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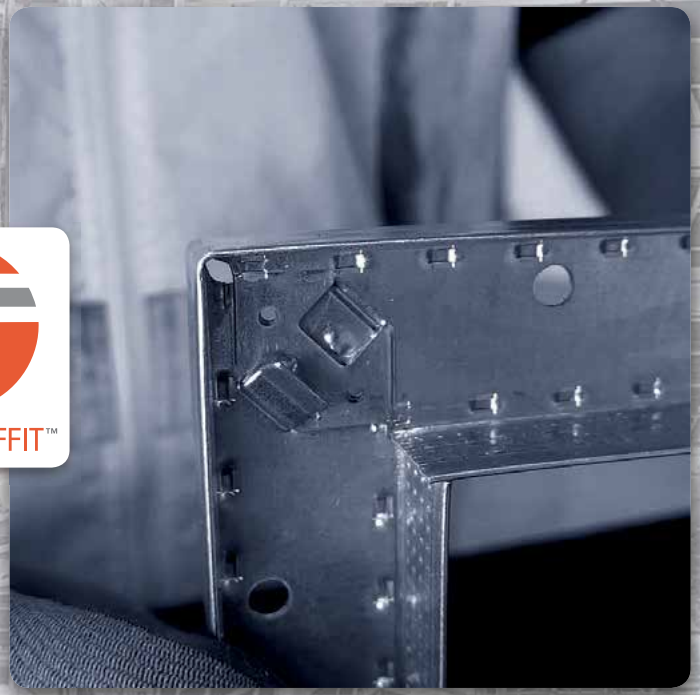

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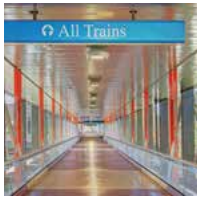

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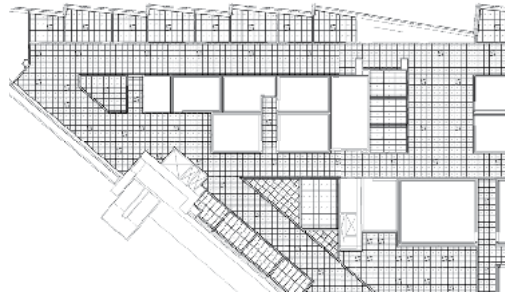

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Undulating three-dimensional metal ceilings are available in 'hills' and 'valleys' to create a distinctive serpentine effect.

Controlling Noise with Metal Ceiling Systems

by Sean D. Browne

All photos courtesy Armstrong Ceiling Solutions

SPECIFIERS WHO CHOOSE ACOUSTICAL CEILING SYSTEMS IN COMMERCIAL APPLICATIONS ARE DISCOVERING WHAT THE CEILINGS INDUSTRY HAS OBSERVED FOR QUITE SOME TIME: THE GROWING USE AND POPULARITY OF METAL CEILING SYSTEMS IS A DIRECT RESULT OF THEIR EYE-CATCHING VISUALS, NOISE CONTROL, AND LONG SERVICE LIFE.

One of the main reasons for their popularity is the sleek, upscale, high-tech look metal brings to a space. This sophisticated feature makes them ideal for use in high visibility areas, such as lobbies, conference rooms, corridors, theaters, and transportation terminals, as well as in corporate, retail, and hospitality environments. Long popular in European commercial design, today's metal ceiling systems are offered in a wider variety of sizes, forms, and shapes than ever before.

Durability is another reason for their growth. Metal ceiling panels are often chosen over other options because of their service life, especially in areas where

access to the plenum is frequent or where the ceiling is exposed to occupant interaction, frequent cleaning, or other potentially damaging situations.

Most metal ceiling systems are manufactured from electrogalvanized steel or aluminum. Many of them also feature a factory-applied powder-coated finish for added durability. Humidity resistance and low maintenance are other important considerations in the selection of metal.

Aesthetics plus acoustics

Specifiers do not always associate metal with good acoustics. Yet, metal ceilings can provide effective acoustical control in addition to their eye-catching aesthetics, making them a versatile and functional design element. To obtain the acoustic benefits, however, the panels must be perforated and backed with a sound-absorbent liner behind the perforations, usually in the form of a thin black acoustical fleece, mineral fiber panels, and/or an encapsulated fiberglass infill.

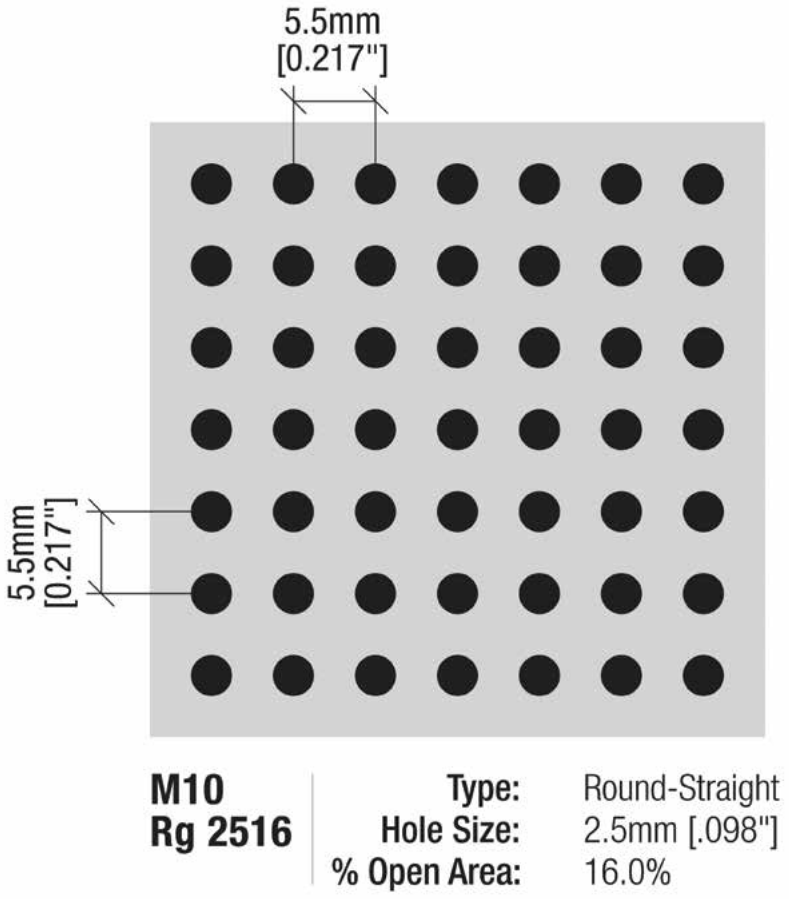
Thickness, density, and mounting method affect the sound absorption of the backloaded acoustic material. In typical backloading applications, the material is laid on top of the perforated metal panels with an air gap between the material and the deck.

