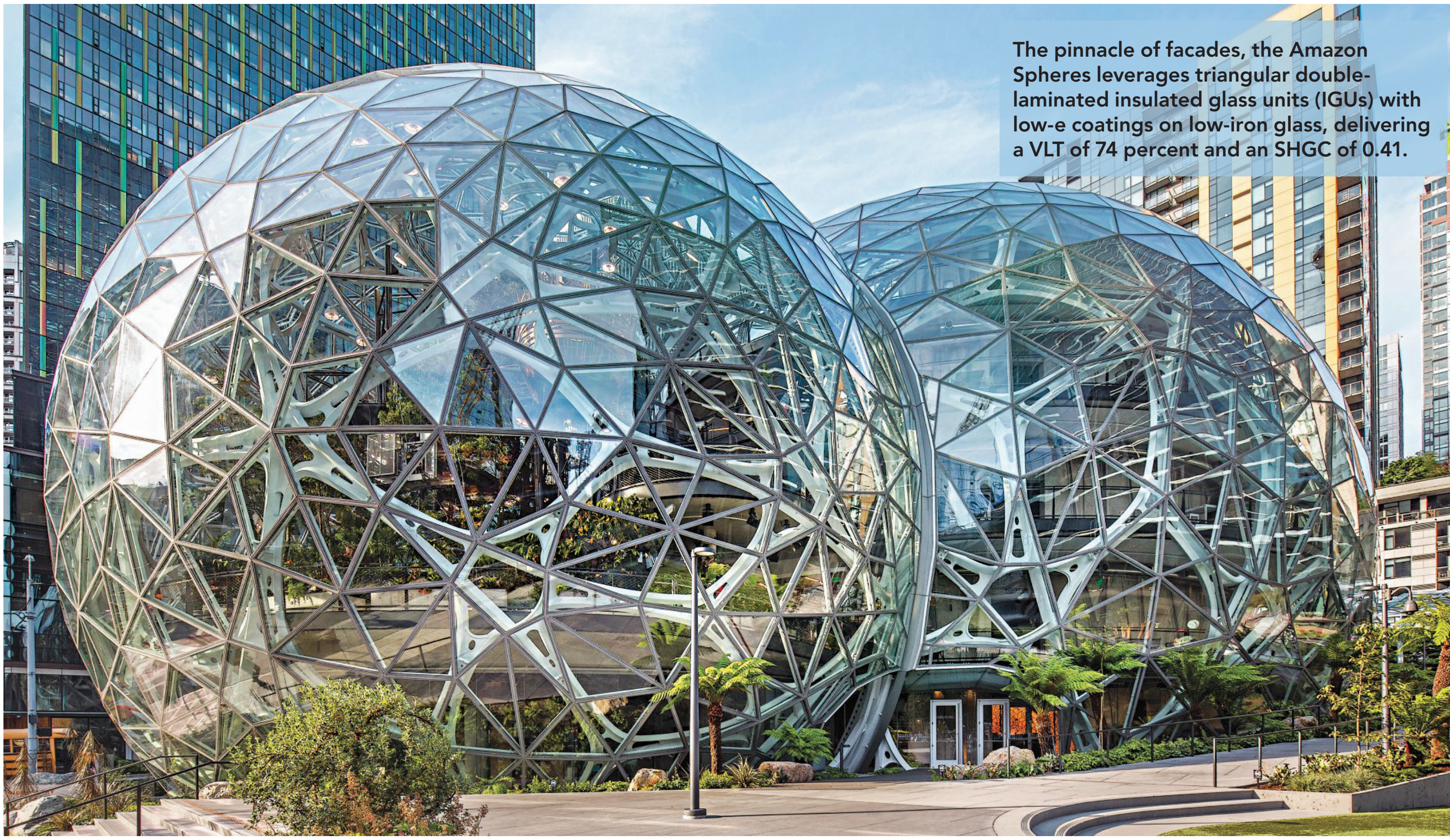
Photo courtesy of Vitro Architectural Glass



The pinnacle of facades, the Amazon Spheres leverages triangular double-laminated insulated glass units (IGUs) with low-e coatings on low-iron glass, delivering a VLT of 74 percent and an SHGC of 0.41.

