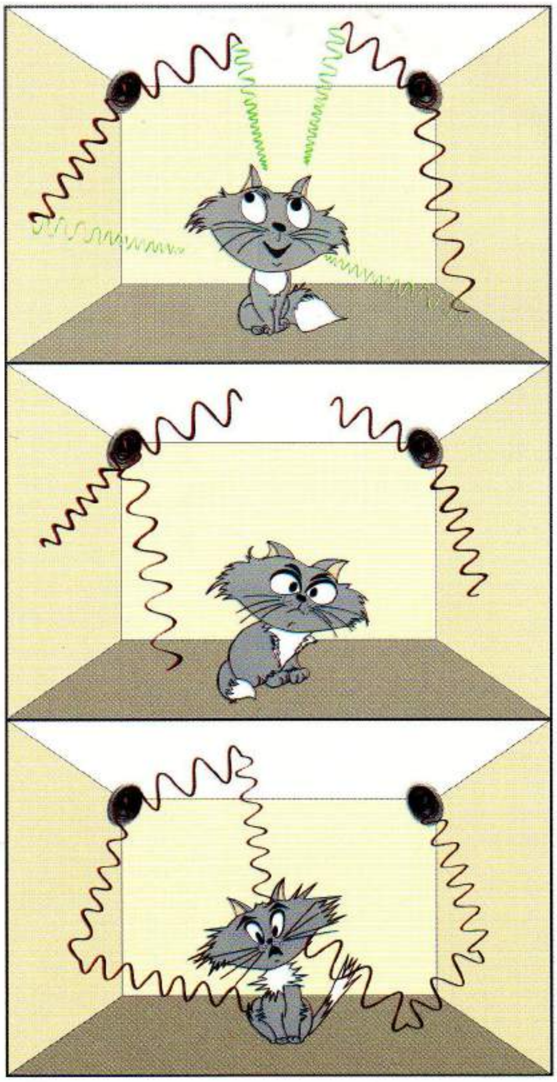
The basics of room acoustics

In evaluation of acoustic characteristics, the question of how room decoration affects the sound propagation is considered.

The acoustic qualities of the room can significantly change the nature of any acoustic system and affect the sound perception. The sound which source is, for instance, a stereo sound system of high quality is reflected from the walls, floor, ceiling, and all objects in the room, 'returned' and superimposed on each other. At the same time the sound in the room does not disappear after the power turnoff. This effect is called reverberation (afterperception).

According to the reverberation time we can talk about the degree of sound perception by the room and by the objects inside the room.

The reverberation time is the time required for reflections of a direct sound to decay by 60 dB below the level of the direct sound. The longer the reverberation time is, the less energy (including sound) is absorbed by the materials and dispersed. The strong reverberation of the sound leads to the multiple superposition of reflected waves on one another, creating the 'multiple echo' effect. But complicated and the sound absorbed room will lead to that good music and man's talk will sound indistinctly and lifeless.



COMFORTABLE ROOM
The optimal reverberation time.

Comfortable, low level of noise, clarity of speech, music perception and etc.

«DEAD» ROOM
A short reverberation time.

Uncomfortable, all sounds are absorbed too quickly making perception difficult.

«SONOROUS» ROOM
A long reverberation time.

Uncomfortable, multiple reflections of sound waves from the surfaces (walls, ceiling, and floor) create the high noise level.

For the acoustic valuation of the rooms, the standard time value of reverberation is used. The reverberation time, when the sound in the room turns out the best, is called the optimal reverberation.
The use of sound-absorbing materials in decoration of the rooms can bring the standard reverberation time to the optimal, i.e. can create comfortable acoustic conditions.

