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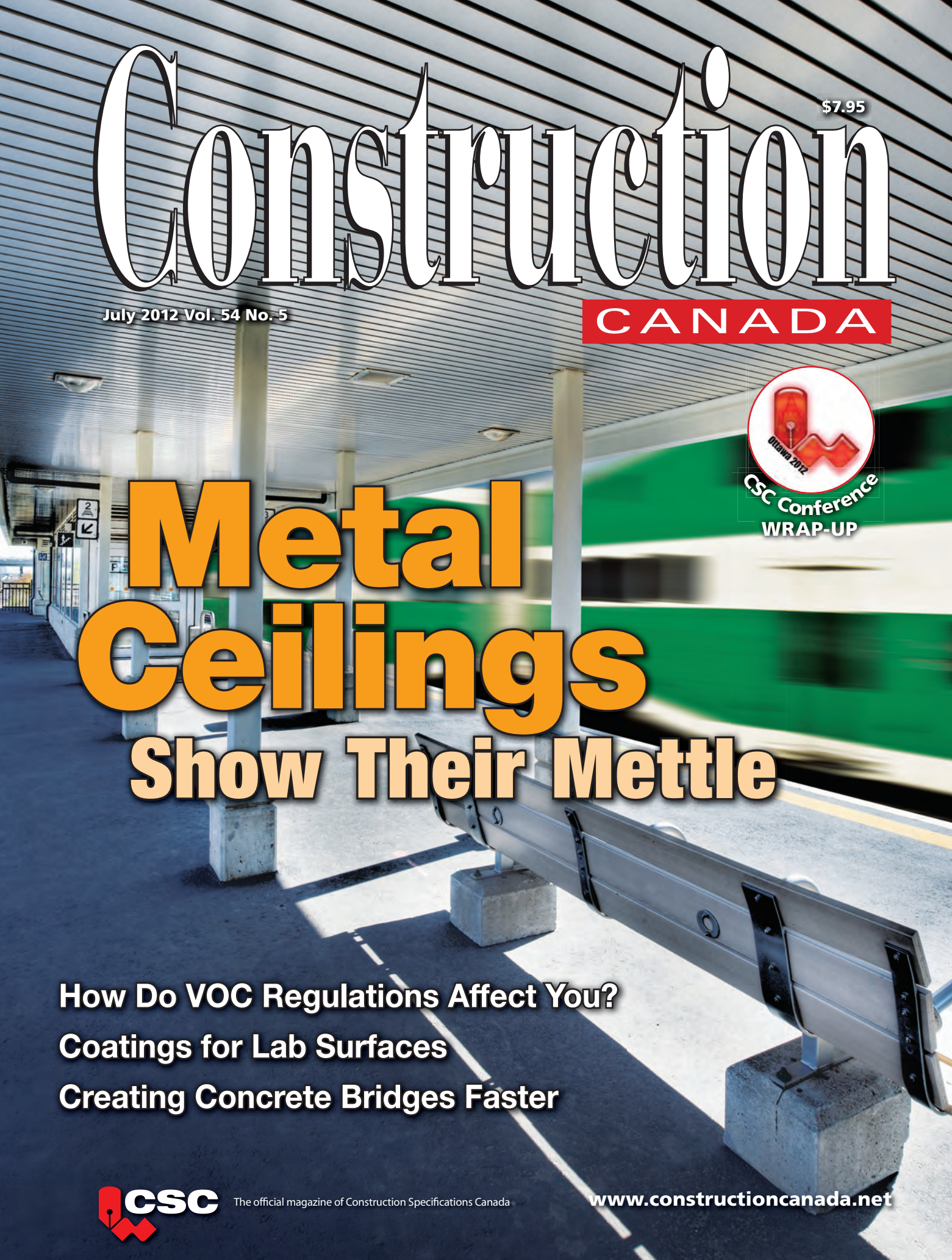

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Cover Story

Metal's Winning Ceilings

Photo © Bochsler Creative Solutions, Burlington, Ont.
Photo courtesy Chicago Metallic Corp.

By Edward Williams

Metal ceiling systems are gaining popularity in commercial ceiling markets because they not only conceal, but also attract attention with dramatic designs and decorative flourishes. The systems meet rigorous performance requirements for acoustics, wind loads, humidity, fire, earthquakes, and sustainability; they also provide access to mechanical systems and low-maintenance reliability.

Many contractors appreciate these cost-competitive systems and their ease of installation, contributing to labour savings and on-time completion. Architects and designers enjoy the creative potential and customization. Specifiers, meanwhile, are challenged to balance all the features and benefits to determine the optimal system.