Choices Abound for Attractive & Smart Facade Design

Mindful specifications to satisfy aesthetics, comfort, and sustainability

Sponsored by AZON, Cascade Architectural, Inpro, and Vitro Architectural Glass
By Andrew A. Hunt

Julia Morgan, an American architect and engineer who designed more than 700 buildings in California, including the Hearst Castle in San Simeon, California, once said, "Architecture is a visual art, and the buildings speak for themselves." This sentiment is no truer than when looking at the facade of the structure. The facade is the "first-blush" impression that will set the tone for the entire experience within the walls of the building.

Today, architects have an ever-expanding pallet of options when it comes to facade types and styles. As the number of options grows, it is important to keep several key aspects in mind. Specifically, the balance of beauty and function. Facades must not only satisfy the visual aspirations of the project but also do their part to support energy efficiency, durability, comfort, security, and occupant well-being. A facade design that has great beauty but fails to provide for thermal protection, moisture management, basic occupant safety, and accommodate for freeze-thaw cycles does a disservice to both the client and the community.

Striking the balance between beauty and durability requires an examination of both needs. Let's take a look first at some innovations and new technologies in facade materials and design elements that can help bring beauty to building facades.

UPDATING THE VINTAGE

An interesting challenge in modern architecture is to incorporate modern technologies into historical situations. Architectural styles helped shape the history of cities in North

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Learning Objectives

After reading this article, you should be able to:

1. Explain how the thermal performance of the facade can be maintained or even improved during historic-window replacement selection.
2. Describe how steel curtains can be incorporated into facade design for both aesthetic and energy-efficiency benefits.
3. List the critical attributes required to ensure a watertight building envelope when specifying a joint expansion system for facade designs.
4. Discuss how advancements in low-emmisivity (low-e) window coatings can help meet or exceed stringent code requirements and provide more energy-efficient and comfortable occupied spaces.
5. Understand the importance of specifying and designing a facade that can help protect the building and occupants from seismic and extreme weather events.

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America in the late 19th and early 20th centuries. Character-defining aspects of window openings in the facades were artful, decorative elements while being functional and practical, allowing natural lighting and views. When updates to historic or vintage buildings are needed, few building owners will want to compromise the authentic look and feel of existing frames and panes.

Often the signature looks of classic windows included narrow or wide sightlines and curved window tops with thinner frames and shallow openings. These design elements are not always possible using conventional framing materials, and it would seem traditional materials may not work to replace traditional window styles. Modern thermal-barrier aluminum framing is the ideal material due to its inherent flexibility, option of narrow sightlines, bent shapes, and worry-free performance.

Besides materials and performance considerations, another challenge for architects is to carefully design installation spaces in historic buildings to incorporate often larger and more complicated frames for modern windows. Thicker frames and multiple panes often require a deeper space and a more involved insulation and air-sealing strategy to ensure the windows perform as expected. This can be especially true in areas that are prone to extreme weather events. High-wind areas where hurricanes are expected can introduce their own set of challenges, both aesthetic and code related, when updating historic buildings.

Photo: Taylor Kallio, Kalamazoo Aerial Media

Installing modern windows in historical buildings often requires a challenging redesign of the openings to incorporate larger, higher-performing framing materials.

IN WITH THE NEW

If the facade design calls for a more contemporary look, coiled wire fabric can provide a unique yet functional aesthetic. Coiled wire fabric is constructed of interlocking metal wire spirals that form a durable mesh panel. Because of this unique construction process, panels may be spliced together at the job site for projects requiring larger spans of fabric than shipping vehicles are able to accommodate. Splicing on-site means that projects of huge scale, like sports arenas or massive convention centers, can have a near seamless facade material extending over the entire building. The material is customizable and flexible and has a variety of metal material options as well as colors, attachment methods, and finishes.

As part of a facade strategy, coiled wire fabric can be used in a variety of situations that require a unique solution. For instance, parking garages attached to commercial buildings can pose a dauting challenge for architects. Incorporating an overall design scheme that is both attractive yet functional can be accomplished with coiled wire fabric, specifically in terms of safety. Coiled wire fabric systems are utilized for fall protection in lieu of traditional railing infill or walls for elevated areas. The material provides fall protection plus ventilation—which is helpful for builders to meet code requirements, allowing air to flow freely.