The optimal reverberation time, depending on the room volume (V), can be calculated using the following formulas:

The purpose of the room	*The optimal reverberation time*
Listening to the newscast, The high quality voice transmission	$T_{OPT} = 0{,}3 \lg V - 0.05 \pm 10\%$
Listening to the music programs, Including musical theatres, studios	$T_{OPT} = 0{,}4 \lg V - 0.15 \pm 10\%$
Listening to the symphonic music	$T_{OPT} = 0{,}5 \lg V - 0.3 \pm 10\%$

The following formula (the Sabine formula) is using for calculation the standard time of reverberation in the room:

$$T = \frac{0{,}164V}{A}$$

T - the time of reverberation, V- the volume of the room, A- the total level of sound absorption in the room calculated on the principle of:

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

α_n – the sound absorption coefficient of n material, S_n – the surface area of n material,
α – the sound absorption coefficient.
The sound absorption is the reduction of sound energy in the room due to the loss of energy by the sound waves on reflection from different surfaces. The sound absorption coefficient is a ratio between reflected and absorbed sound energy. The value "0" of the sound absorption coefficient corresponds to total reflection, and the value "1" to total sound absorption.

The European standard EN ISO 11654 classifies the materials based on the value of sound absorption coefficient α_ω:

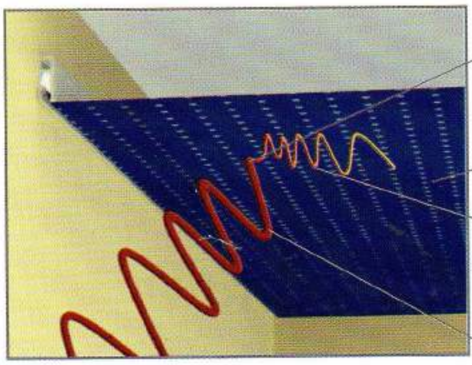
The class of noise-absorbing material (EN ISO 11654)	*α_ω – values*	*The class of noise absorption (according to VDI 3755/2000)*
A	*0,90; 0,95; 1,00*	*maximum absorbing*
B	*0,80; 0,85*	*maximum absorbing*
C	*0,60; 0,65; 0,70; 0,75*	*highly absorbing*
D	*0,30; 0,35; 0,45; 0,50; 0,55*	*absorbing*
E	*0,15; 0,20; 0,25*	*low absorbing*
Non-classified	*0,00; 0,05; 0,10*	*reflecting*

SAROS DES)GN

The stretch ceilings made of perforated PVC foil SAROS DESIGN COMFORT

SAROS DESIGN SOMFORT stretch ceiling is the easily producible way to create acoustic comfort in the room on the basis of a new line of perforated materials, while maintaining the attractive appearance typical for stretch ceilings.

The sound waves from a source located in the room are partially absorbed through the holes in SAROS DESIGN COMFORT perforated stretch ceiling. Air in the pores of the stretch ceiling offers resistance to the initial sound wave partially transforming it into heat energy and reducing its power. Air in the ceiling void provides additional resistance to the sound. Further vibrations of the reflected sound waves are absorbed by stretch ceiling thereby ensuring the reduction of the reverberation time in the room.



THE TRANSFORMATION OF THE SOUND WAVE ENERGY INTO HEAT ENERGY IN THE HOLES OF STRETCH CEILING

SAROS DESIGN COMFORT CEILING

THE SOUND WAVE, WHICH HAS LOST A SIGNIFICANT PART OF ITS ENERGY

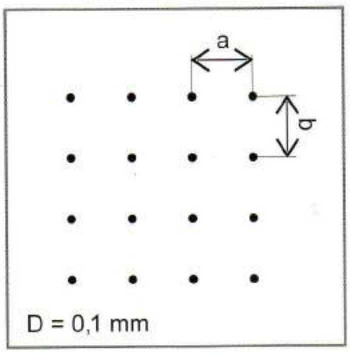
THE SOUND WAVE FROM THE SOURCE

The absorption efficiency by perforated stretch ceilings is determined by the following characteristics:
-Diameter of the perforation holes
-Distance between the holes
-Thickness of PVC foil
-Distance between the stretch ceiling and the main ceiling in the room