A brief history

In 16th century Europe, decorative ceilings began appearing with plaster coated over structural framework. Considered to be a cost-prohibitive luxury, they were reserved for wealthy estates and public buildings. Reflecting the grandeur of these prestigious spaces, plaster ceilings evolved into a decorative art form. Even apprentice plasterers were taught how to design and craft cornices, rosette, and other details. Artisan plasterers excelled at intricate ornamentation.

Pressed metal ceilings, known as 'tin ceilings,' were introduced in the second half of the 19th century as an affordable alternative to artistic plaster. Tin ceiling panels and accessories could be mass-produced at a fraction of the cost, and installed in a fraction of the time, compared to plaster. Similar to plaster, cornices were used to finish the perimeter of the tin ceiling-to-wall transitions.

Many historic tin ceiling patterns are still available.[1] These original ceilings were the 'nail-up' variety, meaning they were installed with nails over wooden furring strips. This method is used today, but a 'lay-in' style also was developed to interface with ceiling suspension systems. Typically, pressed metal ceilings offer no acoustical absorption. Some manufacturers now provide patterns with perforations to address this issue.

Office space designers in the 1950s were inspired to use lay-in metal panels as 'drop' ceilings. This became the preferred method for concealing HVAC, power, and signal distribution equipment. The drop ceiling is characterized by a grid suspension system of metal 'tees' with acoustical panels placed within the system modules. Along with the acoustical panels, the ceiling suspension became the support for air diffusers, lights, and other devices.

Metal panel ceilings

Designers quickly learned the advantages of substituting metal panels for soft mineral board panels and fibreglass panels in the lay-in systems. Metal ceilings proved to be more durable in public areas than 'soft' panel ceilings. Today, the lifespan of a properly maintained metal ceiling is five to six times the longevity of cellulose-based ceiling panels.

Contributing to the long life of metal ceiling panels is the fact they do not

absorb water like mineral-fibre ceiling panels can. Absorbed water may lead to the growth of unwanted mould and mildew, factors in sick building syndrome (SBS). In some regions, where high humidity is unavoidable, excess moisture may lead to sagging in mineral-fibre panels. This can be critical for healthcare facilities, food-processing centres, laboratories, and other places where wellness and cleanliness are essential.

Metal ceiling systems also can provide a high level of acoustical absorption using perforation and acoustical material behind the panels. When using perforations, it is advisable to include a border around them. This prevents bending the panel edge where a row of perforations occurs. Metal panels can be manufactured with square edges to lay-in to a grid, or they can have reveal edges for a more decorative look.

Metal ceilings offer designers other esthetic advantages as the variety of finishes is greater than with white, acoustical mineral board. Like these 'soft' systems, metal ceiling systems also can be installed in pods or clouds.

A variation to the lay-in system is the 'snap-up.' This system hides the suspension grid, provides very tight joints, and can offer a high degree of security. Like lay-in panels, snap-up metal panels can be perforated for acoustics. Perforated panels can be manufactured with holes so small as to appear solid, or can incorporate variable-sized holes to create:

- patterns in geometric shapes;
- directional wayfinding signage;
- logos and illustrated team mascots; and
- photographs.

The strength of snap-up systems and their metal panels makes them a reliable choice for challenging interior designs, as well as exterior applications. When used outside the building, it is highly recommend a wind load test report be requested. Exterior wind load requirements are dictated by local code.

Photos courtesy Chicago Metallic Corp.

Many historic tin ceiling patterns are still available. These original ceilings were the 'nail-up' variety, meaning they were installed with nails over wooden furring strips. This method is used today, but a 'lay-in' style also was developed to interface with ceiling suspension systems.

Many manufacturers have data available for positive wind-load testing. To truly evaluate the ceiling system's performance, specifiers should request the manufacturer's proprietary test data for both positive and negative wind loads. This will reveal how the product performs in sustained and reoccurring winds, such as in coastal regions or mountain ranges. These same considerations must be given to certain other applications such as subway stations, tunnels, and passageways between buildings.

Standards

Raw materials

- ASTM B209, *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.*

Performance

- ASTM C423, *Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method*; and
- ASTM C635, *Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.*

Safety

- ASTM E84, *Standard Test Method for Surface-burning Characteristics of Building Materials;* and
- Underwriters Laboratories (UL) 580, *Tests for Uplift Resistance of Roof Assemblies.*

Installation

- ASTM E580, *Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions*;
- ASTM E795, *Standard Practices for Mounting Test Specimens During Sound Absorption Test*;
- ASTM E1477, *Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers*; and
- ASTM C636, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.*

For more, see the Ceilings and Interiors Systems Construction Association's (CISCA's) *Metal Ceilings Technical Guidelines*, which is available at www.cisca.org/i4a/pages/index.cfm?pageid=3281.

