CEILING&WALL | SYSTEMS

Between us, ideas become reality™

Quiet in the classroom

Enhancing the learning environment through better acoustics

Armstrong®
CEILING SOLUTIONS

Quiet in the classroom

Enhancing the learning environment through better acoustics

On any given school day, thousands of students across the country are unable to understand 25 to 30 percent of what's said in their classroom. The reason: excessive noise and reverberation within the classroom interferes with their ability to clearly hear their teacher. The result: a decreased level of concentration, an increased level of stress, and an overall reduction in the level of learning. Considering that the primary mode of teaching involves speech and listening, is it any wonder that good acoustics are required in classrooms?

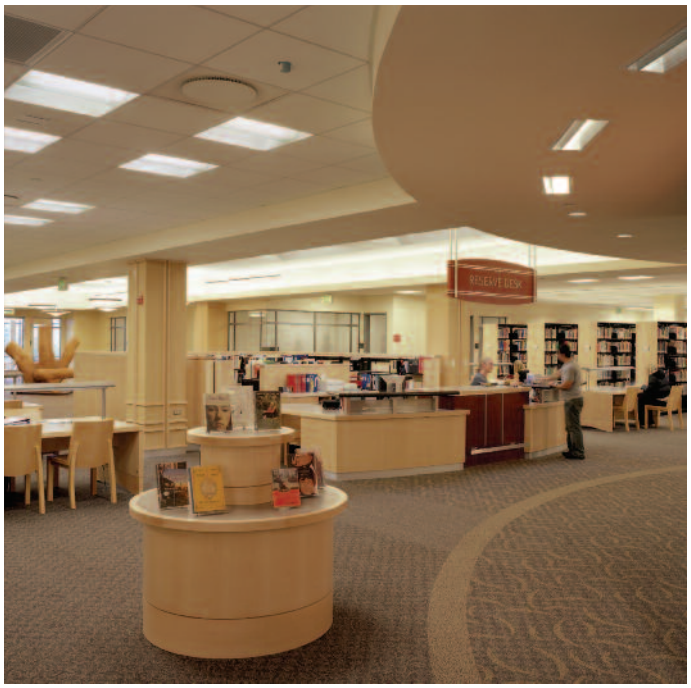
To help create more effective spaces for teaching and learning, Armstrong offers a portfolio of ceilings that can substantially improve classroom acoustical design. As the industry leader, we have invested heavily through the years to raise the effectiveness of the ceiling plane to help you bring out the best in students. So familiarize yourself with today's acoustic requirements, choose the right Armstrong ceiling, and enhance the learning experience for students and teachers alike.

MAKING THE GRADE

To address the problems caused by inadequate acoustic design, the American National Standards Institute (ANSI) and United States Green Building Council (USGBC) have both established criteria to help provide optimal conditions for hearing and comprehension in classrooms. Here's what you need to know about each.

ANSI STANDARD S12.60

ANSI released Standard S12.60 for Classroom Acoustics in 2002 and revised it in 2009. The standard focuses on speech intelligibility by setting maximum permissible levels for reverberation time to ensure good speech clarity, and for background noise to ensure that speech can be heard above the noise. It also takes into account the differences between permanent and relocatable classrooms.



BACKGROUND NOISE

The maximum allowable background noise for both permanent and relocatable classrooms is divided into two parts: noise generated from exterior sources, such as highways, and noise from interior sources, such as HVAC equipment.

The maximum allowable background noise from exterior sources for both permanent and relocatable classrooms is 35 decibels A-weighted (dBA). (The decibel level of an average conversation is about 65.)

The maximum allowable from interior sources is 35 dBA for permanent classrooms and 41 dBA for relocatable. However, for relocatable classrooms, the maximum permissible noise level will drop to 38 dBA in 2013 and 35 dBA in 2017.

REVERBERATION TIME

The maximum allowable reverberation time for permanent classrooms is 0.60 seconds for small classrooms (less than 10,000 cubic feet) and 0.70 seconds for larger ones (over 10,000 cubic feet). However, you must also show by calculation that these spaces are readily adaptable to allow for a reduction to 0.30 seconds for students with profound hearing disabilities.

The maximum allowable reverberation time for relocatable classrooms is 0.50 seconds for small classrooms and 0.60 for larger ones. These times are lower, primarily because these spaces usually have less volume than permanent classrooms.

VOLUNTARY NOW, MANDATORY IN FUTURE?

The ANSI standard is currently voluntary unless referenced by a state code, ordinance, or regulation. However, some school districts require compliance with it as part of their construction documents for new schools, thus making the design team responsible for addressing the issues. In addition, four entities have already adopted the standard, including New York City Public Schools, New Hampshire Department of Education, the State of Connecticut, and the Los Angeles Unified School District.