Photo courtesy of Cascade Architectural

Coiled wire fabric can serve as a fall-protection barrier in open-air parking garages, balconies, and elevated walkways.

Coiled wire fabric serves a wide range of functions when installed as a facade for building exteriors or parking structures. Solar shading is vital to the comfort and productivity of workers, especially in a day and

Photo courtesy of Inpro

Compression joints work exceptionally well in both areas with the potential for extreme seismic activity and open-air structures where temperature changes are expected.

age where glass is increasingly used on offices and skyscrapers to utilize natural daylighting and reduce energy consumption. Although, too much natural sunlight may produce an uncomfortable environment for building occupants. One way to allow a degree of sunlight to ideally illuminate interiors is a coiled wire fabric facade. The material will let light through but with less intensity. In fact, when used as an exterior shade or scrim, coiled wire fabric materials have shown to reduce energy consumption by up to 12.3 percent—providing shade and effectively reducing air-conditioning costs.

Metal wires are available in durable powder coatings. Plus, in comparison to other metal-mesh systems, coiled wire fabric can span longer distances and is lightweight—eliminating additional structural embedment requirements or extra supports to bear the system's weight.

A WELL-DESIGNED SEAM

Large facade materials like stone panels and glass are favorite options for architects, but the details can make or break the final visual appeal of the project. A priority when specifying large monolithic-style facade materials is to appreciate the basic science Mother Nature will demand.

At a minimum, facade designs must incorporate expansion-joint systems to help control the swelling and contraction of materials during temperature changes. Likewise, in seismically active areas, expansion joints are required to help mitigate damage from earthquakes. Failure to plan for the inevitable movement of large facade materials flies in the face of basic building code and will result in cracked materials and the potential for structural failure. In addition, these expansion-joint systems need to also protect the interior from moisture intrusion. While we will look at the importance of incorporating the facade into the building envelope later in this course, for now, let's consider the aesthetics of specifying expansion-joint systems into building designs

Like the zipper on a coat, expansion-joint systems will extend the entire length of the facade design. This seam may even extend into horizontal surfaces such as decks, walkways, and ceilings if a uniform design for all exposed surfaces is used. For architects looking to "hide" or at least minimize the visual impact of expansion joints, there are several options available. Expansion joints designed for both thermal and seismic applications can be specified with covers that discretely conceal the expansion mechanism hidden below. Covers also are an excellent choice for areas where foot traffic is expected, as the joint covers can allow for a smooth and uninterrupted walking surface.

Compression joints are another style that offers crisp sightlines in areas where there is the potential for more extreme seismic activity. Compression systems incorporate folds of rubber that can be customized in a variety of colors and finishes and flush mounted to either interior applications, like parking garages, or exterior surfaces, like facades. Compression joints are a maintenance-free option that can be neatly installed and offer a minimal visual break in surfaces while providing the building with structural protection.

CAN YOU SEE CLEARLY NOW?

Glass as a primary facade material remains the go-to option for many architects, and unlike projects from the 1990s when highly reflective tinted glass was the trend, the general tendency today is to specify "clear" glass. However, when specifying glass, it is important to understand that to achieve a truly transparent aesthetic, design professionals should know that clear glass is not completely clear—it has a distinct green hue when viewed under light.

Visible light transmittance (VLT) is a measurement of the percentage of available visible light that passes through a glazing material. Glazing VLT ratings can range from 12 percent if glazing is treated with highly reflective coatings to 84 percent on uncoated "clear" glass. But even at 84 percent VLT, a significant amount of visible light is not entering the space.

For applications that require very clear and colorless glass with exceptional light transmission, low-iron glass is a good choice. Low-iron glass is made by selecting raw materials that are naturally low in iron. In addition, the melting process is carefully controlled to ensure the product properties remain consistent. Low-iron glass is also ideal for applications where glass edges are visible or a neutral color is desired.

Low-iron glass offers many benefits in addition to outstanding visual clarity. Because of its purity of color, there is a minimum color cast when viewing through the glass, ensuring a true representation of what lies beyond. Because it is practically colorless and lacks the slightly green cast of regular clear glass, the VLT is higher in thicker pieces of low-iron glass compared to standard clear glass of the same thickness.

