Enhancing Acoustic Performance through the use of Window Shade Fabric
White Paper

As architecture and design evolve, more demand can be seen for obtaining creative solutions for occupancy comfort. In designing for commercial projects, architects often consider thermal and visual comfort for the occupant by attempting to control heat and light levels. However, there is another factor that is quickly gaining traction in the industry—noise control.

Architects have designed around acoustics for years in regard to stadiums, theaters, and concert halls where the intent is to enhance the sound quality in order for the occupant to have an enjoyable experience. However, designing with acoustics for the intent to increase occupancy comfort and reduce unwanted noise has been neglected in a number of modern applications such as commercial buildings. Unwanted sound can cause stress, particularly in situations involving occupants who are hard of hearing or in environments where intelligible conversation is imperative such as classrooms, offices, lecture halls, and conference rooms. Additionally, environments that are naturally high traffic areas, such as canteens and restaurants, should take into account the amount of conversational and background noise that is likely to be encountered.

Predominantly noisy environments can be unpleasant for patrons when the acoustical performance of the environment is not taken into consideration. An effective way to design with acoustical performance in mind is by utilizing materials that can aid in noise reduction. The intent of this article is to explain the terms associated with acoustical performance, define what types of materials enhance this performance, and explain how to determine the correct material and application for a specific project.

Methods and Applications for Sound Transmission

Outdoor-indoor transmission class (OITC) is a rating indicating the transmission of sound between outdoor and indoor spaces as specified in ASTM E1332[1]. This rating provides a measurement for exterior areas with a broad range of frequencies (80 to 4000 Hz) that include low frequency noises such as traffic or airport noise that are not accounted for with other acoustic performance standards. The higher the rating, the better the performance. OITC ratings tend to be lower than sound transmission class ratings due to the necessity to account for lower sound frequencies.

Sound transmission class (STC) is a rating of how well a building partition blocks or reduces the amount of sound. This is typically used in combination with OITC. This is a common rating for interior walls,

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[1] ASTM E1332, "Standard Classification for Rating Outdoor-Indoor Sound Attenuation", 2016. [1] ASTM E413, "Classification for Rating Sound Insulation", 2016.

ceilings, floors, doors, and windows. Both OITC and STC ratings are not utilized for window shade fabric or other attachments. This rating is related primarily to building materials to prevent sound from transmitting from one individual space to another. The standard used to provide this rating is ASTM E413[2]. This rating is calculated over the frequency range of 125 to 4000 Hz. Higher ratings result in better performance. Typical ratings range from 25 (normal speech heard directly through the barrier) to 50 (loud sounds heard faintly through the barrier). An STC of less than 35 is considered low and not a good performer at blocking sound, while an STC greater than 55 is considered high and a good performer of blocking sound transmission.

Methods and Applications for Sound Absorption

STC rates how well a material blocks sound from traveling to other spaces within buildings, but how do we control sound within a single enclosed space? The acoustic sound absorption provided by materials within an individual room can aid in overall noise reduction within an enclosed space. Acoustic sound absorption is the process by which a material, structure, or object disrupts sound energy when sound waves are encountered, as opposed to reflecting that energy. When a sound wave in a room strikes a surface, a fraction of that energy is absorbed and lost in the room. The amount of energy not absorbed, and reflected off a surface, reverberates in the room and prolongs the sound.

Sound absorption is measured using the reverberation room method as specified in ASTM C423[3]. One of the results obtained through the use of this method is Noise Reduction Coefficient (NRC). This coefficient is a representation of the amount of sound energy absorbed upon striking a surface. An NRC of 0 indicates perfect reflection, and an NRC of 1 indicates perfect absorption. The higher the number, the more sound is absorbed and the better the material performs acoustically.

NRC is the term most familiar to the industry. However, it is being slowly replaced by Sound Absorption Average (SAA) because this coefficient utilizes more sound frequencies and provides a more precise result. The NRC averages 4 different frequencies primarily considered to be equivalent to human speech (250, 500, 1000, 2000 Hz). SAA utilizes 12 one-third octave bands from 200 Hz to 2500 Hz. Generally, both coefficients are reported using ASTM C423 and both have a potential range from 0 to 1.