The number, size, and shape of the perforations also impact the acoustical performance of the ceiling panel. Depending on the perforations, sound can pass through the ceiling panels and be absorbed by the material behind them.

Factors determining how much sound can pass through perforated metal panels are:

- metal thickness;
- number of perforations;
- perforation diameter;
- distance and spacing between perforations; and
- percent of open area of panels.

FIGURE 1



The perforation pattern in this ceiling panel allows more than 95 percent of sound to pass through it to be absorbed by the backing material.

Metal ceilings can provide effective acoustical control in addition to their eye-catching aesthetics, making them a versatile and functional design element.

Larger perforations, closely spaced, on thin metal provide the highest level of sound transparency available while thicker metal with smaller holes spaced further apart will have less transparency, thereby blocking sound from the absorptive material behind the panels.[1]

Consider the perforation pattern in Figure 1. This panel allows more than 95 percent of sound to pass through it to be absorbed by the backing material. Acoustical tests performed at a National Voluntary Laboratory Acreditation Program (NVLAP) facility on the panel yielded the following: with only a thin acoustical fleece, the has panel achieved a noise reduction coefficient (NRC) of 0.80, meaning it absorbs 80 percent of the sound striking it. With both a thin acoustical fleece and a fiberglass infill, the NRC is 0.90.

Perforations vary in size and pattern depending on aesthetic appeal. For years, only limited perforation choices were available, but today they are offered in a myriad of options. It is even possible to have extra microperforated panels where the holes are so small, they are essentially invisible. It is also possible to have custom perforations, allowing designers to transform images to the metal ceiling panels, and offering a unique visual with acoustical performance.

Multitude of choices

The chosen perforation pattern affects the acoustical absorption of the ceiling. When selecting metal ceilings, there are three general categories of perforated panels to consider when aesthetics and acoustics are needed for a space.

Highly perforated

These ceilings have a perforation area of more than 20 percent of the ceiling area. They are available in a variety of patterns and shapes, including circles, squares, diamonds, bars, and slats. Since the panels are essentially transparent to sound, performance is dependent on the acoustic treatment placed behind the ceiling.

Generally, when the open percentage of the metal is above 20 percent, the acoustical absorption of the backing material is 100 percent preserved. To validate this, the Industrial Perforators Association (IPA) performed an analysis of three perforated metal panels with fiberglass backing. The panels were 46 percent open area, 37 percent, and 23 percent. All were tested for acoustical absorption and compared to the fiberglass alone.

One of the main reasons for the growing popularity of metal ceiling systems is the sleek, upscale, high-tech look they bring to a space.

The tests found "there was virtually no diminishment of the fiberglass blanket's sound absorption performance by the presence of any of the perforated metal panels. They were equally transparent with only minor and insignificant variations. Each of the tests followed the performance of the bare blanket very closely at all frequency levels."[2]

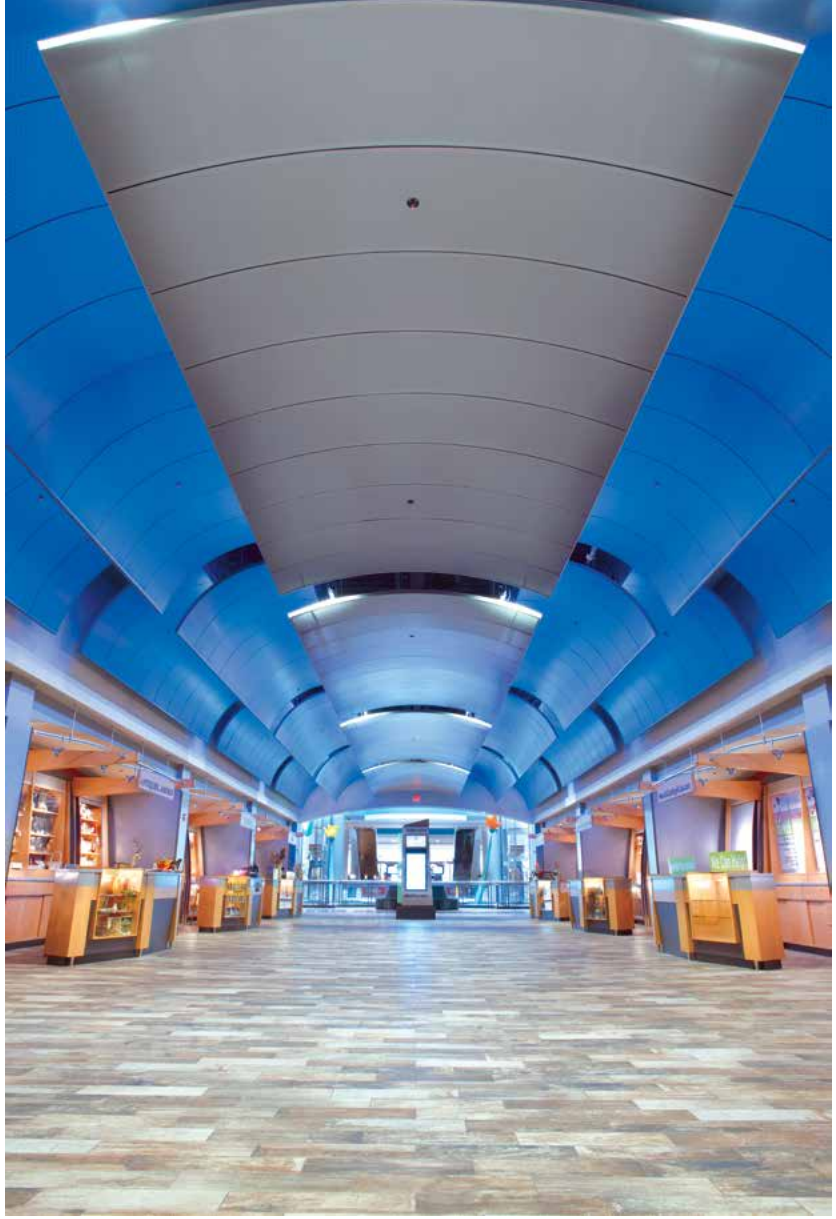
Highly perforated ceilings are frequently found in retail applications, especially boutique environments, and hospitality installations such as restaurants. They are also used in many types of high ceiling applications such as gymnasiums. Since there is so much open area, use of a black acoustical backer is recommended.

Moderately perforated

These ceilings have an open area of less than 20 percent. The perforations are predominantly circular, although other shapes are available. These ceilings are commonly used in commercial applications, including office and educational buildings, and healthcare facilities.

If the acoustical goal is to lower the sound of occupant voices, it is advisable to choose a panel with an open area as close to 20 percent as possible. Additionally, the smaller the perforation, the better.

Curved metal ceiling clouds at the Destiny USA Mall in Syracuse, New York, not only evoke the look of petals of an artichoke, but are also perforated and backed with an acoustical fleece for sound control. Light-emitting diode (LED) fixtures switch hues to illuminate the clouds, resulting in an ever-changing kaleidoscope of colors.



