DELTA BUILDING SYSTEMS

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Acoustical Properties

• Acoustic Properties

Noise control in buildings is of great significance for the health and well-being of the occupants, especially in residential dwellings, since they must provide an environment that is restful and relaxing. The building envelope must also maintain privacy for the occupants. Noise control is also an important factor in other types of buildings such as schools, hospitals, and offices.

DELTA BLOCK AAC, a porous concrete material, provides a sound insulation value of up to 7 dB greater than other building materials of the same weight (mass per area). DELTA BLOCK surface mass coupled with the mechanical vibration energy damping within its porous structure produces a building material with exceptional sound insulation properties.

In addition to using a wall material with superior sound insulation properties in relation to its mass per area, it is always essential to construct the wall in a manner that closes off air leaks and paths by which noise can go around or through the assembly. Hairline cracks or small holes will increase the sound transmission through the wall at the higher frequencies. DELTA BLCOK's simple construction methods and details help to eliminate these cracks and holes in the walls, thus providing a final wall assembly, which offers superior sound insulation characteristics for the occupant.

The **sound pressure level** is the most important physical value to describe or quantify airborne noise inside and outside buildings. It is defined as the ratio between a base sound pressure in our atmosphere (ca. 20 µPa) and the sound pressure caused by noise. The threshold of pain corresponds to a sound pressure of approximately 100,000,000 µPa, similar to a jet plane taking off at a distance of approximately 50 yards. The relationship of sound pressure to sound level is represented using a logarithmic scale.

In fact, the logarithmic scale of the sound level is appropriate because the perception of loudness by the human ear is also logarithmic. Therefore, a 10 dB increase in the sound pressure is perceived as a doubling of the sound loudness.

The **frequency range** of human beings depends on the individual state of health. The range of human acoustic perception starts approximately at 20 Hz and ends at 20 kHz. STC measurements in buildings normally reference frequencies between 50 Hz and 5 kHz. In the USA, requirements for STC values are determined by the frequency range between 125 Hz and 4 kHz.

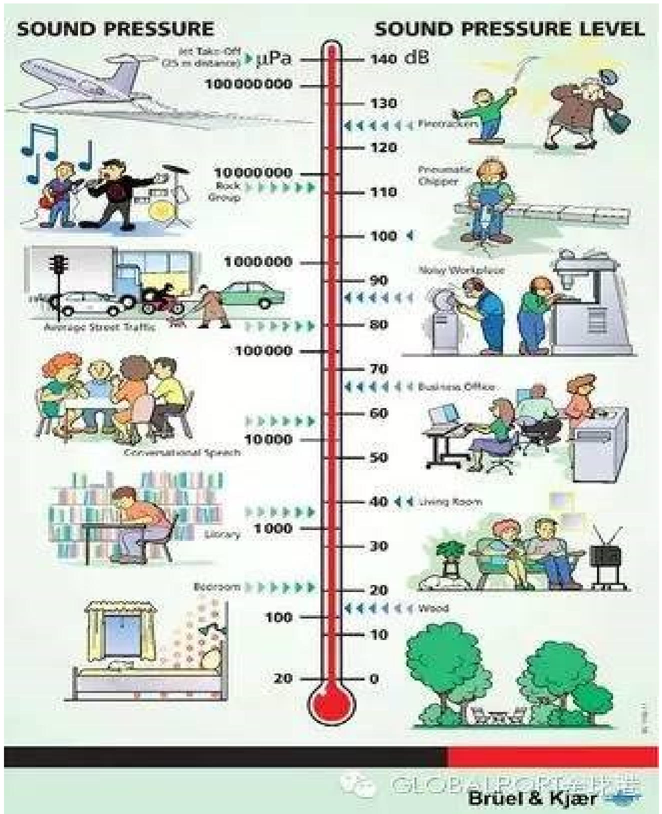
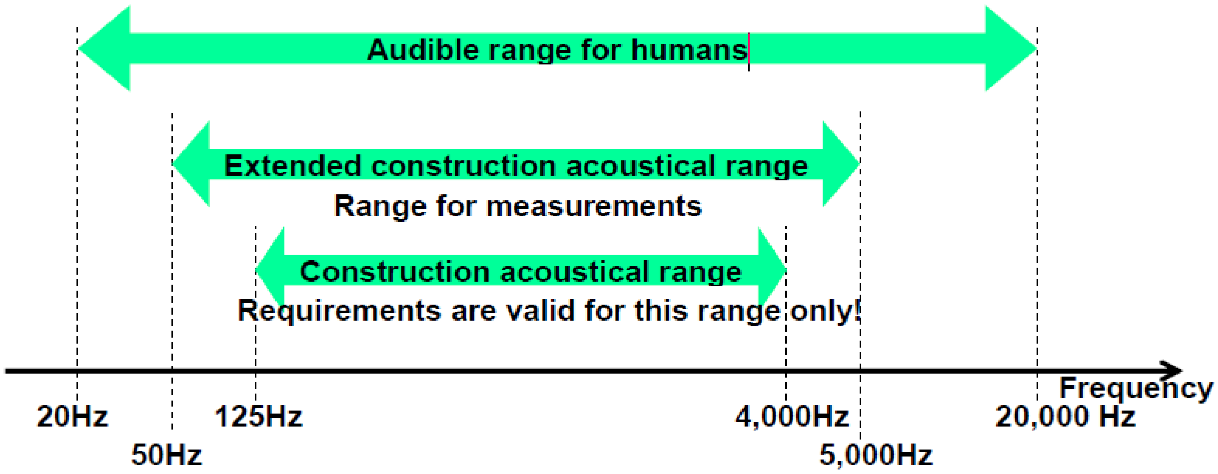