A double-glazed insulated glass unit (IGU) consists of two glass lites separated by an airspace. Often, design professionals specify a double-glazed IGU with low-iron glass as the exterior lite—typically to achieve greater transparency and color fidelity—and then use clear glass as the interior lite. This compromises the design intent of maximizing daylight and color fidelity, as the green hue that is inherent in clear glass will dilute the clarity of the low-iron glass on the exterior.

PROTECTING BUILDINGS FROM FOUL WEATHER

The dual role of the facade requires the material and installation to create an attractive and engaging visual appearance while playing its part in the building envelope. This role as the first line of defense for the building, especially in climates or areas prone to extreme weather events, requires that architects thoughtfully select materials and installation systems that will add beauty while maintaining building integrity against the onslaught of rain, wind, and temperature.

In addition to weather, energy performance remains a critical aspect when specifying the facade. The facade is part of the building envelope, and as such, it plays an important role in mitigating heat transfer, loss of conditioned air, and durability issues. No matter what the style or material of the facade, basic building science must be employed to ensure the durability, comfort, and safety of occupants.

INTELLIGENT FACADES ARE THE FUTURE

An idea that is moving from the fringe into mainstream architectural thinking is the concept of the "intelligent facade." This concept centers around the idea that building design should be proposed and developed to manipulate solar energy to provide electricity, active and passive cooling, and thermal energy for the building. Ideally, this strategy is done in a largely transparent manner, allowing for a high return on energy conservation investment while occupants are mostly unaware of the technology being used.

The overall concept is based on some of the best practices already being utilized but then thoughtfully and creatively maximizing the potential return on these designs. For instance, increasing natural lighting is already a popular concept, but intelligent facades take the idea and include site locations that improve views and visually invite the exterior into the occupied space by maximizing lines of sight. Visually enhancing daylighting conditions are further used to both reduce energy use and control heat within the building through advance glazing and automatic shading system design.

Intelligent facades also heavily rely on utilizing photovoltaic collection to power heating and cooling systems on an almost micro-grid level. Design elements include decentralizing the mechanical equipment from the building core. A new term coined to help describe this approach to facade design is integrated concentrating solar facade, or ICSF. ICSF is part of an overall strategy that can also include nontraditional building design elements. like placement of mechanical equipment around the perimeter of the building and vertically installed HVAC systems rather than traditionally horizontally ducted systems. By moving heating and cooling units to the perimeter of the building to be closer to the solar collectors, the ICSF approach is meant to help reduce the building's overall reliance on central power and allow for energy generation and use to be more closely linked. The use of storing heat energy through thermal mass is also an element of intelligent facades, as is passive cooling design and using the natural flow of air and energy within large commercial buildings to improve comfort while reducing energy use, maintaining outdoor views for building occupants, and also utilizing solar panels and thermal mass to collect and store solar energy.

MORE THAN JUST WINDOW DRESSING

Materials used in historic high-rise buildings were primarily single-pane glass, wood, galvanized steel, and iron. During restoration projects, updating the windows while maintaining the aesthetic of vintage facades is mission critical. Each building is unique, and the potential impact of energy-savings with windows and proper installation can be significant. Fortunately, sustainable products, methods and high-performance properties in modern windows are available to preserve the look of treasured history while providing thermal efficiency, comfort, and protection against facades exposed to weathering in extreme climates and conditions.

In regions subject to catastrophic events caused by nature or humans—earthquakes, blasts, or hurricanes—materials must remain very strong to withstand multiple adverse forces and the ravages of time. When specifying to address such events, understanding and utilizing modern window components can greatly improve the durability of projects. Aluminum thermal-barrier windows, for instance, offer higher performance in impact resistance, shear strength, and heat distortion than other materials and methods.

At the core of aluminum thermal barrier is a manufacturing process called pour and debridge, a highly efficient technology used to create the framing material, that incorporates a non-metallic polymer component. The role of pour-and-debridge polymer thermal barriers in aluminum is to interrupt the flow of energy through the metal and provide exemplary structural strength in the facade. The technology that is used to enhance custom-made vintage windows is also used by manufacturers of curtain walls, windows, storefronts, doors, and skylights.