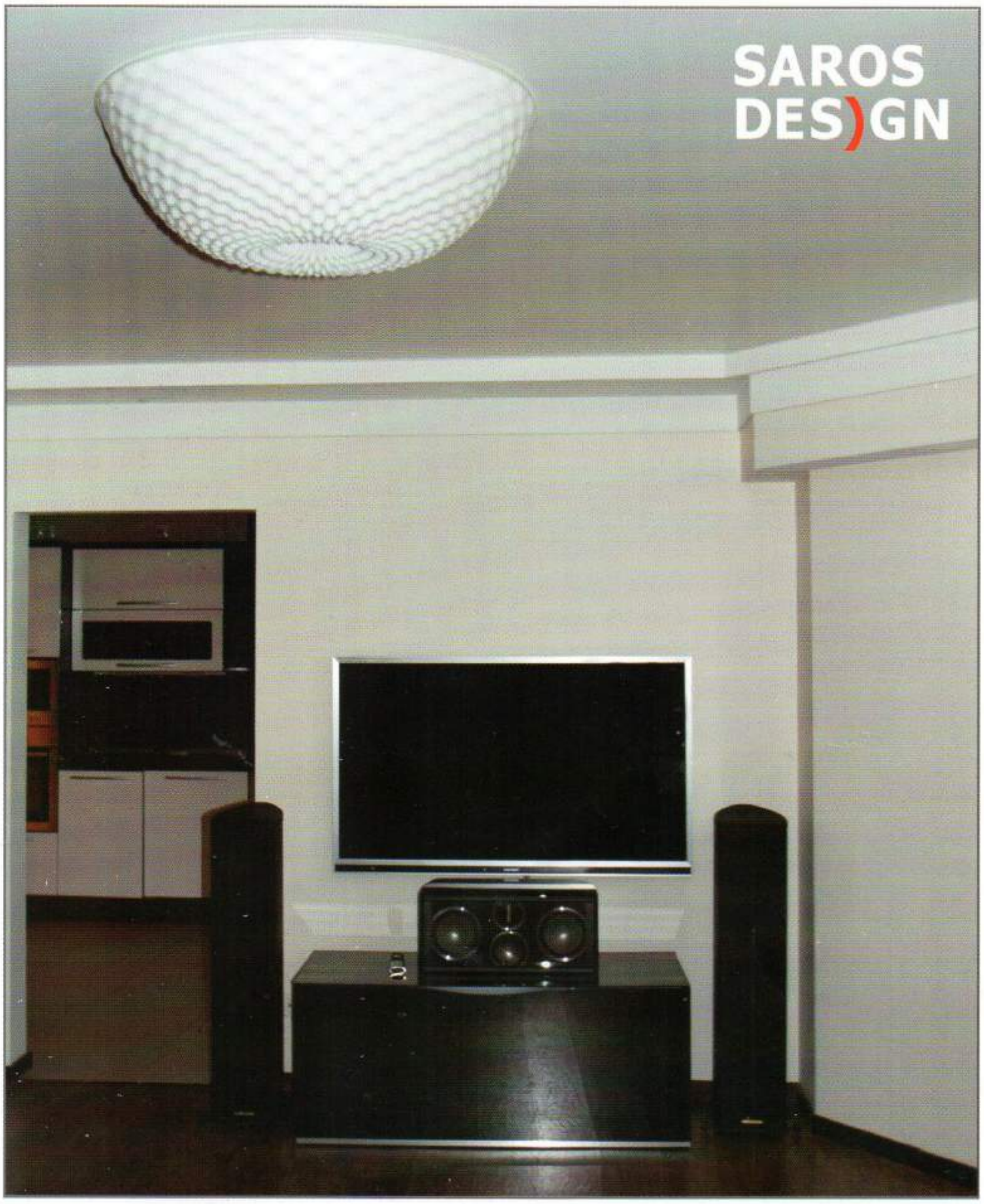
Taking into account all these characteristics, it is possible to choose the best solution to optimize acoustics for every room.

Currently our company produces three types of perforations on PVC foil which differ in diameter of holes and their closeness.