Minimally perforated

These ceilings have an open area of less than two percent, but can still provide good acoustical performance if properly designed and backed with an appropriate infill. Minimally perforated ceiling panels can be installed in a range of applications to reduce occupant sound level and/or the background noise created by an HVAC system.

Visually, the perforations can hardly be seen and give the appearance of an unperforated ceiling. Consequently, if a visible perforation pattern is aesthetically desired in the ceiling, it is recommended to select one of the other choices above.

Variety of finishes

Metal ceilings are offered in a variety of finishes that coordinate with other interior metal finishes. The most popular colors are white, silver gray, and gun metal.

Today, there are even metal ceiling panels offering the rich, warm look of wood, but at a much more affordable cost than real wood. These ceilings are made possible by a technology embedding a realistic image of maple, cherry, walnut, and other wood species onto the surface of the metal ceiling panel. The powder-coated finish (post-coated) produces a consistent color tone and grain, greatly reducing the variations occurring in real wood panels. And, the panels can be perforated for acoustic control.

Metal ceilings with real wood veneers are also available. These ceilings are usually offered in three standard veneer finishes—maple, light cherry, and dark cherry. Custom finishes are also available.

For a more contemporary look, a broad range of metal mesh panels are available. The mesh family of ceilings is typically offered in three types of panel patterns—welded wire, woven wire, and expanded metal.

Case study

The ability of a metal ceiling to provide aesthetics and acoustics, along with a custom color, was recently demonstrated in Boston. As part of a new multi-use residence hall, the Berklee College of Music desired a space that would serve as a dining area during the day and a performance venue for students at night. Due to the dual function, both aesthetics and acoustics were key considerations in its design.

To meet the challenge, the Boston-based design team at William Rawn Associates created the 'Caf', a two-story, 400-seat space featuring a 10-m (32-ft) high ceiling, a gracefully curved second floor balcony, and a floor-to-ceiling glass wall.

According to designer Brian Putnam, the design team wanted to impart a dynamic quality to the space to complement its urban setting. One way the team accomplished its goal was to use metal torsion spring panels in a custom red color in the ceiling: "Red was chosen because it is the school color and both eye-catching and highly visible from the street," Putnam said.

Apart from its looks, the light weight of aluminum ceiling panels and their durability were some of the considerations for a metal ceiling.

"Torsion spring ceiling panels were chosen because they have no exposed grid and still allow accessibility where needed," Putnam added.

The ceiling panels are installed in a series of clouds mirroring the balcony's 'ribbon wall,' which has been designed with sweeping curves to redirect sound. All of the metal panels in the ceiling are perforated and backed with a fiberglass infill for acoustic control.

"To create the space we desired, we knew we would be heavily reliant on the ceiling, both in terms of aesthetics and acoustics," Putnam said. "It is amazing how much of a signature element it has become."

Variety of shapes

In terms of shapes, the most common design choice is a 0.6 x 0.6-m (2 x 2-ft) panel although metal ceilings are also available in geometric, linear, and plank versions as well as radial and curved systems in an assortment of sizes.

Other choices include undulating 3D metal ceilings available in 'hills' and 'valleys' to create a distinctive serpentine effect.

> Metal ceiling panels can offer the rich, warm look of wood at a much more affordable cost. The panels can be perforated for acoustic control.

Perforated metal ceiling panels installed diagonally produce a visual reminiscent of lightning bolts at a conference room in National Oceanic and Atmospheric Administration (NOAA) facility in Grandview, Missouri.

A variety of 'free-floating' ceiling clouds and canopies are also available, many of which are curved to create a 'wave' profile. Some are available in 'kits' to minimize or eliminate onsite cutting and measuring.

Case study

The myriad of metal ceiling options provides specifiers with the opportunity to create signature ceilings in a wide variety of spaces. A case in point is the conference room at the new National Oceanic and Atmospheric Administration (NOAA) facility in Grandview, Missouri.

The room is used to host everything from staff briefings to national meetings. As a result, the design team at Burns & McDonnell, Kansas City, Missouri, felt it was important to create a space that would not only embody the center's mission, but also provide the staff with a space they could be proud of.

"We wanted to create a space that would leave a lasting impression of the facility," said Rhonda Hulkill, the senior interior designer, "and the best opportunity for making an impression is the ceiling."

The design team achieved its goal by creating a ceiling featuring custom 0.6 x 1-m (2 x 4-ft) metal ceiling panels installed diagonally across the room in "a herringbone pattern. The result is a visual reminiscent of lightning bolts. A 152-mm (6-in.) gap separates each of the bolts, while blue fluorescent lighting behind the panels represents the sky and adds even more interest to the ceiling visual.

All the metal panels are perforated and backed with an acoustical fleece to provide sound absorption.

"Considering the multiple uses of the space, acoustical performance was a key consideration," Hulkill said.

According to the associate architect Vicky Borchers, metal ceiling panels were chosen because of their durability and light reflectance.

"We wanted a certain amount of reflectance to extend the blue light into the room and give the space more life. Since the panels are floating, we also wanted sharp, crisp edges as they are visible," she said.

As far as making an impression, she reports that the conference room has become the facility's signature space.

"It is definitely the space everybody remembers and also the first place the staff takes everyone," she added.

Ease of installation

Some specifiers may think metal ceilings are difficult to work with. However, they can be installed easily in standard suspension systems and integrated well with standard light fixtures, including high hats and linear and geometric lighting.

Many metal ceilings are designed for installation in 24 mm (15/16 in.) exposed tee suspension systems, making them ideal for renovation applications as well as new construction. Since there is no need to replace an existing suspension system, renovation projects can be completed quickly. Other metal ceilings can be installed in 14 mm (9/16 in.) suspension systems.

In the case of 'free-floating' clouds and canopies, installation is made easier through the availability of kits containing all the components required for the job. All components are pre-engineered for fit and finish to help ensure consistent visual quality. They also allow faster and easier installation since the system requires no field modification and only assembly.

Assistance available

The increasing popularity of perforated metal ceiling systems for sound control has resulted in the need for more collaboration between specifiers and ceiling manufacturers, especially in the case of custom installations.

To meet this need, some manufacturers offer a consultative design service including project management for the ceiling system, from concept to completion. The team is comprised of specialists with expertise in both architecture and engineering whose sole mission is to partner with architects and designers in the implementation of signature ceilings. There are also a myriad of tools and custom reports available to determine the proper acoustical treatments needed when specifying metal ceilings for a specific space. **CS**

Notes

[1] For more information, read "Acoustical Uses for Perforated Metals: Principles and Applications" by Theodore J. Schultz, PhD, at www.iperf.org.

[2] Visit www.iperf.org/files/9013/9266/7856/IPA_Riverbank_Handbook.pdf.