To create an aluminum thermal barrier window, the aluminum profile is extruded with a strategically placed channel to encapsulate an insulating polymer. The channel surface is conditioned with special equipment to create a "mechanical lock," and then a two-part polymer is dispensed into the channel as a liquid. This is the "pour" part of the process. As the liquid hardens, it creates a durable, structural insulating element on top of the aluminum. Once the polymer is set, the bottom of the metal channel is removed, leaving just the polymer. This is the "debridge" part of the manufacturing process. With the aluminum metal-to-metal connection broken, conductive heat transfer through the frame is greatly reduced, thus resulting in a highly energy-efficient frame with remarkable structural strength.

Companies that specialize in window restoration and installation of historic replication material are challenged to provide products that match original aesthetics, while providing optimal thermal efficiency.

KEEPING IT DRY

The building facade can be more than just an aesthetic design choice. Most facade styles can and should be incorporated into the building envelope to help support or enhance energy savings and water-mitigation strategies. A well-designed and properly installed building envelope can help reduce energy costs, increase comfort, and support green or sustainable building goals while creating a more durable structure.

Elements like wind and water batter a building. Temperature shifts swing from freezing to baking and back again. Whatever the facade material, it must be able to withstand the weather and contribute to the overall building envelope.

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Preserving the Image of Battle Creek

One project that serves as an example of how to incorporate new fenestration technologies into vintage facades is The Milton, a mixed-use redevelopment project in downtown Battle Creek, Michigan. The Milton luxury apartments are combined with retail and business space. Constructed in 1931 as the Old Merchants National Bank, the building is listed in the National Register of Historic Places and is one of the last projects designed by Chicago architectural firm Weary and Alford. The repurposing of the 19-floor historic downtown high-rise building proved a challenge from both a preservation of historic properties and an extreme climate standpoint. All of Michigan is located in a climate zone exposed to extreme weather conditions—Battle Creek averages 53 inches of snowfall annually— so facade materials must be thermally efficient against harsh northern winters. The warm season lasts for 3.8 months from May to September, when temperatures in the city will average 75 degrees Fahrenheit and will reach 95 degrees Fahrenheit or greater on the hottest days.

Photo: Taylor Kallio, Kalamazoo Aerial Media
The Milton in Battle Creek, Michigan, required windows that met both historic preservation requirements and extreme weather demands.

Kate Shields, a project estimator with glazing contractor Blackberry Systems in Kalamazoo, Michigan, worked on the project. She says, "The Milton has been one of our most comprehensive restoration and replication projects that we have undertaken in the past 30 years. The 90-year-old project required us to not only restore historic metals, decorative skylights, and the original historic storefront, but the steel windows also had to be completely replaced due to the poor condition they were in. The original steel windows had a unique design of a two-lite casement over a lower fixed transom with narrow stile sightlines, posing a challenge to replicate."

Working directly with the manufacturer, Shields was able to develop a design detail that matched the sightlines and profiles within the $^1/_8$-inch tolerance required by the National Park Service historic preservation standards for the treatment of historic properties. She says, "To accomplish this, we used a custom panning. Structural and thermal performance were important as well due to the height of the building and exposure to the elements in Michigan. Our experience working on large high-rise buildings such as The Book Tower and 600 Vinton Building in Detroit helped prepare us for the challenges we faced here in downtown Battle Creek."

Using structural aluminum fenestration materials with polyurethane polymer thermal barriers, the final installation was able to optimize energy savings, increase comfort, and lower operational costs. The custom thermal-barrier window glazing consists of 1-inch insulating glass with double-silver, low-emmisivity (low-e), argon-filled, warm edge spacers that provide a U-factor of 0.30 for high energy efficiency, comfort, and protection when the weather and temperatures are extremely cold or hot.

Shading and Protection

Balancing the needs for beauty with the functional needs for energy savings, protection from the elements, and comfort of occupants is not always an easy task, especially in exterior facade applications like parking garages and walkways. These areas leave visitors and their vehicles exposed to whatever Mother Nature can dish out, be it extreme heat, hurricane-driven rain, or frozen winters.