Design considerations

When designing with metal ceiling panels, there are additional factors to take into account. The most common—and least expensive—sizes are 2 x 2 ft and 2 x 4 ft. In Canada, it is important to remember there can be a difference between 'hard' and 'soft metric.' In other words, a standard 2 x 2-ft Imperial-sized panel may be provided as a soft metric 610 x 610-mm panel. However, a hard metric panel may be 600 x 600 mm in size. If the contractor orders Imperial-sized lighting fixtures and air diffusers, they will not fit into the metric-sized modules. Someone in the process has to check to see what modules are designed for the ceiling.

Another consideration involves the suspension system (*i.e.* lay-in or snap-up), which is selected for esthetics, maintenance, and possible security requirements. In some areas, seismic-rated suspension may be necessary. During January through April 2012, six provinces and territories recorded earthquakes. The largest magnitude events this year have occurred near Vancouver Island. Designers of ceilings in buildings in the Territories and along the southeastern border are advised to keep earthquakes in mind.

Solid or perforated panels can be an esthetic decision, but most often involves acoustic issues. Solid panels with no perforations offer no acoustical absorption; they reflect sound. Generally, a perforated panel with a non-woven backer will absorb 65 per cent of the sound striking it. This can be expressed as a noise reduction coefficient (NRC) of 0.65. That same perforated panel with an encapsulated fibreglass pad, in lieu of the non-woven one, absorbs about 90 per cent of the sound striking it, for a 0.9 NRC. The perforation pattern and resulting open area are the biggest factors in achieving this. To put this in perspective, standard 16-mm (⅝-in.) mineral board panels generally offer 0.55 NRC, while higher-performing acoustical tile will range from 0.75 to 1.00 NRC.

The material choice depends on the application, and may be influenced by green building goals. Steel is only suitable for interior use and must be painted or clear-coated, and contains a minimum of 25 per cent recycled content. Aluminum may be used in either interior or exterior applications, and can contain 100 per cent recycled content. Typically, aluminum panels

Curved systems are most often used in open-plenum ceiling applications to create undulating waves, floating islands, rising vaults, and sweeping transitions.

with the highest recycled content are painted to hide any imperfections and inconsistencies in the material.

The finish on a metal panel is an esthetic choice. Baked enamel and powder coat paints can be selected in nearly any colour, including metallics and simulated wood grain patterns. Simulated wood finishes on metal provide the appearance of real wood in a much more durable material that can also provide acoustical performance. Natural wood veneers with various stains and finishes can be requested, and brass and chrome plating may be available. Regardless of the technique, specifiers should also give attention to matching the finished panels with trims, suspensions, and accessory items to ensure the desired look. This is especially true when systems are to be curved or custom panels and trims are being created.

Linear metal ceilings and open-plenum systems

Linear metal systems were developed in the 1960s to add design elements to commercial spaces' ceilings. They are typically flat, but can be curved by using different suspension methods. The width is an esthetic choice; length is usually the main focus. Commonly, they are specified for long (linear) building applications, such as airport terminals and corridors.

The spacing between the linear panels may be determined by numerous factors, balancing both form and function. If the space between the panels is closed, one must also consider whether the 'filler' should be integral to the panel or installed as an applied accessory item.

As with metal panel ceiling systems, linear metal systems can include perforations and insulation for acoustical absorption, and they are available in myriad sizes, materials, and finishes. They may be used inside or outside, and can extend from the interior through to the exterior soffits. Many designers like the visual continuity this provides, particularly in highly transparent buildings with large glass openings. As with other exterior ceiling applications, it is important to remember to request a positive/negative wind-load test report. On the interior, one must be aware lights and air diffusers must be specifically designed for use with linear systems.

Linear metal systems also can be installed as an open-plenum system. As the names suggests, 'open plenum' refers to an application where the occupied space is not separated from the space above by a continuous ceiling.

Other open plenum systems include beam assemblies, which use deep sections to create large, open modules. These systems allow completely free circulation of air and the creative placement of light fixtures and other features. They are effective in defining a ceiling plane without a solid ceiling, and letting displays define the space, such as in a retail centre or showroom. Specifiers select:

- depth and width of the beams (typically 25 to 102 mm [1 to 4 in.]);
- module size (typically 305 to 1219 mm [12 to 48 in.]); and
- finish.