ADDITIONAL **INFORMATION**

Author

Sean D. Browne is the principal scientist for Armstrong Ceiling & Wall Solutions in Lancaster, Pennsylvania, where he leads the Armstrong acoustics program. A member of the Acoustical Society of America (ASA) and ASTM, Browne has engineering degrees from Florida State University and the University of Miami, and has been published in the journals of the International Symposium on Room Acoustics (ISRA) and Acoustical Society of America (ASA). He can be reached at sdbrowne@armstrongceilings.com.

Abstract

Specifiers who choose acoustical ceiling systems in commercial applications are now discovering what the ceilings industry has observed for quite some time: the growing use and popularity of metal ceiling systems. One of the main reasons for their popularity is the sleek, upscale, high-tech look metal brings to a space. Metal ceilings can also provide very effective acoustical control in addition to their eye-catching aesthetics, making them a versatile and functional design element. In order to obtain the acoustic benefits, however, the panels must be perforated and backed with a sound-absorbent liner.

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Metal ceiling
Perforated panels
Sound absorption

Rejuvenation of Suspended Ceilings

by Steven H. Miller, CDT, and Michael Chusid, RA, FCSI, CDT

Photo courtesy Foundry Commercial

THE CEILING IS THE MOST VISIBLE SURFACE IN MOST ROOMS, THE LEAST OBSTRUCTED OF THE HORIZONTAL AND VERTICAL BOUNDING PLANES. INEVITABLY, AESTHETICS IS ONE OF THE CEILING'S MAJOR FUNCTIONS. THE MOST COMMON TYPE OF SUSPENDED CEILING IN NON-RESIDENTIAL BUILDINGS HAVE A T-BAR CEILING SUSPENSION SYSTEM OR GRID WITH LAY-IN CEILING PANELS. COMMERCIAL-GRADES OF THESE PRODUCTS TEND TO BE DURABLE IN TERMS OF SERVICEABILITY, BUT AESTHETIC FUNCTION IS PRONE TO PREMATURE FAILURE. TO PUT IT ANOTHER WAY, MANY CEILINGS UGLY OUT BEFORE THEY WEAR OUT.

The impetus for rejuvenation varies. The ceiling's visual condition may simply have fallen below a level that is acceptable to the owner or occupant. Remodeling of other aspects of a space can raise the question, "What should we do about the ceiling?"

The COVID-19 pandemic is prompting other changes that may affect ceilings. Businesses are taking a fresh look at their premises to see if they are clean and hygienic. Property owners and their design consultants may have to remediate deficiencies in their buildings, remodel to accommodate changes in workflow or occupant spacing, or replace mechanical systems for improved ventilation—these changes can occasion a reconsideration of the ceiling's condition, as well.

Rejuvenation-triggering problems can include a T-bar grid that is yellowed, stained, rusted, and, in more extreme circumstances, bent or damaged. Ceiling panels and tiles are even more vulnerable to discoloration and stains, and some are prone to physical damage. For example, absorbent panel materials that have been exposed to moisture can develop "water stains" that may actually be colonies of mold or bacteria.

Can a ceiling be rejuvenated? Is it worth the cost? Or should it be removed and replaced with new materials? Answers to these questions depend on the degree of damage and the demands of the occupant.

On the grid

Of the two major components of a suspended ceiling—the T-bar grid versus the panels populating it—the former is usually more durable. In most instances, grid can be renewed by cleaning, repainting, or applying cover strips; replacement is only required if it has significant damage or the function of the ceiling has changed.

Before undertaking any substantive modifications to the ceiling, it is advisable to verify that the suspension system is adequate for the proposed work. For instance, when the authors looked above the suspended ceiling of an office they had rented, they discovered abandoned ductwork had been lowered and was dangerously resting on the grid. In another violation of safety requirements, heavy fluorescent troffers had not been secured independently to the structure above and were imposing load on the grid.

Grids are commonly made of light-gage steel, but may also be aluminum, plastic, or pultruded fiberglass. Assuming the suspension system was installed properly to begin with, it should provide years of serviceability under normal conditions. Heavy use, misuse, or abuse can induce sagging or misalignment of tees, or damage to the suspension wires supporting the grid.

The original ceiling panels at OC Recording Company (left) emitted a bad odor and were falling apart and filling the air with dust and fibers, according to the owner of the Santa Ana (California)-based studio. He said that the replacement ceiling panels (right) improved the appearance, air quality, and acoustics of the space and he has, ''noticed a lot less dust on my desk.''

Photos courtesy OC Recording Company

These painted metal ceiling panels can be rejuvenated by wiping with a degreasing cleaning agent. However, the non-woven acoustic fabric behind the perforations may have to be replaced since grime attached to the fabric is more difficult to remove and may also interfere with noise reduction.

Photos courtesy Ceilume

Suspension systems are particularly apt to be damaged during above-ceiling work, by impact from moving objects, and though improper use of the grid to support items beneath the ceiling.

The grid's appearance can be less enduring. Painted coatings are prone to fade or yellow. Steel T-bar can rust, despite a thin galvanized coating, especially if it has been scratched through to the underlying steel or is located in a humid or chemically aggressive environment. Grid may also get stained or discolored by indoor air contamination, ordinary dust and grime, sprayed particles, splashed liquids, airborne grease, smoke, and handling with dirty hands. Grid that no longer matches the color adjacent ceiling panels can draw attention to the deteriorated appearance of a ceiling. The appearance will be particularly jarring if dirty grid is juxtaposed against new panels.

Cleaning the grid

In many cases, simple cleaning may be all that is required. Prior to cleaning the grid, adjacent ceiling panels, wall finishes, and anything beneath the ceiling may have to be protected, depending on the messiness of the cleaning procedure and how damage-resistant the adjacent materials are.

Lightly attached dust or dirt may be wiped or vacuumed off. Soiling that is stuck to the surface requires washing. Common household or janitorial cleaning products will usually do the job; always test in an inconspicuous location on grid before applying any cleanser broadly.

If ceiling panels are in-situ then, consideration must also be given to how the proposed cleaning technique will affect panels. Some types of ceiling panels can be damaged by liquid cleaning products and even gentle brushing or vacuuming can cause erosion of fibers. It may be necessary to remove or

mask such panels to protect them—both are labor-intensive processes that can also dislodge fibers and dust.

Grid refinishing

For grids that cannot be cleaned adequately, refinishing may be an option. Grids can be refinished either by painting or by covering with a refinishing strip. Before repainting, the grid must be cleaned thoroughly to remove contaminants. Any rust must be removed and priming may be required. Some paint manufacturers recommend sanding existing gloss and semi-gloss coatings before repainting. Adjacent ceiling panels, especially fragile or porous panels would have to be masked or removed.

