Acoustics

Quick Selection Guide

Sound Absorption Class	Sound insulation D_{nfw} 21–30	31–40	40+	n/a
A	120 130 150 200 320 330			500 510 600* 610*
B	740*			500 510
C		120 130 150	200 320 330	500 510
D			120 130 150 200	

* For further information please refer to product pages

SAS PLUS

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Specification Criteria

The science of acoustics and its application within buildings can often be complex and confusing for the non-specialist. SAS International is an expert in this field and can support your project, providing guidance and experience to help you specify the most appropriate products for your design that meet industry and legislative standards. The information below should help explain some of the more relevant acoustic terminologies and technical aspects.

Sound Absorption

This is a measure of how much sound is absorbed by a surface. The remaining sound is reflected back into the space. In the absence of sound absorbing surfaces a room will become noisy and reverberant, because the sound keeps 'bouncing around'. This results in a number of undesirable effects - poor clarity of speech and excessive loudness being among the most important. As more sound absorption is introduced to a space, so the noise level will reduce and the sound decay more quickly.

Sound absorption is defined as a coefficient between 0 and 1, where the latter means that all sound is absorbed by the surface – thus none is returned to the room. The sound absorption of a surface is not the same for all types of sound. Porous materials are more efficient at absorbing mid and high pitched (or high frequency) sound than low frequency. Thankfully, we are normally less concerned about these low sounds because speech occupies the mid-high frequency range.

The international standard BS EN ISO 11654:1997 defines sound absorption in varying degrees of detail. The Sound Absorption Coefficient (α_s) and Practical Sound Absorption Coefficient (α_p) both describe how sound is absorbed at different frequencies. The Sound Absorption Rating (α_w) simplifies this data further by expressing it as a single figure, obtained by comparison with a weighting curve. In addition, the standard defines Sound Absorption Class, which ranks the effectiveness of a surface from A to E, where A is the most sound absorbing.

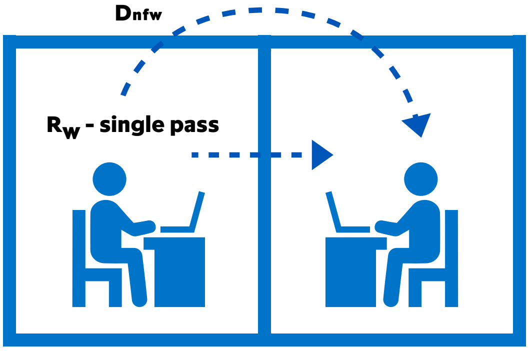
Initial selection of a sound absorbing product can normally be based on the single figure α_w or the Sound Absorption Class. Generally, it is only an acoustician that needs more detailed information.

Sound Insulation

This is the measure of how effectively sound is limited when passing through a building element. Sound insulation is important for glazing, partitioning and ceiling systems where the passage of sound from one space to another needs to be controlled. Two definitions of sound insulation are used depending on the product and its installation.

The first of these definitions is sound reduction, which is a measure of how effectively sound is blocked by an element – a 'single pass'. As with sound absorption, it is not the same for all types of sound and is normally worst at the low frequencies. If the sound reduction performance is stated as a single figure it uses the R for reduction and a subscript 'w' which stands for 'weighted'. As such, a R_w figure is a simplified indication of how much direct sound is stopped from getting through a building element. It is used to describe glazing and partitions.

In addition to the direct 'straight through' definition, sound insulation is also quantified in terms of a 'flanking' route – the so-called 'double pass'. The abbreviation used is D_{nfw} which means a sound level difference via a flanking route that is normalized and weighted (this supersedes D_{ncw} where the 'c' is an abbreviation for ceiling). It basically defines how much sound is blocked by passing through the same element twice. This is a relevant metric for ceilings which span more than one room and have a common void.



SAS products are tested in accordance with BS EN ISO standards, which differ slightly from the respective ASTM standards.

For sound absorption, research has shown that the difference in results when tested to BS EN ISO 354 vs ASTM 423 is only +/- 3%. As such, the SAA based on the BS EN ISO can be considered equivalent to the value based on ASTM 423.

The difference in BS EN ISO and ASTM flanking sound level difference standards is more fundamental. The specified size of laboratory and sound absorption therein is different, as is the calculation methodology. SAS has undertaken laboratory tests of the same sample testing in accordance with both standards. We have concluded that the laboratory environment makes about a 1.5dB difference and the calculation methodology a further 0.8dB. This means that the CAC tested in accordance with ASTM E1414 will be 2-2.5dB greater than the same sample tested in accordance with BS EN ISO 20140-9.