Type 1. Microperforated stretch ceilings



Key Features:
- diameter of the hole = 0.1 mm
- distance between the holes a = b = 2 mm
- number of holes in 1 square meter = 250 000
- foil thickness 0.17 mm



SAROS DESIGN COMFORT acoustic ceilings made of microperforated PVC foil were tested in Acoustical Investigation & Research Organisation LTD (London) accredited by UKAS laboratory. According to the issued certificate № L/3220 of 26.01.2012 it was given «D» class of absorption:

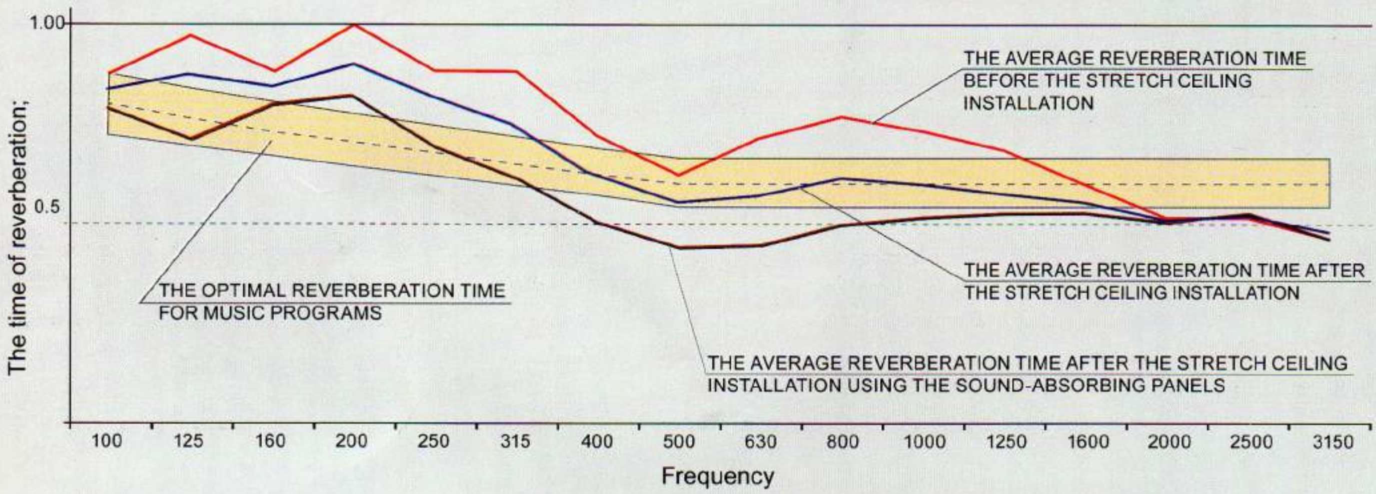
AIRO Test №	*PVC foil type*	*EN ISO 11654:1997 standard*	
		Coefficient of absorption α_ω	*The absorption class*
L/3220/1	*Lacquered*	*0,40*	*D*
L/3220/2	*Mat*	*0,30*	*D*
L/3220/3	*Satin*	*0,30*	*D*

SAROS DESIGN

The recommendations for the acoustic stretch ceilings installation

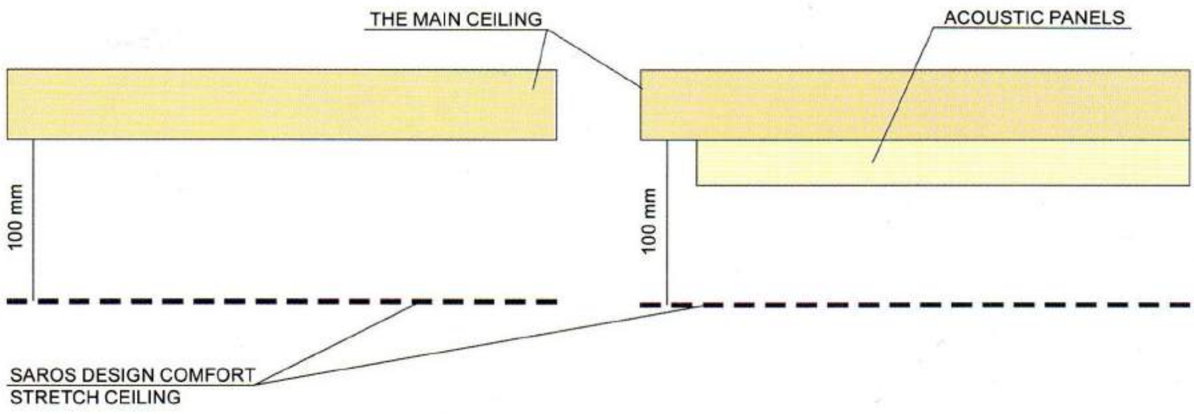
The tests, measuring the acoustic characteristics in the living room, carried out by our request showed that the installation of SAROS DESIGN COMFORT stretch ceiling, made of microperforated PVC foil, reduces the reverberation time in the room and creates comfortable acoustic conditions (see the graph of the reverberation time in the living room before installation of SAROS DESIGN COMFORT stretch ceiling and after). It should be emphasized that acoustic comfort improves not only when you are listening to the music programs, movies and etc. SAROS DESIGN COMFORT stretch ceiling generally reduces the level of unfavorable noises in the living area making it quieter and more comfortable.