Grid covers may be a more cost-effective choice when labor is included in the calculation. Available options include adhered strips and plastic covers that slide over the bottom flanges of standard T-bars and perimeter angles. Adhesive types require grid to be thoroughly cleaned, and they must be pressed firmly into place to assure adhesion. Slide-on covers require less labor; they can be applied without removing adjacent panels and are easy to install without special training or tools. Grid covers are available in white and colors that match or are compatible with popular panel colors and faux finishes.

Panel discussion

Ceiling panels comprise the majority of a ceiling's surface and present most of its aesthetic failures. Their surface may be discolored or soiled by many of the same processes affecting the appearance of grid. In addition, panels with textures, fissures, perforations, or crevices have more surface area that can harbor contaminants. Porous types of panels can emit odors, absorb stains, and support mold and mildew if exposed to moisture. Painted metal panels are subject to the same types of failures as metal grid is. Black or gray streaks are often seen surrounding HVAC diffusers, when particulates in the ventilation stream collect in the immediate area due to the Coandă effect (*i.e.* the tendency of a fluid jet to stay attached to adjacent surfaces).

Liquid staining agents can come from either below or above the ceiling. Splashed liquids from below are essentially surface stains that may be cleanable, depending on the absorbency of the ceiling material. Liquids from above—usually water from leaks or condensation—can enter absorbent materials and cause stains that go through the entire thickness of the ceiling product. Leaks often carry dirt or other contaminants picked up on their journey to and through the ceiling panels.

> Damaged, dirty, and stained ceiling panels can be removed and replaced, and discolored suspension grid could be cleaned and repainted. In some circumstances, it may be expedient to cover the old materials with refacing panels and slide-on grid covers.

> Dust, soot, grease, and other schmutz can accumulate around air diffusers due to the Coandă effect. Panels with textures and tegular edges provide additional surface area to trap contaminants and make cleaning more challenging.

In the case of 'water stains,' no form of cleaning or refinishing can be expected to last long if the source of water is unaddressed. Fixing leaks or remediating condensation should be the first step before any other options are tested.

Panel surfaces can also be physically damaged by impacts. Some frangible ceiling materials suffer edge and corner damage simply through routine handling. This can cause fibers to slough off, potentially causing skin and respiratory irritation.

Panel cleaning

Dusting or vacuuming will often remove loose or lightly adhered dust and dirt from ceiling materials. Vacuuming may be more effective on panels with crevices, as it can remove dust lodged below the surface. A major manufacturer of mineral fiber panels recommends vacuuming as a primary method, with a caution related to the textured surface of the product: "Care must be taken while vacuuming to avoid excessive pressure. Use a blotting action to minimize potential loss of surface texture."

More severe grime and stains may require some sort of liquid cleaning agent. Washable products like metal or thermoformed vinyl panels can often be cleaned in place with a damp cloth or sponge. If necessary, they can be removed from the grid and washed with soap and water or other mild cleansers.

Most mineral fiber panels cannot be exposed to bulk liquids, including cleansers, without damage. Some types,

however, have coatings or membranes that allow a greater degree of cleaning and stain resistance. Manufacturers suggest light wiping with a sponge or cloth dampened with mild detergent. Few mineral fiber products, however, can actually be washed. Many thermoformed and metal ceiling panels, in contrast, are comparatively stain resistant and robust and can be washed without damage.

In all cases, manufacturer's instructions for the specific product should be consulted to determine what type and degree of cleaning is allowable. Manufacturers should also be asked for clarification of vague marketing terms, such as "cleanable" or "scrubbable," made without reference to standards or quantifiable test results.

Professional cleaning services may have access to cleaning methods and materials that are unavailable to typical maintenance crews (See "Cleaning Services and Proprietary Methods," page 21).

Panel refinishing

There are limitations on panel refinishing options pertaining to the ceiling's performance requirements. Painting panels may alter the flame spread and smoke development properties of the ceiling and invalidate the results of product test data. Manufacturers of most types of ceiling panels say painting voids their warranties.

Mineral fiber panels often have surface crevices or fissures that are crucial to the panel's acoustic control performance. If the perforations get filled with paint, noise reduction coefficients (NRC) drop significantly. A leading mineral fiber panel manufacturer offers recommendations for painting even though it voids the warranty. They include the caution, "the painter should be very careful that he does not close up the acoustical surfaces," and say, "at minimum, repainting will result in a .05 to .10 reduction in NRC." Repeated painting is likely to cause an even more precipitous drop in noise reduction.

Small, discreet stains on mineral fiber panels can be touched-up by spot-painting and have minimal impact on acoustics. There are paints in aerosol spray cans with upward-pointing nozzles available on the consumer market for precisely this application. The ability of these paints to suppress a specific stain, and to match the color of an existing panel, can only be determined by field testing.

Water leaking through the floor deck above this ceiling leached dirt and contaminants that stained these back-illuminated thermoformed panels. The panels could be readily cleaned because they are stain resistant, impervious to water, and washable.

CLEANING SERVICES AND PROPRIETARY METHODS

Building owners often contract with independent janitorial or cleaning services to maintain ceilings. These firms have the ladders and lifts that may be necessary to reach high ceilings, drop cloths to cover furnishings and equipment, and special equipment such as vacuum cleaners with extra-long wands or that can be worn on the back.

Thermoformed and metal panels can usually be cleaned as described in the main article. However, the services may be able to provide a variety of proprietary methods to clean grids and panels without removing panels from the ceiling.

One formula for treating mineral fiber panel, is a spray-applied liquid that is said to encapsulate contaminants in droplets that fall to the floor where, presumably, they are vacuumed. Panels are then allowed to dry. Since this is only successful to varying degrees, the standard procedure of the company offering this formula is to use a test panel to determine the optimum cleaning mixture, treat the test panel, and then ask the customer if it is clean enough.

According to one of their service providers, this cleaning method is intended to be cosmetic and is not offered as a form of sanitization. Stains that are associated with water damage are acknowledged to be difficult to remove adequately. If the stains are, in fact, mold, panels should be treated or replaced. According to the service provider, “If [the stains are] coming from above and you have water damage, those tiles are damaged in themselves. You would have to remove all those tiles to properly treat every single one. To treat a tile is probably a lot more expensive than to replace a tile.”

If panels cannot be cleaned satisfactorily, the service offers a recoating application that they claim does not void the panel manufacturers’ warranties or violate fire codes. Such claims should be verified with the product manufacturers and authorities having jurisdiction. The service provider describes the recoat as “not paint-based, or in any way much like a paint. It is almost like a spray powder.” If applied with a specific spray nozzle and pressure, the application is said to not accumulate in the acoustic fissures in the panels, and to not stick the panels to the grid. **CS**

Porous ceiling panels can be damaged by water from leaks, spills, cleaning solutions, and condensation from chilled pipes and equipment and thermal short circuits through the building envelope. Discoloration is caused by contaminants in the water and by colonies of microorganisms feeding on starch and other organic materials in panels. Cleaning is not practical since stains penetrate the surface.