Sound absorption can also be measured using the European standard ISO 354[4]. The absorption data calculated by this method is very similar to the ASTM method; the primary difference being the way the results are calculated and the ASTM method using imperial measurements rather than metric regarding sample size. Calculations from this method are represented by the coefficient alpha (α), which has a value from 0 to 1. The range of results is the same as NRC or SAA. In general, NRC and SAA ratings tend to be the same or slightly higher than coefficients calculated by the ISO method. Any shift in performance when comparing the two ratings comes from the weighting curve used to calculate the data from the ISO method[5]. The ISO standard has sound absorption classes for different results. While these

[2] ASTM E413, “Classification for Rating Sound Insulation”, 2016.
[3] ASTM C423, “Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method”, 2017.
[4] ISO 354, “Acoustics—Measurement of Sound Absorption in a Reverberation Room”, 2003.
[5] Bichel, M. S., Roy, K. P., & Greenslade, J. V. (2008). Comparison of ASTM and ISO Sound Absorption Test Methods. Retrieved October, 2017, from http://webistem.com/acoustics2008/acoustics2008/cd1/data/articles/001547.pdf

classes apply to the ISO method, results for NRC and SAA could fall into similar categories should a particular sound absorption class be specified because they are very similar to the alpha (α) coefficient. The table below illustrates the different sound absorption classes and the range of coefficient that falls into each category.

Sound Absorption Class (ISO 354:2003)	Range of Coefficient
A	0.90-1.00
B	0.80-0.85
C	0.60-0.75
D	0.30-0.55
E	0.15-0.25
Not classified (NC)	0.00-0.10

Ratings from both methods can be used simultaneously as long as the specifier understands that any difference between the two methods is a matter of calculation rather than an actual difference in performance. Mermet used the ASTM method because it is more in line with the North American market.

Measurement of Sound Intensity

To understand how sound transmission and acoustic absorption work, it is important to understand how sound functions. Sound intensity is measured in decibels (dB), typically ranging from 0 to 140 dB, which is the range based on what the human ear is capable of hearing. A decibel of 0 does not mean there is a complete absence of sound, but rather it represents the quietest sound audible to the human ear. The following are some examples of what types of sounds are associated with certain decibel levels.

Decibel level	Types of Sound
10 dB	Almost inaudible; normal breathing
30 dB	Whispering
50 dB	Limited sound; quiet office, car driving by
50-65 dB	Normal conversation
70-80 dB	Unpleasant sound; loud TV; busy restaurant
90+ dB	Machinery; shouting; thunder; concerts

Decibels are measured using a logarithmic scale, with every increase of 3 dB doubling the sound intensity. A decibel level over 85 in considered potentially harmful.

Interpreting the Results of Sound Absorption Coefficients

When looking at NRC or SAA values, you have to take into account for what percentage of sound reduction you are aiming. To give an indication of how sound absorption coefficients work, here are some examples of how standard building materials perform on average.

Product	NRC
Floors, concrete or terrazzo	0.00
Marble or glazed tile	0.00
Glass, 1/4”, sealed, large panes	0.05
Brick, unglazed	0.05
Concrete block, unglazed	0.05
Carpet, 1/8” pile height	0.15
Carpet, 5/16” combined pile and foam	0.35

As demonstrated above, general building materials do contribute to some acoustical absorption. However, this amount is negligible when designing for a predominantly noisy environment. Additional materials may need to be incorporated into the overall design to provide the desired amount of sound absorption.

What materials provide the best acoustic performance? It all depends on the specific environment, but the majority of materials designed specifically for acoustical absorption can have an NRC value from 0.55 to 1.00 (soundproof). The materials often consist of foam in the form of wall panels or partitions. There are also some fabrics and draperies designed specifically for acoustic performance.