The graph: the reverberation time changes in the living room before and after the installation of SAROS DESIGN COMFORT stretch ceiling with using of additional sound-absorbing panels and without it:



In most cases, it is enough to install SAROS DESIGN COMFORT stretch ceiling for good noise absorption in the room. At the same time, it is advisable to make the height of the ceiling void at least 10 cm.

If the purpose of the room requires a higher level of noise absorption, we recommend to use additionally the sound-absorbing materials. The joint use of sound-absorbing materials and acoustic stretch ceilings (the ceiling canvas acts like a membrane) increases the sound-absorbing class of the ceiling (up to the 'B' level – the most absorbing).



The main characteristics of Saros Design acoustic stretch ceilings made of microperforated PVC foil

Characteristics	*The ceiling of microperforated PVC foil*	*The ceiling of microperforated PVC foil and additional use of sound-absorbing layer (40 mm)*
The sound absorption coefficient α_{ω}	$\alpha_{\omega} = 0,30 - 0,40$	$\alpha_{\omega} = 0,85$
The class of sound absorption	*D (absorbing)*	*B (maximum absorbing)*

The example of acoustic calculation for the living room with the home theatre system

We provide the example of calculation for the particular room, which settles the acoustic requirements for the ceiling. It should be understood that these calculations are defined to be a simplification of the real acoustic calculations but quite sufficient in ordinary life.

Step 1: calculation of the optimal reverberation time

First of all, it is necessary to decide what the main purpose of the room is, i.e. answer the question – what we shall listen to. The optimal reverberation time is different for each purpose. However, in our real life we cannot create a separate room for listening to the double-channel stereo system and a separate room for the 5-channel home theater system. Therefore, calculation of the optimal reverberation time is a compromise of our goals.

For example, we are creating the room where we will be generally watching home theatre and listening to music from time to time.

a) Calculate the volume of the room (V,m^3) the size is 6x4m, the height of the ceiling is 3m

$$V = 6 \times 4 \times 3 = 72\ m^2$$

b) Calculate the optimal reverberation time for the room
For Home theatre:

$$T_{opт1} = 0,4\ lgV - 0,15 = 0,4\ lg72 - 0,15 = 0,59\ (\pm 10\%)$$

For listening to music:

$$T_{opт2} = 0,5\ lgV - 0,3 = 0,5\ lg72 - 0,3 = 0,63\ (\pm 10\%)$$

The obtained characteristics of the optimal reverberation time, depending on our goals, turned out to be very close. As we make the room for watching home theater and listening to music, we shall use the average optimal time of reverberation for our room Topt -0,61 for the further calculations. $T_{opт} = 0,61$.

Step 2: Calculation of the ceiling characteristics

We determined the optimal reverberation time for our room. Now we have to calculate the absorption coefficient of our ceiling ($\alpha\omega$).

For example, our room has papered brick walls, parquet floor and sofa. Actual reverberation time depends on how much the sound is absorbed by surfaces of the room (floor, walls, ceiling) and interior items (sofa). By calculating the level of absorption for the existing room surfaces, and by knowing the optimal reverberation time, we can determine the level of sound absorption for our ceiling.