For areas where both solar gain and wind-driven moisture are an issue, coiled wire fabric can be a protective solution. The coiled wire, unlike standard mesh, provides an element of shade that most standard facade elements cannot. However, coiled wire fabrics also offer a level of translucency that delivers a simultaneously open and closed feel.

As a parking-garage facade, coiled wire fabric panels provide an added layer of weather protection for vehicles and occupants inside. In the winter months, less rain, snow, and water are able to enter a structure, resulting in less of a chance for ice accumulation when temperatures drop below freezing. Not only is this a benefit to garage users, but building owners are also at less risk for legal action, and building maintenance staff are less likely to have to spread road salt on the interior of the garage. By reducing the amount of snow or water that enters the garage, these structures do not experience as much wear and tear from winter weather maintenance, and drivers and pedestrians have a safer environment to navigate.

Protecting Patients in the Big Easy

When looking for a solution to help protect patients, visitors, and employees at the recently renovated Children's Hospital New Orleans, architect EYP Architecture and Engineering selected coiled wire fabric on the facade. The $300-million multiphase campus transformation was slated to include a new skybridge, exterior renovations to sections of the hospital's facade, new additions to accommodate more beds and emergency rooms, and a 600-car (244,340-square-foot) parking garage. Finding a facade material to help maintain ventilation while also providing protection from the elements was a critical component of the design process.

Photo courtesy of Cascade Architectural

Coiled wire fabric was specified for the exterior of the Children's Hospital New Orleans to reduce exposure to elements like extreme sun and rain while also providing fall protection and ventilation.

Moses Waindi, senior project architect at EYP Architecture and Engineering, explains that the coiled wire fabric system was a fashionable fit for the project. "Coiled wire fabric presented a more cost-effective solution to wrapping the garage in metal mesh, and we also just preferred the inherent coiled design over other products."

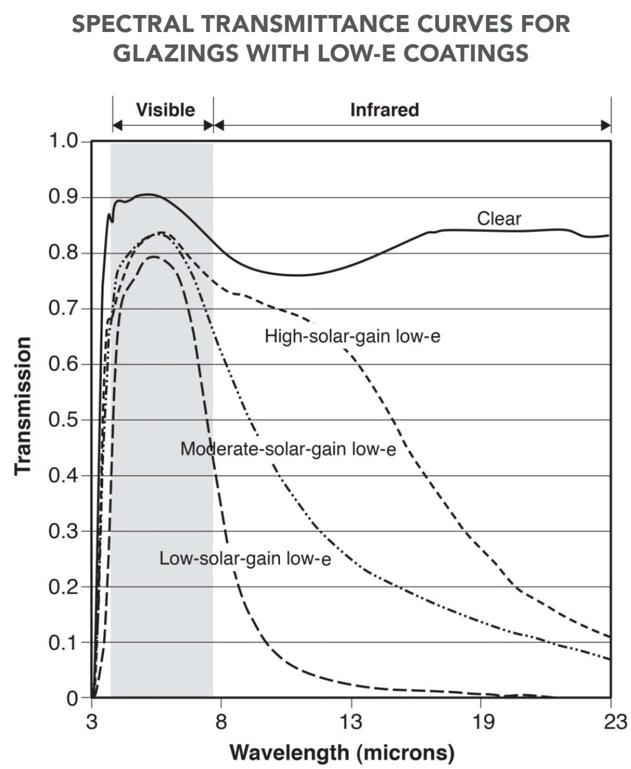
The five-story parking garage features 40 panels of $^3/_8$-inch, 14-gauge coiled wire fabric in 316 stainless steel, which exhibits the highest level of corrosion resistance amongst all types of stainless steel. The panels run parallel vertically from the second story to the fifth, with smaller individual sections of coiled wire fabric spanning the perimeter of the ground level.

Coiled wire fabric facades impart a higher degree of aesthetic value compared to traditional garages that are strictly made up of structural metal and concrete. This was especially vital at the Children's Hospital New Orleans, where a friendly and welcoming atmosphere holds a greater deal of importance.

Functionally, the coiled wire fabric provides natural ventilation so that air can flow freely throughout and car fumes are not trapped within the structure. The panels also protect against rain, snow, and sun, effectively working to keep occupants more comfortable while walking from car to hospital and back. As an added safety precaution, the durable tensioned panels secure the structure's perimeter, providing fall protection for anyone walking or parked near the outer edge of the garage.