If painting perforated vinyl or metal panels, do not allow paint to bridge small openings as this will decrease acoustical performance. Care should also be taken to avoid painting any acoustical insulation or backing that is visible through the perforations.

Panel replacement

Ceiling panels that cannot be cleaned or refinished acceptably will have to be replaced. If replacing an entire ceiling, considerations about what type of replacement panels to use is similar to the decision-making process used in new construction.[1]

If most of the existing ceiling is still relatively new and only a small percentage of panels are discolored or damaged, spot replacements may be the best option. The specifier will have to determine whether replacements will blend with the remaining panels, and develop a process (such as unit pricing) for indicating which ones need replacing.

Consideration should be given to life-cycle costs and whether existing panels should be replaced in-kind or with something more durable and sustainable. If 25 percent of the ceiling needs to be replaced every four years, then the entire ceiling is theoretically replaced in 16 years, in addition to cleaning costs over the interim period. A more sophisticated analysis makes clear that spot replacement becomes less acceptable with time because newer panels will increasingly

contrast with old ones and accelerate the need to replace the complete ceiling. It could be more cost effective to replace the entire ceiling at once with a material that will last 20 years or more, and be less expensive to clean over that period.

Environmental impact should be factored into a replacement decision. A major manufacturer of mineral fiber products recycles panels. However, they may not be recyclable if painted, wet, or moldy (often the condition of panels that need to get replaced), and they must be stacked and palletized.

High-quality vinyl and metal panels are often recyclable without degradation in their material properties. Small quantities of installation scrap can generally be recycled into local material recovering streams, and one maker of thermoformed panels has a take-back program to recycle retired vinyl panels.

Another option avoids, for the time being at least, concerns about recycling decrepit panels. Panels are available that can be used to reface a ceiling; the thin thermoformed panels are installed beneath existing ceiling panels. Combined with slide-on grid coverings, it may be one of the most expedient ways to rejuvenate a ceiling.

Replacement products need to match the fire-safety performance of originals. In this regard, it is important to note some mineral fiber panels are fire-resistance rated, and some thermoformed panels are tested and approved for use as drop-out panels beneath fire sprinklers.

Conclusion

Ceilings are subject to soiling and damage despite being out of reach of most occupants. Due to their exposure, visual degradation may make a ceiling unacceptable even though it is still functional. For ceilings needing frequent cleaning or rejuvenation, it is worthwhile to determine whether replacement or refacing is more cost-effective than restorative treatments. If spot replacement happens often, then complete replacement with more durable and easy-to-clean materials may be a better choice.

Ceilings can become dirty or disfigured during construction due to improper handling, leaks, and damage, so this discussion about rejuvenating ceilings is also applicable to final cleaning of newly constructed or remodeled spaces prior to being turned over to building owners. Full appreciation of durability and maintainability should be part of the product selection process during design and specification. **CS**

Note

[1] Read the article, "Breaking Habits: A Rational Approach to Ceiling Product Evaluation," published in the March 2020 issue of The Construction Specifier.

ADDITIONAL **INFORMATION**

Authors

Michael Chusid, RA, FCSI, is a frequent contributor to *The Construction Specifier*, and a consultant to building product manufacturers. He can be reached at www.chusid.com.

Steven H. Miller, CDT, is a freelance journalist and consultant specializing in the construction industry. He can be reached at steve@metaphorce.com.

Key Takeaways

The ceiling is the most visible surface in most rooms. Inevitably, aesthetics is one of the ceiling's major functions. The most common type of suspended ceiling in non-residential buildings has a T-bar ceiling suspension system or grid with lay-in ceiling panels. Commercial-grades of these products tend to be durable in terms of serviceability, however the aesthetic function is prone to premature failure. To put it another way, many ceilings ugly out long before they wear out.

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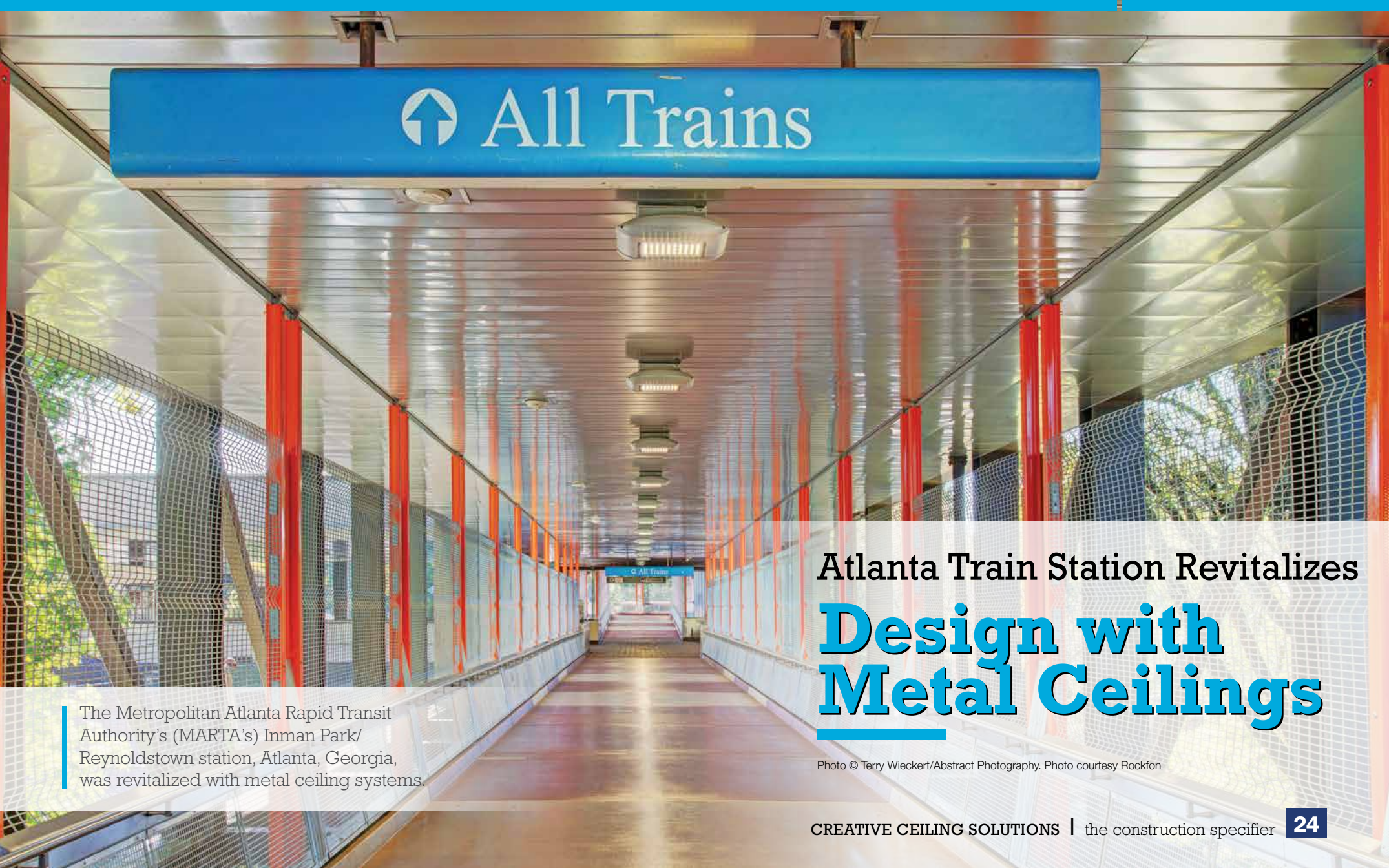

Atlanta Train Station Revitalizes

Design with Metal Ceilings

The Metropolitan Atlanta Rapid Transit Authority's (MARTA's) Inman Park/ Reynoldstown station, Atlanta, Georgia, was revitalized with metal ceiling systems.