Diagram 3.1: Relationship of Sound Pressure vs. Sound Pressure Level

Graph 3.5: Frequency Range

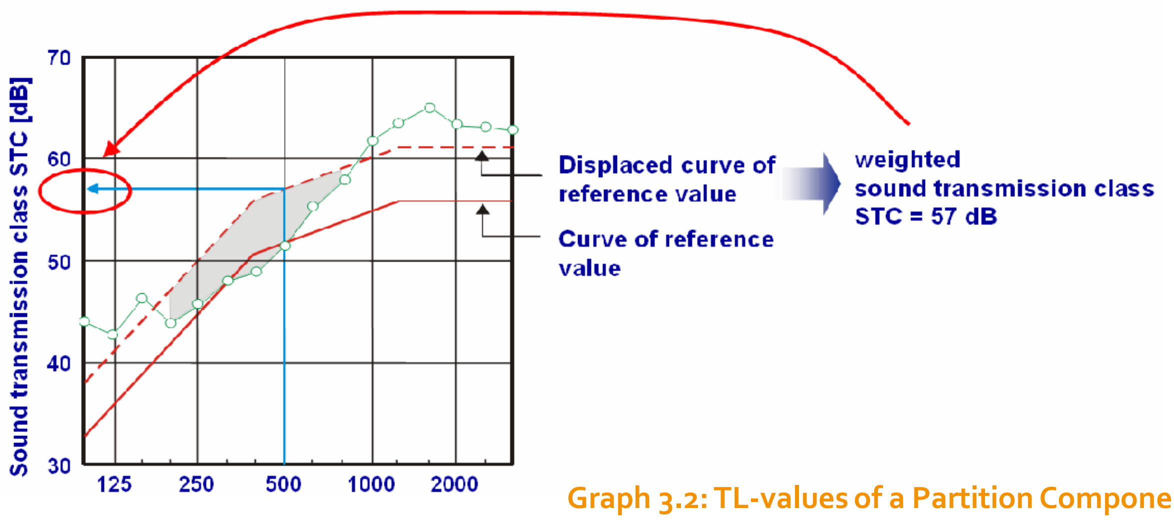


Building components used for sound insulation must be able to perform for a wide range of frequencies. That makes it difficult to evaluate a representative single value, e.g. an average that is easier to handle instead of the 15 different frequencies in one-third octave. Because of this complicated situation, the levels of all measured frequencies are combined using a special weighting of values fixed in ASTM 413 (see "sound transmission loss").

For different frequencies at the same sound level, sounds will not be perceived as being equally loud. For example, a 54 dB sound at 3 kHz at will sound as loud as a 79 dB sound at 50 Hz. Therefore, it is necessary to weight sound according to frequency in order to get a more meaningful measure of the effects of sound. The doubling of the frequency corresponds to one octave. This means the range from 125 Hz to 250 Hz corresponds to one octave.

The **sound transmission loss (TL)** describes the reduction of airborne sound transmission in each frequency between two rooms through partition components like walls or ceilings. The TL is evaluated by the difference between the sound pressure level of the sending and receiving rooms including the sound absorption of the receiving room and geometrical conditions. Several sound transmission loss values corresponding to a specified frequency band may be represented in a sound transmission loss curve.