From the reference table of absorption coefficients we choose the values for materials in which we are interested in (floor, walls, ceiling, sofa). We use the following formula so to calculate the standard (factual) reverberation time in the room:

$$T = \frac{0{,}164V}{A}$$

where V — - volume of the room in m^3, A — the total sound absorption of all surfaces in the room which is calculated by the formula:

$$A = \alpha_{\omega 1}S_1 + \alpha_{\omega 2}S_2 + \ldots + \alpha_{\omega n}S_n$$

$$A = 0{,}11 \times 24 + 0{,}05 \times 60 + 0{,}33 \times 3{,}5 + \alpha_{\omega\ ceiling} \times 24 = 6{,}795 + 24\alpha_{\omega\ ceiling}$$

The optimal reverberation time $T_{opт}$ (calculated on the 1st stage) is 0.61, therefore we obtain an equation:

$$0{,}61 = \frac{0{,}164V}{A} \Longrightarrow A = \frac{0{,}164 \times 72}{0{,}61} = 19{,}36$$

Let's calculate what sound absorption should the ceiling have so that the total sound absorption in the room will be 19.36:

$$19{,}36 = 6{,}795 + 24\alpha_{\omega\ ceiling} \Longrightarrow \alpha_{\omega\ ceiling} = 0{,}52$$

Thereby, in our case in order to obtain the optimal room acoustics we should use SAROS DESIGN COMFORT microperforated stretch ceiling ($\alpha\omega$ = 0,3 - 0,4) and, for example, to place some additional sound-absorbing objects or acoustic panels in our room.

If there were the curtains on the windows and the carpet on the floor in our room then the total sound absorption (A ') in the room would be increased for the value of sound absorption of these surfaces.

$$A' = 0{,}11 \times 24 + 0{,}05 \times 60 + 0{,}33 \times 3{,}5 + 0{,}3 \times 24 + 0{,}4 \times 9 + 0{,}36 \times 5 = 19{,}39$$

In this case the actual reverberation time would have reached the optimal value.

$$T = \frac{0{,}164 \times 72}{19{,}39} = 0{,}61$$

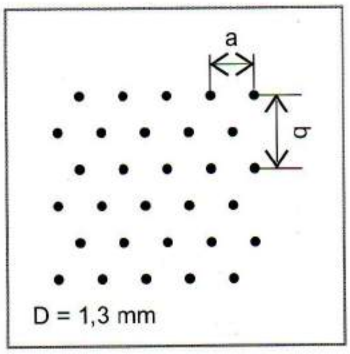
Sound absorbing surface	Surface area, м^2	The average coefficient of sound absorption, α_{ω}
Floor	24	0,11
Walls	60	0,05
Ceiling	24	$\alpha_{\omega\ ceiling}$ (the rated value we are interested in)
Sofa	3,5	0,33
Curtains	9	0,40
Carpet	5	0,36

Reference table of sound absorption coefficients	
The sound absorbing surface	The average coefficient of sound absorption
concrete wall, unpainted	0,02
brick wall, unpainted	0,04
gypsum plaster	0,05
gypsum plaster	0,04
wooden panels	0,07
wooden floor	0,04
marble or tile	0,01
parquet	0,11
linoleum on the solid basis	0,03
glass	0,03
curtains	0,18
drapes	0,54
carpet	0,36
armchair	0,33
water in the pool	0,01

Perforation of large diameter – the additional opportunities

Besides the microperforated PVC foil for the acoustic stretch ceilings installation, we do perforation on PVC foil of large diameters: 1.3 and 1.8 mm. Perforation of large diameter allows not only to ensure good acoustic properties in the room, but also creates a new design and functional opportunities for stretch ceilings.