Photo © Terry Wieckert/Abstract Photography. Photo courtesy Rockfon

THE METROPOLITAN ATLANTA RAPID TRANSIT AUTHORITY'S (MARTA'S) INMAN PARK/REYNOLDSTOWN STATION, ATLANTA, GEORGIA, SERVES APPROXIMATELY 3000 PEOPLE DAILY. WHEN THE NEIGHBORHOOD STATION ORIGINALLY OPENED IN 1979, ITS PEDESTRIAN BRIDGES AND WALKWAYS FEATURED METAL CEILING SYSTEMS. AFTER 40 YEARS OF CONTINUOUS USE, THE STATION WAS READY FOR AN UPDATE. BASED ON THE CEILING'S RELIABLE PERFORMANCE, MARTA ONCE AGAIN SELECTED METAL CEILING SYSTEMS AS THE BASIS OF DESIGN FOR THE STATION'S RENOVATION.

MARTA provided architectural direction on the 2323-m^2 (25,000-sf) station's $6.9-million rehabilitation, renovation, enhancement, and expansion project. MARTA worked closely with Reeves Young as the general contractor and Acousti Engineering Company as the ceiling installing contractor. The manufacturing company provided additional support, helping MARTA with design fulfillment and Acousti with the custom fabrication and installation logistics.

Lasting performance

After evaluating the Inman Park/Reynoldstown station for structural integrity, the original metallic ceiling suspension systems received approval to remain in place with additional reinforcing as part of the station's renovation.

Acousti's structural reinforcement and down bracing should allow the ceiling suspension system to outperform almost any imaginable future need. It is very impressive"

"Acousti's structural reinforcement and down bracing should allow the ceiling suspension system to outperform almost any imaginable future need. It is very impressive," a representative from the manufacturing company said.

Wind load tests also confirmed the metal ceiling systems meet the frequent pressure peaks caused by the MARTA and CSX trains' arrivals and departures.

Since the metal ceiling system extends across both exterior and interior spaces, it also was tested to meet the project's air and water performance requirements for Atlanta's warm, humid climate.

Metal does not absorb moisture and does not support the growth of mold, mildew, or other potentially harmful microorganisms. The metal ceilings are low maintenance and fully recyclable at the end of their use on the station.

Improved appearance

To improve the station's aging appearance, Acousti removed and recycled the old metal ceiling panels, and installed the new systems: linear metal planks in 102-, 152-, and 203-in. (4-, 6-, and 8-in.) widths; snap-in metal ceiling panels in 457-x-610-, 610-x-610-, and 254-x-254-mm (18-x-24-, 24-x-24-, and 10-x-10-in.) dimensions; and perimeter trim in 102- and 305-mm (12-in.) heights.

"Using two systems, factory-finished in satin silver and winchester gray, perforated and non-perforated panels, and multiple sizes, we were able to combine standard design elements for a high-end look without a high-end cost," the representative said. "The variety of color, sizes, and shapes helps break up the long corridors and offer visual cues to passengers."

Positive impact

The ceiling systems enhance the station's performance, appearance, and sustainability, and the integral fixtures support MARTA's safety and energy efficiency goals.

Minimizing disruption to the passengers at Inman Park/Reynoldstown station, Acousti carefully managed its work while the station remained in use throughout the renovation. Work began in December 2018 and was completed on time and within budget for the April 2019 re-opening celebration at the Inman Park Festival. **CS**

The Noble Public School, Oklahoma, used aluminum ceiling panels on its fine arts auditorium and gymnasium to meet the design, budget, and acoustical goals of the multipurpose space.

Acoustic Ceilings are a Slam Dunk for

Oklahoma School's Multipurpose Space

Photo © Simon Hurst Photography. Photo courtesy of Rockfon

OKLAHOMA'S NOBLE PUBLIC SCHOOL'S FINE ARTS AUDITORIUM AND GYMNASIUM SERVES 2860 STUDENTS IN ITS DISTRICT. WITH A PLAYFUL NOD TO THE SCHOOL'S BEAR MASCOT, THE FACILITY WAS DUBBED 'THE DEN' AND OPENED FOR THE 2019-20 ACADEMIC YEAR. ALUMINUM CEILING PANELS WERE UTILIZED TO MEET THE DESIGN, BUDGET, AND ACOUSTICAL GOALS OF THE MULTIPURPOSE SPACE.

The metal ceiling panels can achieve up to 0.90 noise reduction coefficient (NRC), and stone wool can meet specifications of 0.95 NRC and higher.

The old auditorium was built in 1950 and seated less than 400 people, which required the school district to outsource some of their fine arts programs to other locations.

Similarly, the former high school gym was not large enough to host competitive tournaments. Investing in facility improvements across the school district, a 2017 bond allocated more than half of its total to fund the Den's $19-million design and construction.

Respecting the district's goals and budget, TAP Architecture envisioned a multipurpose, two-story, 4645-m^2 (50,000-sf), single structure. This plan was considered an economical option compared to building separate facilities for a performing arts center as well as a basketball gym.

Optimizing acoustics for the wide range of activities planned within the auditorium required thoughtful design and high-performance materials. Forming the 17 clouds above the performing arts' audience seating area, lay-in aluminum ceiling panels were acoustically improved with a backer. This solution provides the absorption required for speech intelligibility and to make band music clear and comfortable to hear.

Complementing the ceiling clouds' high performance, their cherry woodgrain finish presents a refined aesthetic with durability. Sturdy, extruded aluminum perimeter trim is finished to match in cherry, neatly framing the ceiling clouds.

The metal ceiling panels can achieve up to 0.90 noise reduction coefficient (NRC), and stone wool can meet specifications of 0.95 NRC and higher. This high level of sound absorption decreases reverberation and improves speech intelligibility for group communication. Using ceiling products with higher NRC ratings also can help with cost savings because fewer sound-absorbing products need to be installed to reach the goal amount of absorption in the room.