THE LOWDOWN ON LOW-E FACADES

Large or jumbo glass is a favorite choice for building facades, but it has historically created some challenges with solar heat gain and comfort for occupants. Architects today can achieve the look they want on sprawling glass-dominant facades while still satisfying demanding performance expectations. Gone are the days of specifying large expanses of glass with the understanding that energy performance will be compromised.



Source: Measure Guideline: Energy-Efficient Window Performance and Selection. *Building America Program, Energy Efficiency and Renewable Energy, U.S. Department of Energy. November 2012.*

This graph shows how different types of low-e coatings can reduce the amount of infrared solar radiation. Note that by choosing different types of low-e coatings, more or less heat energy can be allowed to pass through the window. This is important when choosing window coatings in colder climates where additional solar heat gain may be advantageous.

To satisfy increasingly stringent energy codes (such as ASHRAE 90.1) and green building standards (such as LEED), low-e coatings can have a significant impact on energy efficiency by reducing the amount of solar heat transmitted into the building, even to the point of permitting specification of smaller HVAC systems.

Low-e glass coatings were developed to minimize the amount of ultraviolet and infrared light that can pass through glass without compromising the amount of visible light that is transmitted. A microscopically thin transparent coating allows low-e glass to reflect exterior heat in warm temperatures and hold in heat during cold temperatures, making buildings light, bright, and energy efficient.

GETTING BRIGHT ON LIGHT

A little understanding of basic science is helpful to appreciate how low-e coatings on glass facades can greatly impact the energy performance of a building. Visible light is a small fraction of the entire large light spectrum of energy that surrounds us every day. Microwaves, radio waves, x-rays, and ultraviolet are all forms of light that we cannot see. Also, outside the visible light spectrum is infrared, which is heat energy. Different materials can reflect, absorb, or manipulate the wave forms of light energy, and low-e coatings have a high reflectance to long-wavelength infrared radiation. When applied to a pane of glass, the coating reduces long-wavelength radiative heat transfer between glazing layers by a factor of five to 10, thereby reducing total heat transfer between two glazing layers. Coating a glass surface with a low-e material and facing that coating into the gap between the glazing layers blocks a significant amount of this radiant heat transfer, lowering the total heat flow through the window. Low-e coatings may be applied directly to glass surfaces or to suspended films between the interior and exterior glazing layers.

There are many different types of low-e coatings available, but almost all are microscopically thin, virtually invisible metal or metallic oxide. The benefit is that low-e coatings can lower the U-factor of the window without interfering with the visibility. For example, uncoated glass has an emissivity of 0.84, while some advanced low-e coatings can reduce emissivity to 0.02.

Low-e coatings are broken down into three classifications: high, moderate, and low solar gain.

High-solar-gain low-e coatings typically have a solar heat gain coefficient (SHGC) value greater than 0.40 and are designed to reduce heat loss but admit solar gain. High-solar-gain products are best suited to buildings located in heating-dominated climates and particularly to south-facing windows in passive solar designs.

Moderate-solar-gain low-e coatings typically have an SHGC value of 0.25–0.40. Such coatings reduce heat loss, maintain high light transmittance, allow a reasonable amount of solar gain, and are suitable for climates with heating and cooling concerns.

Low-solar-gain low-e coatings typically have an SHGC value less than 0.25. These products are considered spectrally selective low-e glass and are used to reduce heat loss in winter and heat gain in summer. Low-solar-gain low-e coatings are generally specified in hot, sunny climates.

Spectrally selective coatings are optically designed to reflect particular wavelengths but remain transparent to others. Such coatings are commonly used to reflect the infrared (heat) portion of the solar spectrum while admitting more visible light. They help create a window with a low U-factor and SHGC but a high VLT.

A final consideration when evaluating low-e windows is the UV, or ultraviolet, protection the window coatings offer. Blocking UV light is important because it can protect furniture, art, carpet, and decor from the fading effects of UV exposure. Low-e windows can block more than 70 percent of the UV light coming through the window, but for projects such as galleries or offices with extensive art collections, finding a low-e coating with greater UV protection can be important.