According to ASTM 413, a standardized evaluation is used to obtain a sound transmission class (STC) from the measured TL. Graph 3.6 shows a sound transmission loss curve corresponding to 16 airborne sound transmission loss values. The TL-values were measured for a one third-octave band frequency through an "airborne sound transmission loss" laboratory test or a field measurement in accordance to the American standard ASTM E 90.



Graph 3.2: TL-values of a Partition Component

The **sound transmission class** is a single number rating providing a convenient way to describe the sound transmission loss (TL) values. It provides an estimation of the performance of the wall or floor in certain common sound insulation conditions. The STC is determined by comparing its sound transmission curve with a standard reference curve. The reference curve is superimposed over the sound transmission loss curve and shifted upwards or downwards, relative to the TL-curve, taking in consideration certain conditions of ASTM 413. The sound transmission class (STC) is taken to be the transmission loss value, measured in decibels (dB), corresponding to the intersection of the reference curve and the 500 Hz frequency line.

Between neighboring rooms there is a transport of sound straight through the partition assembly. In massive buildings there is in addition to this **sound transmission,** bypass noise transportation along flanking components called **flanking sound transmission**. The lower the flanking sound transmission the higher the TL. It is very important to regard this flanking sound transmission as well because there might be a large influence on the result of the TL.

• Relationship Between Sound Transmission Class and Sound Reduction Index (R' w)

In European countries there are two important terms to describe the acoustic performance of assemblies. Rw [dB] is the abbreviation for TL or sound reduction index (SRI) without flanking sound transmission (e. g. in laboratories).
When describing the sound reduction of partition components in buildings it is necessary to describe the complete sound transmission (direct and bypass) using R'w [dB].

The difference between STC and Rw is not very wide. The approximate relationship between the two can be expressed by the equation STC = Rw + 1 [dB]. The safest calculation is to set STC = Rw [dB]. The small difference between these two parameters is caused by the discrepancy of the range of frequencies considered.

Sounds generated by pedestrian foot traffic in buildings in adjacent rooms are referred to as impact **noise**. This type of noise is easily perceived by occupants of space beneath the space where the impact occurs. The most important value to interpret a floor/ceiling construction is the **impact insulation class** (IIC).

The equivalent of IIC according to the European standards is L'n, w [dB]. The calculation of IIC according to ASTM E 989 (edition 1989) is in general synonymous with building L'n, w [dB] according to ISO 717-2 (edition 2006). So it is acceptable to work with the following relationship:

IIC ≈ L'n, w.

• Code Requirements

Building regulations governing acoustic performance are sometimes only recommendations and not usually enforceable by law. In addition to the requirements for design of the building elements, the overall design of the building, the quality of construction and workmanship can have marked effects on the actual sound insulation within a building.

In general the acoustic performance of walls and ceilings between neighboring dwellings in apartment houses must have a STC ≥ 45. In areas with high noise, e. g. between a living unit and public space or service areas, the requirement increases up to STC ≥ 50 dB. In some buildings and regions in the USA the required acoustic performance is satisfied if a field sound transmission class (FSTC) of 5 dB below the code required STC is measured.

Acoustic Performance of AAC

The most important character of a solid homogenous single wythe partition element is to describe its acoustical performance is the mass per area or surface-related mass (thickness time's density). The higher the mass per area of a wall assembly the higher the STC will be. AAC has been shown to provide better insulation to sound transmitted by air than other building materials, for example concrete under comparable conditions. The inner damping of AAC is one of the significant reasons for the high sound insulating performance of AAC. In comparison with other materials of the same mass per area, AAC has up to a 7 dB higher STC. The German standard DIN 4109 (1989) allows a 2 dB increase in sound insulation for AAC walls, with a surface-related mass in the range of 85 - 320 kg/m².

Design for Sound Insulation Based on Tables

Table 3.3: Surface-related Mass vs. Sound Insulation is valid for all single Wythe wall assemblies made of AAC. Regarding the SRI there is no difference between single layer walls (inside and outside), ceilings or roof assemblies. An AAC roof and wall score the same SRI in the case that the components have the identical surface related mass.