Reviewing the many variables, building materials, and interior finishes, the project's design progressed through 2018. In January 2019, the selected ceiling systems were shipped to Oklahoma. Lasco Acoustics & Drywall, Inc., installed nearly 975 m^2 (10,500 sf) of acoustic stone wool; more than 288 m^2 (3100 sf) of metal ceiling panels; plus 887 linear feet of metal perimeter trim.

Minimizing maintenance, the metal and stone wool ceiling systems are simple to clean. They also resist moisture, mold, and other microorganisms. All of the stone wool panels installed in the Den are GreenGuard Gold certified for low-emissivity (low-e) products. Products earning this certification are recognized by the Collaborative for High Performance Schools and other organizations as supporting healthy indoor air quality (IAQ).

Above the common areas on the upper level, an additional 23 ceiling clouds are composed with acoustic stone wool panels and perimeter trim finished in silver satin. Immediately surrounding the stage, stone wool panels were installed within Chicago metallic exposed acoustical suspension system. The stone wool panels were also used on the lower level's offices, lounge, hallways, and gymnasium locker rooms.

The Den's new gym more than doubles the capacity of the former space. Configured as a basketball court, approximately 1500 people can be seated in the new venue. **CS**

Acoustic Ceilings Help Washington Spy Museum

Create Essence of Espionage

The International Spy Museum, Washington, D.C., blends acoustics and color to enhance the visitor experience.

Photo © Nic Lehoux. Photo courtesy Rockfon

THE INTERNATIONAL SPY MUSEUM IN WASHINGTON, D.C., WAS DESIGNED AND CONSTRUCTED TO CAPTURE THE ESSENCE OF ESPIONAGE, SECRECY, AND INTRIGUE. ACOUSTICAL CEILING TILES HELPED CONTRIBUTE TO THE INTENSIVE, QUIET, AND FOCUSED FEELING PERMEATING THE SPACE.

Designed by London-based architect Rogers Stirk Harbour + Partners in collaboration with Hickok Cole of Washington, D.C., the 13,006-m^2 (140,000-sf) building is recognizable for its look. The building's exterior features sloped columns, a backlighted, folded metal panel skin, and a pleated glass veil—all emphasizing the museum's theme of "hiding in plain sight."

The theme continues into the building's eight-floor interior. Sustainable goals also guided the building's design and construction and helped it earn the Leadership in Energy and Environmental Design (LEED) Silver certification. The purpose-built nonprofit museum facility more than doubled the space of the previous location's education and programming area. Above the two-story lobby and retail area and the three floors of exhibition and theater space are two floors of set-back event space and a rooftop terrace.

Sound-absorbing, acoustic stone wool ceiling panels were installed in the building's two-story lobby, corridors, bathrooms, designated galleries, and the event space. The ceiling panels offer a noise reduction coefficient (NRC) of 0.85 or higher.

In the hallways, ceiling tiles with smooth, white surfaces reflect 86 percent of available light, and provide high sound absorption (NRC = 0.90). In the restrooms, cleanable acoustical ceiling tiles also offer a cleanable surface with good sound absorption (NRC = 0.85).

Sound-absorbing, acoustic stone wool ceiling panels were installed in the building's two-story lobby, corridors, bathrooms, designated galleries, and the event space. The ceiling panels offer a noise reduction coefficient (NRC) of 0.85 or higher

With an NRC of up to 0.90, 0.6 x 2.4-m (2 x 8-ft) anthracite panels were selected for the lobby and 0.3 x 1.5-m (1 x 5-ft) concrete panels for the gallery and event space.

All of these stone wool ceiling panels offer high fire performance and have earned Greenguard Gold certification for low volatile organic compound (VOC) emission. Stone wool's natural properties for resisting moisture and humidity also are key attributes in museum installations with sensitive climate-controlled protection.

Clark Construction Group, LLC, from Bethesda, Maryland, was the general contractor on the project. Jaffe Holden from Norwalk, Connecticut, was the acoustic consultant. The installing contractor was CJ Coakley Co., Inc. from Falls Church, Virginia. **CS**

Philadelphia Library Creates Warm, Inviting Space with Wood

At the Charles Library, located at Temple University's main campus in Philadelphia, Pennsylvania, the design team used western red cedar to impart a warm, inviting, natural look.

Photo courtesy Armstrong Ceiling & Wall Solutions

LOCATED AT THE NEXUS OF TEMPLE UNIVERSITY'S MAIN CAMPUS IN PHILADELPHIA, PENNSYLVANIA, THE 20,439-M^2 (220,000 SF) CHARLES LIBRARY SERVES AS A CENTRAL POINT OF INTERSECTION BETWEEN STUDENTS, FACULTY, STAFF, AND THE SURROUNDING COMMUNITY.

"An early goal of the Charles Library design was for it to be an organizing element and a way to pull students to the library from multiple parts of the campus," said Chad Carpenter, SnøhettaSnøhettatect. "We wanted the physical space of the library to be a collector and a warm, comforting place that everybody would understand as the center of campus."

To impart the warm, inviting, natural look it desired, the design team chose custom wood panelized linear ceiling and wall systems. Between the exterior and interior ceiling and wall applications, over 4645-m^2 (50,000 sf) of western red cedar panels were installed.

Western red cedar was also chosen because of its inherent flexibility.

"Western red cedar has three qualities that made a big difference in the domes," said Carpenter. "It is suitable for use outside, so the inside and outside can be the same wood. It is flexible, so it is not particularly hard to bend, and it has an incredible variation in color tone."

Three arched entrances lined with linear western red cedar panels extend into the lobby from the exterior and form a three-story domed atrium featuring a variety of curves and intersections. The central dome in the atrium features a curved oculus that allows light to filter into the lobby from the uppermost floor.

The unique geometry that characterizes each of the domes was achieved by gently bending the wood panels and installing them in a custom curved framing system.

"The primary dome is a revolved ellipsoid, which allowed it to be made out of a limited number of different panels," said Carpenter.

An early goal of the Charles Library design was for it to be an organizing element and a way to pull students to the library from multiple parts of the campus

"The rest of the system was made out of single-curvature geometries, which allowed them to be made using the same shaped panel."

The oculus is the only area of the ceiling where the panels are not bent.

"The oculus is the place where the curvature is the tightest in one direction but the planks themselves are all straight," said Carpenter. "The curvature is only in the backer."

The installation of the oculus was very complex and required a high level of skill on the part of the ceiling contractor.

"If you were to point to a place where the contractor really leaned into the craft for that particular product, it would be right there," said Carpenter. "It looks really great."

According to Carpenter, the key to the clarity of the overall ceiling design was the precision of the panel manufacturing process and the digital coordination with the framing contractor.

"A precisely made panel and careful coordination between ceiling fabricator, ceiling contractor, framing contractor, and design model were all vital," said Carpenter. **CS**