As a subset of beam systems, open-cell systems offer an inexpensive way to add a design element to open areas. These systems use a standard grid, painted 360 degrees. This type of ceiling system should be used with heavily perforated panels and wire/mesh panels. Standard grid faces are 24, 14, and 35 mm (15⁄16, 9⁄16, and 1 3⁄8 in.). Standard grid module sizes are 610 x 610, 610 x 1219, and 1219 x 1219 mm (2 x 2, 2 x 4, and 4 x 4 ft). As previously noted, specifiers must be cautious in reconciling Imperial-sized grids with soft and hard metric-sized grids.

For open-plenum systems, 'masks' are used to provide an attractive way to block the view of the structure and mechanical systems above the ceiling from a casual viewing angle without impeding air movement. Depending on the ceiling height, the view is usually obstructed at a 45-degree viewing angle. For an industrial look, plenum masks with woven wire and expanded metal can be selected in carbon steel or stainless steel, unfinished or painted, and in several styles.

Plenum mask cell ceilings involve a grid suspension system with vertical-slat covers installed over the web of the grid to give a solid appearance. Ceiling suspension modules are usually sized as standard grid modules. Once the web covers and cells are installed, the openings are much smaller; cell sizes range from 104 x 104 mm (4 x 4 in.) to 305 x 305 mm (12 x 12 in.). This provides the desired plenum masking, while still allowing for the installation of standard services such as air and light diffusers and security devices. Steel- or aluminum-cell ceilings and metal panels can be mixed for visual interest, and a wide range of finishes can be specified.

Another type of plenum mask is the baffle system, used to hide the structure above with a linear design element. Baffles give a space a very different look when viewed from different angles. Along with specifying steel or aluminum and the appropriate finishes, the depth and spacing of baffles must also be noted.

Planks, panels, curves, and trim

Used as design elements to cover large areas and provide accessibility, planks are panels that are three times longer (or more) than their width. The decision of attachment styles is largely based on the frequency of access to the plenum. Ideal for large public spaces and as design features in offices, planks can be formed into custom shapes and can be manufactured as solid or with perforations. The acoustical properties of planks mimic those of metal panels and the finish options are the same.

Also ideal for frequently accessed plenum areas, torsion spring panels allow maintenance staff access without taking the panel completely out of the ceiling. These products can be specified for flat or curved installations as planks or as panels, solid or perforated, and finished with paint, wood grain laminates or veneers. Due to the strength of the connection to the grid system, this type of system can be effective in areas concerned with seismic activity.

Well-suited for renovation applications, but not for most seismic areas, clip-in panels are easily removed and replaced into standard 24-mm (15⁄16-

Snap-up metal panels make it simple to retrofit and conceal the suspension systems. These easily-installed panels provide very tight joints and a dramatic alternative to exposed gridlines. Snap-up metal panels can be perforated for acoustics.

Plenum-mask cell ceilings involve a grid suspension system with vertical-slat covers installed over the web of the grid to give a solid appearance. Baffle systems for plenum masking hide the structure above with a linear design element giving a space a very different look when viewed from different angles. Above, the Caribbean transit station in Saint Martin uses an open-plenum-masking system with 102-mm (4-in.) deep metal baffles installed side-by-side to provide a continuous linear appearance.

Metal ceiling panels may be perforated in one of many different pattern options for increased acoustical performance and visual variety. For this Acura dealership in Maple, Ont., lay-in metal ceiling panels integrate with standard lighting and air diffusers.

Photos © Bochsler Creative Solutions, Burlington, Ont. Photos courtesy Chicago Metallic Corp.

in.) suspension systems—this can be helpful for spaces that must quickly adapt to changing décor and tenant needs. The panels may be specified as square or reveal edge. The former conceals the suspension from view, while the latter exposes the suspension in a recess detail.

Panels are available in almost any finish and colour, but when reveal panels are desired, one should check for compatibility of existing suspension grid colour. Reveal or square, all clip-in panels are installed from the room's interior over a new or existing ceiling grid. The ceiling grid must be a 24-mm style and completely square.

While several metal ceiling systems can be installed on a radius, other systems are specifically designed for curves. These are categorized as one- or two-directional curved systems, and concealed curved systems: A two-directional system refers to a ceiling system that uses exposed curved main tees and cross-tees. A one-directional system uses exposed curved main tees, and concealed systems hide the suspension from view. Each curved system forms undulating 'ribbons.' The peaks and dips of the ribbon's curvatures are commonly called 'vaults' and 'valleys,' respectively. A minimal 457-mm (18-in.) radius is necessary for these valleys and vaults.