Mass per Area kg/m²	For All Massive Materials R'w According to DIN 4109 (db)	For AAC Rw According to Din 4109 (db)	For CMU walls $STC=23*(W)^{0.2}$ According to NCMA TEK(13-1)
80	33	40	40
85	34	40	41
90	35	41	41
95	35	42	42
105	37	43	42
115	38	45	43
125	39	46	44
135	40	47	45
150	41	48	46
160	42	49	46
175	43	50	47
190	44	51	48
210	45	52	49
230	46	53	50
250	47	54	51
270	48	55	51
295	49	56	52
320	50	57	53
R'w	Sound Transmission loss with flanking sound transmission along bypasses in buildings		
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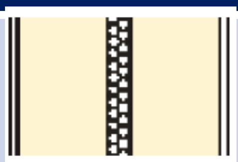
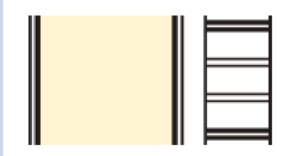
Table 3.3 surafe-related mass vs Sound insulation

• Sound Transmission Class of Single wall

Thickness (mm)	Dry Bulk Density (kg/m^3)	STC (dB)
100	550	38
120	550	40
150	550	42
200	550	45
250	550	48
300	550	50
400	550	54
** plaster is included the calculations 20 mm each side		

• Sound Transmission Class of double wall

structure		Measured value Rw (dB)
2x100 mm AAC 550 (kg/m^3) , plastered with 20 mm each side ,40 mm filled with mineral wool		55
2x120 mm AAC 550 (kg/m^3) and 40 mm air layer , plastered with 5 mm gypsum puttying		52
2x150 mm AAC 550 (kg/m^3) and 40 mm air layer , plastered with 5 mm gypsum puttying		53
2x150 mm AAC 550 (kg/m^3), plastered with 5 mm gypsum puttying, 50 mm filled with mineral wool 100 (kg/m^3)		55
250 mm AAC 550 (kg/m^3) with thin bed mortar with an air layer 60 mm , 115 mm flush joint brickwork of ceramic bricks , 10 mm DELTA plaster (internal		62
2x200 mm AAC 550 (kg/m^3) and 40 mm air layer , plastered with 20 mm gypsum puttying		62

• Surrounding Noise

Increasing noise levels caused by road traffic or industry is an increasing problem for existing and new building sites. Facades, windows, and outside walls also have to work as sound barriers. Traffic noise, caused by cars, trucks, busses, trains or aircrafts; generate high occurrences of low frequencies. The STC primarily is defined for noise spectra caused by common behavior of people in buildings and human speech, lower frequencies are not considered in the calculation of STC.
To address the lower frequencies from outside noise an additional ranking has been established. The single number rating of the outdoor-indoor transmission class (OITC) includes lower frequencies.
The sound reduction in lower frequencies of nearly all materials is usually smaller at higher frequencies. The weighting of sound transmission loss (TL) according to ASTM E 1332 transforms the STC to OITC.

The "rule of thumb" is as follows: OITC usually is 5 – 10 dB less than STC.

• References

- International Building Code 2006; International Code Council
- NCMA TEK 13-1 (1990) National Concrete Masonry Association; "Sound Transmission Class Ratings for Concrete Masonry Walls"
- NCMA TEK 13-2 (1983) National Concrete Masonry Association; „Noise control with concrete masonry in multifamily housing"
- ASTM E 90 – 90 „Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
- NCMA TEK 69A (1978) National Concrete Masonry Association; „New Data on Sound Reduction with Concrete Masonry Walls"
- ASTM E 989 – 2006 „Standard Classification for Determination of Impact Insulation Class (IIC)"
- ASTM E 492 "Single-number rating is called impact insulation class (IIC)"
- ASTM E 1007 "Single-number rating is called field impact insulation class (FIIC)"

Technical Support

Delta Building System offers technical assistance across Egypt. Visit www.plenaegypt.com or your local Distributor who will offer free estimating services; technical support to project architects, engineers, builders and owners.

Health & Safety

Information on any known health risks of our products and how to handle them safely is shown on their package and/ or the documentation accompanying them.

Additional information is listed in the Material Safety Data sheet.To obtain a copy visit www.plenaegypt.com

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Guarantee

Delta Building System Autoclaved Aerated Concrete products are guaranteed to be free of defect in material and manufacture.

Installation workmanship and coating application work is guaranteed by the personnel who perform this work.

Substitution of this claddings' listed components is not permissible and if alternative brands, materials or elements are used, this will void all guarantees.

This guarantee excludes all other guarantees and liability for consequential damage or losses in connection with defective cladding, other than those imposed by legislation.

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