In August 2010, however, the U.S. Access Board, the Federal agency responsible for advancing accessibility for Americans with disabilities, announced that it will begin the process of developing rules and regulations pertaining to classroom acoustics based on ANSI Standard S12.60.

Once this rulemaking process is completed, the ANSI standard will apply to all classrooms that are newly constructed or significantly renovated nationwide.

LEED® FOR SCHOOLS

Launched in 2007, LEED for Schools addresses the unique nature of the design and use of K-12 schools. It is the first of the USGBC Ratings Systems to recognize acoustics as an integral and important element of indoor environmental quality.

ACOUSTIC PREREQUISITE

To provide classrooms that facilitate better teacher-to-student communication, LEED for Schools includes a minimum acoustical performance prerequisite. To attain it, you must meet two requirements: First, design classrooms and other core learning spaces to include sufficient sound-absorptive finishes to meet the maximum reverberation

time of 0.60 seconds (classrooms less than 20,000 cubic feet). Second, meet a maximum background noise level from HVAC systems in classrooms and other core learning spaces of 45 dBA.

You can comply with the first requirement in one of two ways: Confirm that 100% of all ceiling areas (excluding lights, diffusers, and grilles) are finished with a material that has a Noise Reduction Coefficient (NRC) of 0.70 or higher. Or, confirm that the total area of acoustical wall panels, ceiling finishes, and other sound-absorbent finishes equals or exceeds the total ceiling area of the room (excluding lights, diffusers, and grilles). All materials must have an NRC of 0.70 or higher to be included in the calculation.

In the case of classrooms and other core learning spaces greater than 20,000 cubic feet, confirm through calculations that the spaces are designed to have a reverberation time of 1.5 seconds or less.

ENHANCED ACOUSTICS

It is also possible to obtain a LEED® Indoor Environmental Quality (IEQ) point for enhanced acoustical performance by meeting two further requirements: First, reduce the background noise level from HVAC systems in classrooms and other core learning spaces to 40 dBA or less. Second, design the building shell, classroom partitions, and other core learning spaces partitions to meet a Sound Transmission Class (STC) of at least 50, with the exception of windows, which must have an STC of at least 35.

MEETING THE STANDARDS

Designing a classroom to meet the acoustical requirements of ANSI and LEED is neither difficult nor costly. The key is including acoustic concerns early in your planning stages. With that in mind, here are general guidelines for reducing reverberation time as well as background noise.

Reducing Reverberation Time Reverberation time can be reduced by adding sound-absorbing material to a room. In order to obtain good acoustical characteristics in learning spaces, however, the location of sound absorption treatments is an important consideration.

In classrooms where ceiling heights are ten feet or less, the best option is to place most, if not all, of the sound-absorbing material on the ceiling. To reduce reverberation, choose a ceiling panel that has an NRC of at least 0.70.

Armstrong has the perfect choice for classrooms: School Zone™ Fine Fissured™ ceiling tiles. Designed specifically for educational facilities, these ceiling tiles feature greater impact resistance and better sound absorption than most conventional ceiling panels commonly used in these applications. Armstrong Ultima®, Mesa™, and Fine Fissured ceiling tiles are also good choices.

When ceiling heights are greater than ten feet, include an increasing amount of the sound-absorbing material on the walls. Acoustical wall treatments frequently take the form of ¾" to 1" thick, vinyl or fabric-covered panels with either a mineral fiber or fiberglass substrate.

Depending on the substrate and the mounting, Armstrong Soundsoak® acoustical wall panels absorb 50-90% of the sound striking their surface. That's 3 to 6 times the sound absorption of fabric-covered gypsum panels.

MORE THAN JUST ACOUSTICS

The proper choice of an acoustical ceiling goes a long way toward creating a better learning environment. However, improved acoustics isn't the only benefit. There are numerous other features incorporated into Armstrong ceilings that help optimize classroom design even further:

HIGH LIGHT REFLECTANCE Proper lighting is critical to effective learning. Poor lighting can cause eyestrain and fatigue, which can hamper a student's ability to concentrate. Armstrong high light reflectance ceilings, meaning those that have a Light Reflectance (LR) value of 0.83 or higher, can help improve this situation by creating brighter, more evenly lit spaces. They also reduce glare and enhance daylighting in the room.

SAG RESISTANCE School facilities often have to cycle or shut down their HVAC systems for extended periods of time, such as summer vacations, resulting in increased humidity levels and the possibility of sagging ceilings. Armstrong HumiGuard® ceilings are specifically designed for these types of applications. In fact, these humidity-resistant ceilings are guaranteed to resist visible sag for 30 years.