ASTM E1111 describes the test procedure to establish the Articulation Class of a ceiling. Given that this test quantifies the sound transmission over a barrier, in the presence of a sound absorbing ceiling plane, it is not surprising to find that the Articulation Class is related to the sound absorption of the ceiling. Research has shown that straightforward formulations connect AC and SAA. As such, SAS are able to provide an accurate estimate of Articulation Class based on the sound absorption of our products.

The Science Explained

It is often helpful to understand some of the basic science behind how SAS products provide the performance quoted. An acoustician should be familiar with these concepts, however it is understood that such expertise is not available on every project. In that event, SAS' acoustic specialists are pleased to assist.

Sound Absorption

SAS products absorb sound using an open-cell porous material faced with a perforated metal sheet. The perforated metal offers no acoustic function other than to be 'transparent' to the incident sound. This is achieved by forming numerous holes of appropriately large diameter. Acoustic transparency is limited as the hole diameter approaches the thickness of the metal sheet. Similarly, perforation areas of less than 10% result in the higher frequency sound being reflected as it 'sees' too much metal and not enough hole. There is limited benefit in using perforation areas greater than 25%.

Most ceiling tiles rely entirely on the porous material behind the perforated metal to absorb the sound. Micro-perforated tiles are the exception and can offer sound absorption without a distinct porous backing. In both cases, sound is absorbed because the air particles have to vibrate within a medium that limits this movement. Porous absorbers are most effective when they coincide with air that is vibrating a lot. However, the vibration of air particles is not the same at every frequency or in every location within a room. As such, the effectiveness of a sound absorber is dependent on where it is placed.

Suspended Ceilings

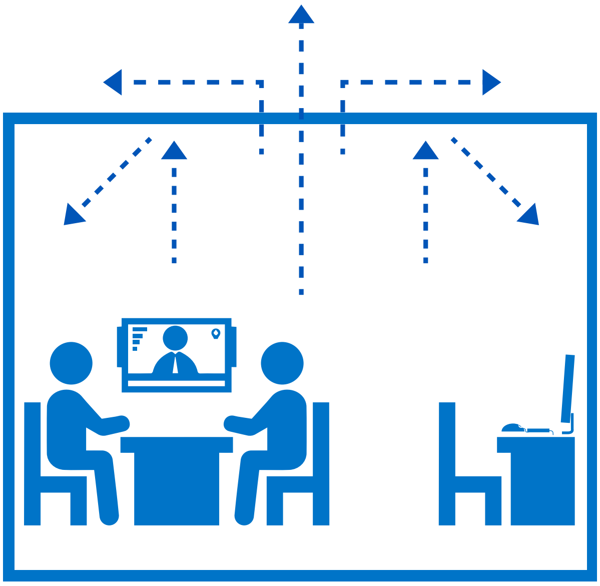
Suspended ceilings are positioned a small distance from a sound reflecting surface which means that the air particle vibration (or particle velocity, as it is called) is easily predicted. It also means that the particle velocity is high, at a given frequency, which results in efficient absorption. This optimum placement is the reason why very thin porous materials can offer significant absorption. Nevertheless, thicker porous linings are generally more effective than thin ones.

Wall Panels

Wall panels are similar to suspended ceilings in terms of being close to a sound reflecting surface. The sound absorption is often poorer at low frequencies because the gap between the panel and wall is less than a typical suspended ceiling void.

Baffles and Rafts

Baffles and rafts are similar in design to wall panels. The main difference is in terms of their position and orientation within the room. Baffles and rafts are placed a long distance from the soffit and as such are 'in the room' and acoustically do not act like one of its surfaces. The particle velocity in these locations is not easily predicted and not likely to exhibit high magnitudes. However, because these elements are 'in the room' they are an acoustic 'object' not merely a surface. The larger contact area and diffractive effects at the edges result in sound absorption that is greater than the same single-sided area placed parallel and close to a soffit. It is an oversimplification to assume that it will exhibit twice the sound absorption in line with a doubling of 'visible' area. This argument ignores the importance of it's position in the room and the low frequency transmission through the raft/baffle.

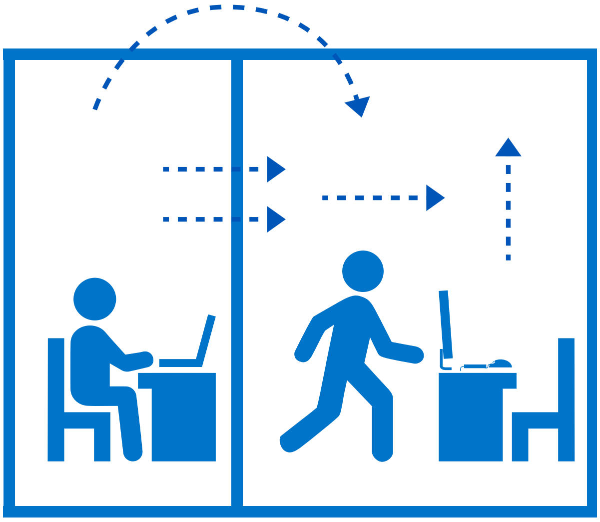


Sound Insulation

Sound is able to pass through solid elements like doors and partitions. This is possible because the vibrating air particles cause the solid element to vibrate also, albeit on a very small scale. The vibrating element then causes the air particles on the opposite side to vibrate and this is perceived as sound.