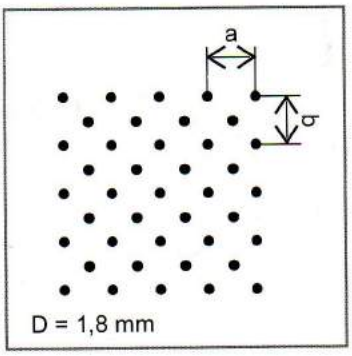
Type 2. Perforation of large diameter



Key Features:

- *diameter of the hole = 1.3 mm*
- *the distance between adjacent holes a = 15 mm, b = 9 mm*
- *The number of holes in 1 square meter = 15 000*
- *thickness of the foil 0.17 mm*

Type 3. Perforation of large diameter



Key Features:

- *diameter of the hole = 1.8 mm*
- *the distance between adjacent holes a = b = 8 mm*
- *number of holes in 1 square meter = 25 000*
- *thickness of the foil 0.17 mm*

The problem of acoustic comfort is particularly topical for public buildings and rooms (shopping centers, restaurants, gyms, etc.), because they are defined by a higher noise level.

However, there are not only the strict acoustics requirements are imposed to the ceilings in these rooms. First of all, the stretch ceiling should provide an opportunity for proper work for all engineering systems in the room and still have an attractive appearance.

Installation of SAROS DESIGN COMFORT stretch ceilings with perforation of large diameters (1.3 and 1.8 mm) allows you to place all engineering systems (ventilation, fire extinguisher system) in the ceiling void. The holes in stretch ceiling allow air to circulate freely, and, if necessary, in case of fire system necessity, will leak. At the same time, SAROS DESIGN COMFORT stretch ceiling fully retains its aesthetic functions.

For example, SAROS DESIGN COMFORT stretch ceilings are ideal for sports centers with swimming pools. The presence of perforation of large diameter makes possible the implementation of natural circulation of air and prevents the accumulation of condensate in the ceiling void.

Installation of stretch ceilings made of perforated foil in public buildings solves another important problem - the «movement of stretch ceiling» («inflation», or «inhausting»), which occurs due to the hit of the air masses into the ceiling void.

Since the diameter of the holes in these types of perforation is bigger than in microperforated PVC foil, they do not perform an independent acoustic function. However, with the additional use of acoustic panels, perforated ceilings of large diameter provide sound comfort.

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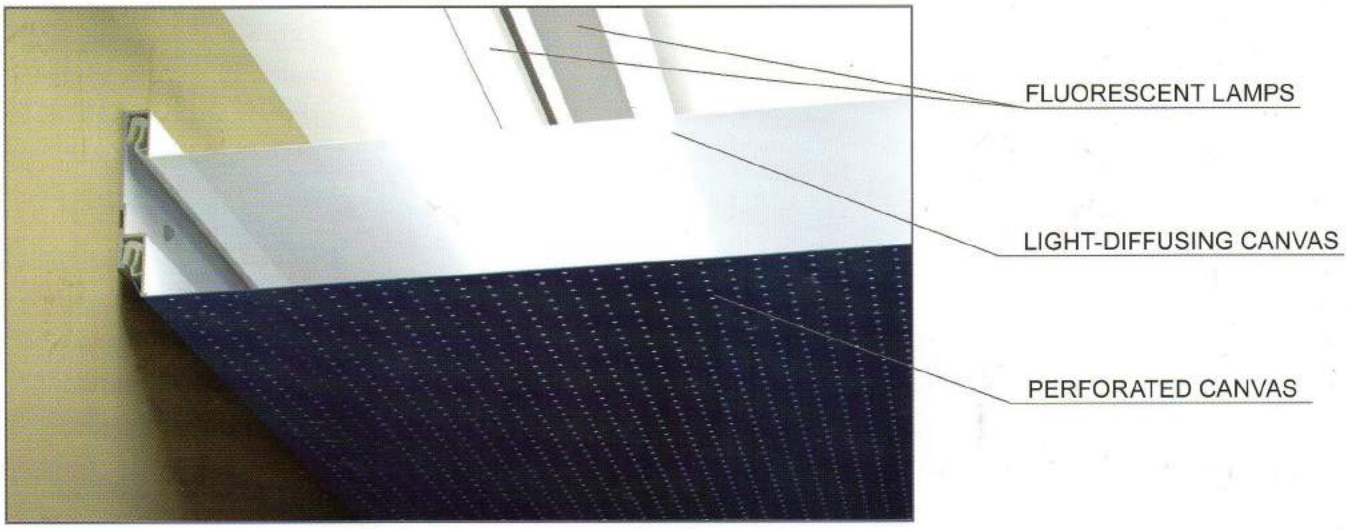
COMFORT COLLECTION