MOLD/MILDEW RESISTANCE High humidity conditions can also lead to the growth of mold and mildew on any surfaces, including ceiling panels. To help remedy this situation, Armstrong offers acoustical ceilings featuring BioBlock® Plus, a broad spectrum anti-microbial treatment that inhibits mold/mildew and bacterial growth on both the front and back of the ceiling panel.

SUSTAINABILITY All Armstrong ceilings are made with recycled material, some containing as much as 83%. Ceilings with high recycled content can help achieve LEED credits in the Materials and Resources category. The ceilings can also be reclaimed at the end of their useful life as part of the Armstrong Ceiling Recycling Program, a closed-loop program that enables school districts to ship old ceilings from renovation projects to an Armstrong manufacturing plant as an alternative to landfill disposal.

INDOOR ENVIRONMENTAL QUALITY Increasing attention is being given to the quality of the indoor environment and the presence of Volatile Organic Compounds (VOCs) within it. Armstrong offers the widest selection of acoustical ceilings that satisfy requirements for formaldehyde and VOC emissions. Many Armstrong mineral fiber acoustical ceilings have no-added formaldehyde. All other Armstrong acoustical ceilings are classified as low formaldehyde.

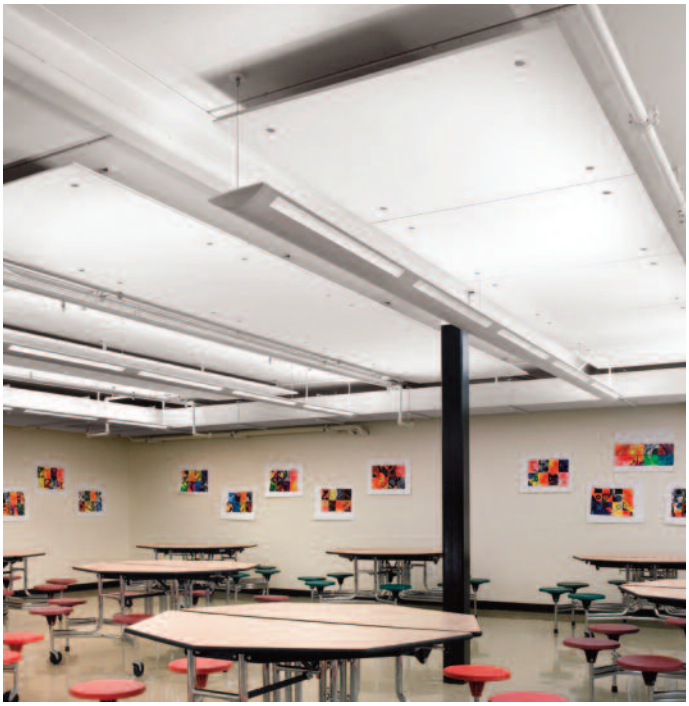
Reducing Noise Traveling Through the Plenum Many walls stop at the suspended ceiling, rather than extending up to the deck of the floor or roof above. As a result, noise from an adjacent space can penetrate the ceiling plane and move unimpeded throughout the ceiling plenum. Some portion of this sound can pass back down through the ceiling into adjoining rooms, adding to the background noise in each room.

To reduce this type of noise intrusion, choose an acoustical ceiling panel that has a Ceiling Attenuation Class (CAC) of 35 or higher. Once again, Armstrong School Zone™ Fine Fissured™ is a good choice because not only does it have a high NRC of 0.70, but also a high CAC of 40. Most Ultima®, Mesa™, and Fine Fissured ceilings also have a high CAC.

Reducing Noise Traveling Through the Walls Years ago, interior school walls were built of brick or concrete block, so sound intrusion wasn't a problem. Today, noise intrusion must be addressed because most walls are constructed using metal studs with a layer of gypsum wallboard on each side and an air space in between.

According to the ANSI standard, the minimum STC of a wall separating two adjacent classrooms is 50. The use of Soundsoak® wall panels on either or both sides of the wall along with fiberglass insulation in the cavity will help achieve this rating and reduce noise transmission between rooms.

Reducing HVAC Noise The main source of background noise in classrooms is usually the HVAC system. In terms of acoustical design, a centralized system is much better than window or room units. Room units contain fans that are usually loud and difficult to treat with sound-absorbing materials due to their position in the classroom.



It is also important to locate air handlers and rooftop mechanical equipment away from critical listening spaces such as classrooms. It is best to locate them over spaces that are inherently noisy, such as corridors, cafeterias, and gymnasiums.

ACOUSTICAL TREATMENT EARNS AN A+

A test conducted by Dr. Kenneth Roy, senior principal research scientist for acoustic technologies at Armstrong, demonstrates the difference a high performance acoustical ceiling can make in an existing classroom.