When determining what level of noise reduction is needed for a particular environment, there are many factors that will influence this including sound transmission class, sound absorption, and sound reverberation (the buildup of sound from the reflection of other materials). In terms of decibel reduction, it is difficult to determine an exact calculation of decibel drop based on sound absorption, because these results are calculated very differently. An actual decibel drop is more of a determination of sound transmission class since this measures the transmission loss, which is a measurement of the loss of dB from one side of a partition to another. For example, a partition that reduces the decibel level from 80 dB on one side to 50 dB on the other would have a STC of 30. Sound absorption cannot specifically classify decibel drop without measuring the decibel level of the room before and after installation. However, it can provide an idea of the overall reduction in noise based on a percentage.

For example, when looking at a material designed specifically for acoustic performance with a rating of 0.90, it can safely be assumed that 90% of the sound within that room has been absorbed by the material. This is a significant amount of sound reduction. However, the end user is likely to pay more of a premium for these types of products and materials such as wall panels, which are a more permanent fixture and may not fit well into the design intent. While the amount of sound absorption specified will vary by architect and project, most indoor environments are not going to require this level of sound absorption. The majority of noisy environments can see a significant impact from just 30-40% sound absorption. It is possible to find unique and less expensive ways of designing for good acoustical performance through the use of window shade fabric.

Functionality of Fabric Design Regarding Acoustic Performance

All window shade fabric has natural acoustic properties since nearly all types of fabric are capable of absorbing some level of sound; but what makes one fabric perform better acoustically than another? It has been determined that a combination of construction and openness factor heavily influence noise reduction.

It has been determined that a fabric with a lower openness (lower percentages of holes or openings in the fabric) performs well at noise reduction compared to fabrics with a higher openness simply because the fabric is able to block a larger percentage of sound from passing through. For example, let's look at Mermet's E Screen 1% with KOOLBLACK® Technology; with an NRC of 0.45. This fabric, in its inherent design, absorbs 45% of the sound in a room.

E Screen has a basket weave design with consistent, square openings in the fabric. Let's look at a fabric with a different construction to see its impact on noise reduction. Mermet's M Screen is a rib weave pattern that is designed with more rectangular holes, providing more inconsistency in the openings of the fabric when compared to a basket weave. M Screen with a 3% openness has an NRC is 0.35. When comparing M Screen 3% to the exact same openness in the E Screen basket weave, E Screen 3% has an NRC of 0.15. As one can see, the construction and design of the fabric has a significant impact on noise reduction. The uneven construction of M Screen allows for more scattering of sound waves contributing to less direct transmission through the fabric, thus allowing for more of the overall sound to be absorbed. It seems the best acoustic performance is achieved through a combination of an uneven construction and the lowest openness factor possible.

Because standard window shade fabric is not marketed specifically for its acoustic performance, there is not a premium added to the product for this performance as there would be for an "acoustic fabric". Therefore, an architect can still design with noise reduction in mind without having to increase the cost of the overall design. The majority of buildings are going to incorporate some type of window shade into the design regardless of acoustic performance considerations, so why not combine the functionality of a window shade fabric along with its potential to contribute to noise reduction? Architects that design with this in mind can essentially "kill two birds with one stone," enhancing performance while saving on design cost.

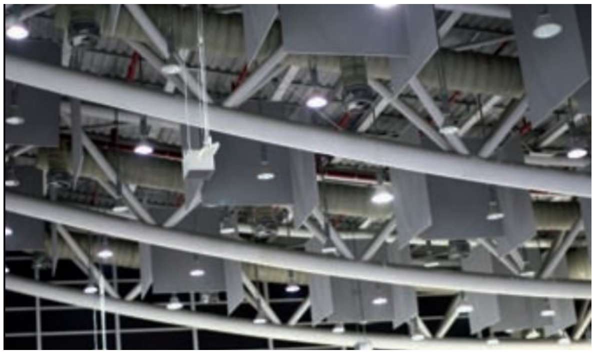
Potential Applications

All aforementioned examples of NRC ratings resulted from using the fabric as its intended application, a free hanging shade, and using a standard room size. Depending on the environment, it is possible to increase the acoustic performance of a standard window shade fabric by applying it in unique ways such as wall panels, free hanging partitions, and tensile structures.