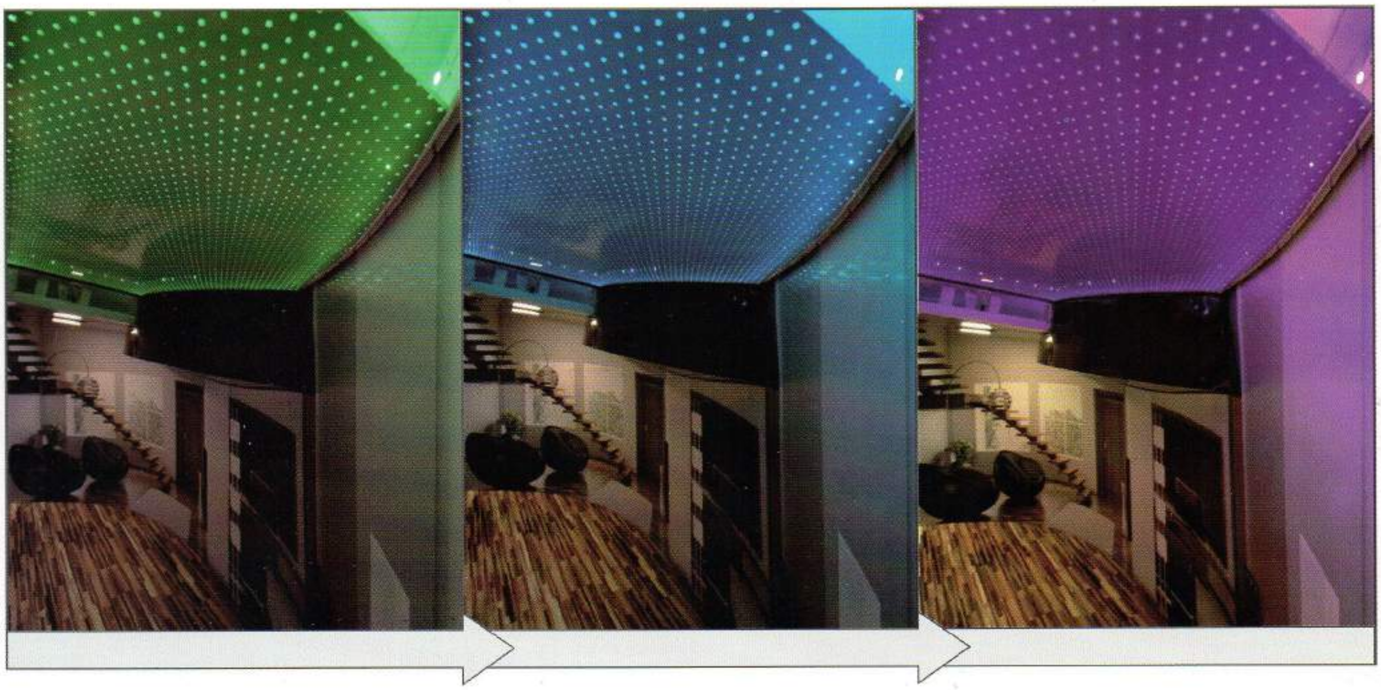
Light constructions with the stretch ceilings made of perforated PVC foil

Perforated PVC foil allows to realize the unusual design concepts and discovers new possibilities in lighting sphere.

As a stretch ceiling we use the perforated canvas with the hole diameters of 1.3 or 1.8 mm. By placing a light source in the ceiling void you can achieve an unusual visual effect. As addition to the total construction we can use light-diffusing canvas between the light source and the perforated ceiling. At the same time the diffused light passes through the holes and the light source becomes invisible.

All fluorescent lamps, as well as LED strips and panels, can be used as the light source. Special lighting effect is achieved by using RGB strips.





STRETCH CEILING SYSTEMS

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