The test took place in a sixth grade classroom at the Robert E. Lamberton Public School in Philadelphia, PA. Built in 1949, the 24' x 44' x 11' classroom consisted of a plaster ceiling, concrete block masonry walls, and a vinyl tile floor. The Noise Reduction Coefficient (NRC) of the existing ceiling was approximately 0.25.

Sound reverberation measurements in the room were found to be an average of 1.08 seconds, far exceeding the ANSI S12.60 maximum acceptable reverberation time of 0.60 seconds.

An Armstrong School Zone Fine Fissured suspended ceiling was then installed. Following the change in ceilings, measurements were again taken and the average reverberation time was 0.56 seconds, within the maximum acceptable parameter.

However, acoustical results were not the only measures of success. A number of subjective factors were also observed. The teacher, for example, indicated there now appeared to be less fidgeting and talking during her lessons. She also said her students seemed to be paying more attention.

An even more telling measure of success may have come from the students themselves. When asked if they noticed any changes, their most common response was about improvement in the noise level. Others also commented that the room was brighter. As one student, who sat in the back of the room, summed it up, "I can hear (my teacher) a lot better today."

RETROFITTING EXISTING CLASSROOMS

Classrooms designed without regard to good acoustics often include a tall plaster or drywall ceiling, drywall or other masonry walls, and a hardwood or tile floor. Unfortunately, numerous classrooms like this were built before the days of acoustical concern. In this type of classroom, reverberation tends to destroy speech intelligibility, especially for younger children.

Acoustical problems in existing classrooms can be solved, but the options are often limited. That's because little can be done to change the architectural infrastructure or HVAC system without great expense. Thus, the most common and affordable solution is to control reverberation time through the addition of sound-absorptive materials.

Installing a suspended acoustical ceiling with an NRC of 0.70 in a classroom that does not already have one will greatly reduce reverberation time.

If a suspended ceiling is already in the room, check the NRC of the ceiling panels. Replacing them with higher NRC panels will greatly improve the acoustical environment. The addition of wall treatment will further improve it.

OPEN PLENUM SPACES

Another retrofit option, especially in open plenum spaces where the HVAC, plumbing, and other building service lines are exposed, is the Optima® Capz™ ceiling system from Armstrong.

This system is a very affordable way to retrofit poor acoustic-performing spaces because it provides excellent sound absorption properties while maintaining the look and feel of open plenum designs.

The ceiling panels have an NRC of 0.90, and can be installed onto the deck above to maximize ceiling height, onto drywall, or suspended with wires. And, installation over only 20% of an area can reduce undesirable reverberation by 50%.

ACOUSTICAL CLOUDS AND CANOPIES

Yet another solution for open plenum spaces and public spaces are Formations™ and SoundScapes® acoustical clouds and canopies, two types of "free-floating" ceilings from Armstrong that add sound absorption in a space while still allowing for the exposed look.

A typical Formations cloud system consists of pre-cut acoustical ceiling panels and a kit containing all the ready-to-assemble suspension system and perimeter trim components required to create the cloud.

Pre-packaged SoundScapes clouds do not require a grid system. These one-piece clouds feature a wide variety of standard and custom shapes and colors, and can be used as individual units or grouped together to create unique visual configurations.

Acoustically, ceiling clouds can actually provide more sound absorption than a continuous ceiling of the same surface area because sound is absorbed on both the front and back surfaces of the cloud. In fact, the more "live" the space, the greater will be the effect on reverberation time from the addition of clouds.

SoundScapes acoustical canopies also help reduce reverberation in the space below them, but are much different in size and look compared to acoustical clouds. For example, cloud systems are available in sizes up to 14' x 14', while acoustical canopies are only about 4' x 6' in size. Visually, acoustical clouds are flat, while canopies are curved and can be installed as hills or valleys.

QUIET CLASSROOMS

The establishment of ANSI S12.60 for Classroom Acoustics and LEED® for Schools provides clear design goals for both planners and architects. They also raise awareness of the learning problems associated with poor acoustics and, hopefully, eventually eliminate design problems from being repeated as new schools are built.

The Armstrong ceilings needed to design and build classrooms for high acoustic performance exist. Choose them properly to ensure that any newly constructed or retrofitted classroom provides an acoustic environment that enhances the learning experience for students and teachers alike.

ONLINE REVERBERATION CALCULATOR

To help demonstrate the beneficial effect of acoustical treatment in a classroom, we've developed a web-based, interactive Reverberation Calculator that allows you to actually hear the difference in sound quality before and after treatment. It will even provide recommendations for a new space or an upgrade to an existing space.

To access the calculator, simply log on to armstrong.com/reverbtool and follow the prompts regarding a description of the space and its surface materials. The program will first calculate the current reverberation time and allow you to hear the quality of the sound. Following selection of acoustical treatment options, it will then allow you to hear the difference in sound quality and reverberation time.