Curved systems are most often used in open-plenum ceiling applications. As with other metal ceiling systems, these curved systems' panels can be solid or perforated, supplied with or without acoustical backers, in a full complement of finishes and colours, including simulated wood grain.

To allow ceilings to float in shapes and forms, manufacturers took another evolutionary step in the late 1980s by developing trim systems. These are custom-designed systems that can be used as ornamentation, to create a change of elevation in ceilings or to add drama. Trim systems can incorporate metal panel ceilings, acoustical ceilings, drywall, and open-plenum designs, even those with beam systems. Trim systems are specified as acoustical or drywall, in the desired colour, and in heights of 51, 102, 152, 203, 254, or 305 mm (2, 4, 6, 8, 10, or 12 in.).

Customized, specialized, or standardized

Customized ceiling systems require close co-ordination between the designer, specifier, manufacturer, and installing contractor. Blending multiple systems and finishes, the team can create one-of-a-kind spaces that reflect the occupants' brand and personal tastes, while working within the timeframe and budget. The earlier the manufacturer is involved in the design discussion, the more easily it can help bring the vision to reality within the project's scope. This collaboration may include full-scale mockups to minimize confusion and maximize the likelihood of a successful installation.

In addition to their design flexibility and ease of installation, the strength of metal ceilings makes them highly compatible with specialized applications, such as correctional facilities. In medium-security environments, one may specify a heavy-duty grid and steel panels that fit

Baked enamel and powder-coat paints can be selected for metal ceiling panels in nearly any colour (including metallics and simulated wood grain patterns), such as for the lobby of Port Credit Retirement Residences in Mississauga, Ont. Natural wood veneers with various stains and finishes can be requested, and brass and chrome plating may be available. Regardless of the technique, give attention to matching the finished panels with trims, suspensions, and accessory items to ensure the desired look.

securely and resist removal after installation. High-security areas require steel planks held in place by heavy steel channels and tamper-proof screws. When specifying for security, it is important to consider the desired level of security, along with the interfaces with HVAC, lighting, and structural systems. One must also take into account whether the ceiling panels should be perforated or solid, steel or aluminum.

Metal ceilings can also be very suitable for cleanroom applications. To accommodate stringent cleaning regimen in these spaces, the panels can be used with several grid systems, including stainless and gasketed. These systems can be used in rooms as strict as Class 100. As with other specialized applications, one must be careful to consider the HVAC, lighting, structure, and interfaces. The decision regarding perforated or solid panels rests mainly on how the airflow through the room is designed.

Addressing more common applications' daily needs for health, safety, and sustainability, standardized metal ceilings:

- are Class A fire-rated (per ASTM E84, *Standard Test Method for Surface-burning Characteristics of Building Materials*), but are not included in any Underwriters Laboratories' (UL) time-rated designs;
- contain no fibrous material content;
- promote neither mould nor mildew growth;
- emit no volatile organic compounds (VOCs) when finished with baked enamels or powder-coated paints;
- offer low maintenance, as long as there is periodic cleaning to remove surface debris; and
- provide performance of 25 to 50 years, at which point they are 100 per cent recyclable.

(As mentioned, metal ceilings are not necessarily suitable for exterior soffits, however.)

Metal ceiling systems can provide a high level of acoustical absorption using perforation and acoustical material behind the panels. Sound mitigation is especially important in high-traffic areas such as this GO Transit station.

Wherever a metal ceiling is specified, it is essential to check local codes for fire, seismic, and wind load, along with acoustic requirements and corrosion resistance needs. Working closely with the building team means collaboration not only among the designer, contractors and manufacturers, but also the owner, occupants, and maintenance staff. The shared goal is to ensure the ceiling system looks and performs as intended.

Notes

[1] For more on tin and faux-tin ceilings, see "Decorative Ceiling Panels: Opting for Metal or Styrene Design," by Jeff Fuller, in the March 2012 issue of *Construction Canada*. Visit www.constructioncanada.net and select "Archives."

Edward Williams is a manager for Chicago Metallic Corp.'s metal ceilings unit. He draws from more than 30 years of experience in manufacturing ceiling systems for commercial spaces, partnering with owners, designers, and installing contractors. Williams is an affiliate of the International Interior Design Association (IIDA). He can be contacted via e-mail at williamse@chicagometallic.com.

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