It can be intuitively understood that heavier elements will offer more sound insulation because they are more difficult to move (Newton’s second law of motion). In fact there are well established relationships between mass/area and sound insulation.

Sound energy is dissipated and reflected as it moves from one medium to another. For this reason, multi-layered constructions are efficient at providing sound insulation even if they are lightweight. A plasterboard partition is a good example of a laminate construction which can offer similar sound insulation to an homogeneous element that is much heavier, like a concrete block wall.



Commonly Asked Questions

Acoustic Performance of Metal

It is a common misconception that perforated metal is a poor sound absorbing material, outperformed by alternatives such as mineral fibre. Through careful specification of the size and number of perforations, metal tiles with mineral wool infills offer sound absorption equal to or greater than other commonly specified materials.

Test Data

The acoustic tests undertaken by SAS quantify the performance of the tiles, not the complete system. The reason for this is that it is infeasible to test the multiplicitous combinations of tile and suspension system. It is the perforation type, infill and cavity depth that govern the acoustic performance of a system – other variables have very little affect.

Change in Ceiling Void Depth

Most SAS systems are laboratory tested using a 1'3" void depth. If other void depths are used then the sound absorption performance will change at the low frequencies. As the cavity depth decreases, so the low frequency limit of sound absorption increases. For example, the sound absorption at 800Hz associated with a $3\frac{15}{16}$" will be similar to the absorption at 200Hz due to a 1'3" cavity. The effect of not employing a cavity can be seen by considering the performance of a tile backed with plasterboard or a steel plate.

Effect of Borders Around Perforated Area

There are options for different border widths around the perforated tile area. Whilst a larger border will theoretically result in less sound absorption, the effect in practice is minimal.

Effect of Tile Size

Larger tiles provide greater sound absorption at low frequencies. This is because they exhibit lower stiffness and as such support flexural waves, also termed panel absorption.

Ceiling Tile Acoustic Performance

Sound Absorption

				Hz						
Perforation	**Inlay**	α_w	**NRC**	**125**	**250**	**500**	**1K**	**2K**	**4K**	**Class**
1522/1820	Thin Acoustic pad	1.00	1.00	0.60	0.95	0.90	1.00	1.00	1.00	**A**
1511		0.85	0.85	0.55	0.85	0.75	0.95	1.00	0.80	**B**
1522/1820	Thin Acoustic pad + plasterboard	0.60	0.70	0.30	0.30	0.60	0.95	1.00	0.80	**C**
1511		0.60	0.70	0.30	0.30	0.60	0.95	1.00	0.80	**C**
Ultramicro		0.60	0.75	0.35	0.45	0.70	1.00	0.85	0.45	**C**
1522/1820	Thick Acoustic pad + plasterboard	0.75	0.80	0.35	0.45	0.80	1.00	1.00	1.00	**C**
1511	Thick Acoustic pad + plasterboard	0.70	0.80	0.30	0.40	0.85	1.00	1.00	0.95	**C**
1522 / 1820	Thick Acoustic pad	1.00	1.00	0.55	0.90	0.95	1.00	1.00	1.00	**A**
1511		1.00	1.00	0.55	0.85	0.90	1.00	1.00	0.95	**A**
1522/1820	Fleece	0.80	0.80	0.55	0.95	0.75	0.80	0.85	0.85	**B**
1511		0.80	0.80	0.55	0.95	0.75	0.80	0.85	0.80	**B**

Tested in accordance with BS EN ISO 354:2003.

Sound Insulation

				Hz						
Perforation	**Inlay**	D_{ncw}	D_{nfw}	**125**	**250**	**500**	**1K**	**2K**	**4K**	**Class**
1522/1820	Acoustic pad	27	–	11	19	24	27	30	36	–
Ultramicro		33	–	19	23	29	33	43	47	–
1522/1820	Acoustic pad + plasterboard	49	–	28	38	46	60	63	62	–
1511		48	–	26	37	46	58	63	61	–
Ultramicro		40	–	19	30	35	45	54	58	–
1522/1820	Fleece	–	15	12	14	15	14	15	15	–
Ultramicro		18	–	14	18	17	16	19	23	–
Plain	None	43	–	23	34	40	46	50	47	–

Tested in accordance with BS EN ISO 20140-9:1994.

All SAS products are tested independently by a UKAS accredited laboratory.