Mermet's window shade fabrics are durable and flexible, and they allow for more types of applications aside from just roller shades. On the following page are some examples of how window shade fabric can be applied in distinctive ways to enhance performance. Designing for the acoustic environment can aid in alleviating the stress caused by excess noise and provide a level of occupancy comfort that makes an environment more pleasant and functional. Certain materials such as window shade fabric, when applied correctly to the overall building design, can provide great benefit in terms of acoustical performance.

Velum

Acoustic Baffle



Frame-mounted Ceiling Partition

Stretched Wall

Tensile Architecture

Fabric on Supporting Tensile Structure

Addendum

Acoustic Performance of Mermet Fabrics

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Fabric Name	Openness	Weave Pattern	NRC	SAA
9803™	3%	Offset twill	0.15	0.15
Avila Daylight™ NFR | Residential	<1%	Basketweave	0.05	0.03
Avila Twilight™ NFR | Residential	0%	Blackout	0.05	0.03
E Screen™ 1%	1%	Basketweave	0.50	0.50
E Screen™ 3%	3%	Basketweave	0.15	0.16
E Screen™ 5%	5%	Basketweave	0.10	0.11
E Screen™ 10%	10%	Basketweave	0.05	0.06
E Screen Chroma™	3%	Basketweave	0.25	0.24
E Screen Deco™ 1%	1%	Basketweave	0.50	0.49
E Screen Deco™ 3%	3%	Basketweave	0.15	0.13
E Screen™ 1% with KOOLBLACK® Technology	1%	Basketweave	0.45	0.46
E Screen™ 3% with KOOLBLACK® Technology	3%	Basketweave	0.15	0.16
E Screen™ 5% with KOOLBLACK® Technology	5%	Basketweave	0.10	0.08
Flocké®	0%	Blackout	0.00	0.02
GreenScreen Evolve® 3%	3%	Warp knit	0.20	0.21
GreenScreen® Nature™	5%	Mock leno	0.10	0.11
GreenScreen Revive® 1%	1%	Warp knit	0.20	0.22
GreenScreen Revive® 5%	5%	Warp knit	0.15	0.14
M Screen™ 1%	1%	Rib weave	0.50	0.47
M Screen™ 3%	3%	Rib weave	0.25	0.24
M Screen™ 5%	5%	Rib weave	0.15	0.16
M Screen Deco™ 3%	3%	Rib weave	0.20	0.19
M Screen Deco™ 5%	5%	Rib weave	0.15	0.16
Natté™ 3%	3%	Basketweave	0.25	0.24
Natté™ 5%	5%	Basketweave	0.05	0.06
Natté™ 10%	10%	Basketweave	0.05	0.04
S Screen™ 1%	1%	Plain weave	0.25	0.26
S Screen™ 4%	4%	Plain weave	0.10	0.12
S Screen Naturals™	5%	Fancy weave	0.05	0.07
Satiné™ 1%	1%	Twill weave	0.15	0.16
Satiné™ 5%	5%	Twill weave	0.05	0.06
Sparta Twilight™	0%	Blackout	0.00	0.02
T Screen™ 1%	1%	Satin weave	0.15	0.16
T Screen™ 3%	3%	Satin weave	0.15	0.13
T Screen Deco™ 1%	1%	Satin weave	0.10	0.11
T Screen Deco™ 3%	3%	Satin weave	0.15	0.14
T Screen Deco™ 5%	5%	Satin weave	0.10	0.08
T Screen™ 1% with KOOLBLACK® Technology	1%	Satin weave	0.10	0.11

T Screen™ 3% with KOOLBLACK® Technology	3%	Satin weave	0.15	0.14
Verona Daylight™	<1%	Fancy weave	0.30	0.28
Verona Twilight™	0%	Fancy weave	0.05	0.05
Vizela™	<1%	Rib weave	0.35	0.33