Technological advances in coatings chemistry, such as the introduction of triple-silver- and quad-silver-coated glasses, have significantly improved performance over the past two decades. Today's newest and most advanced low-e glasses are coated with extremely thin layers of silver that are applied to glass through the magnetron sputter vacuum deposition (MSVD) process, significantly improving performance. For example, when an MSVD coating is used on a 1-inch IGU with clear glass, it can block nearly 75 percent of the sun's heat energy—while still allowing more than 60 percent of daylight to pass through. These low-e silver coatings can be applied to a range of glass substrates, specifically low-iron glasses for superior transparency and color fidelity as well as tinted glasses.

Smaller HVAC systems may be specified for buildings glazed with solar control low-e glasses, potentially reducing the associated up-front capital investment required. As a result, the initial facade investment may be repaid in a matter of months.

Daylighting Benefits

The overall benefit of natural light in commercial spaces cannot be understated. Reducing the amount of artificial light will not only immediately reduce the energy consumption, reducing cooling costs where a solar-control strategy is employed or reducing heating costs where a passive strategy is used.

Photo courtesy of Vitro
To optimize performance with the desired aesthetic, low-e coatings can be applied to a variety of tinted glasses ranging from blues and greens to grays and bronzes.

Another benefit of natural daylighting that is more difficult to quantify but no less important is its proven ability to increase mood and productivity for occupants. To maximize the benefits of daylighting, architects can pair low-e coatings with low-iron glass.

Nathan McKenna, segment marketing manager of Vitro Architectural Glass, has helped architects specify glass for facades and has specific advice to ensure both aesthetics and energy needs are met.

"One of the most common ways to increase daylighting today is to use large expanses of glass, sometimes called "jumbo glass." Jumbo insulated glass units typically range in sizes from 130 inches by 204 inches up to 130 inches by 236 inches. Larger sizes can be available for special orders." McKenna also advises on low-e to help reduce solar heat gain. "Using low-iron glass as opposed to conventional clear glass in jumbo insulated glass units can maximize light transmittance for your project while creating brilliant views to the outdoors. However, specifying jumbo glass might result not only in increased daylight but also increased solar heat gain. To improve solar control performance, optimize energy usage, and reduce reliance on artificial lighting, specify jumbo low-iron glass with low-e coatings."

The Amazon in Seattle

The crown jewel of Amazon's $4-billion Seattle campus is an architectural marvel. Designed by NBBJ, The Spheres comprises five floors of collaboration and relaxation spaces, as well as 40,000 plants.

A geometric shape called the pentagonal hexecontahedron forms The Spheres' steel frame. The shape is based on one of 26 known subsets of Catalan solids named for the Belgian mathematician who first described them in 1865. The building consists of elongated pentagonal modules that appear 180 times across the three spheres. By connecting each angle of the module to a centralized hub, the architects created a fluid yet modular pattern that could be repeated throughout the building.

The Spheres' facade contains 2,643 panes of glass. The greenhouse plants require significant amounts of daylight, so the type of glass selected for the facade was important. The glass chosen is ultra clear and energy efficient, thanks to the use of low-iron glass with solar control and low-e coatings, with a film interlayer to keep out infrared wavelengths that produce unwanted heat. NBBJ modeled more than two dozen products before selecting triangular double-laminated IGUs fabricated with a low-e coating that delivers a VLT of 74 percent and an SHGC of 0.41. The glass transmits ample daylight while rejecting heat to facilitate photosynthesis for the ecosystems within.

KEEPING IT DRY

The building facade can be more than just an aesthetic design choice. Most facade styles can and should be incorporated into the building envelope to help support or enhance energy savings and water-mitigation strategies. A well-designed and properly installed building envelope can help reduce energy costs, increase comfort, and support green or sustainable building goals while creating a more durable structure.

Photo courtesy of Inpro

Expansion joints on One World Trade Center in New York City help protect the interior from moisture intrusion from multiple sources.

Elements like wind and water batter a building. Temperature shifts swing from freezing to baking and back again. Whatever the facade material, it must be able to withstand the weather and contribute to the overall building envelope.

Expansion joints are a critical element of facades when materials like stone, metal plates, or glazing are specified. Expansion joints work to allow the rigid materials to safely expand and contract with temperature changes. While these devices help protect facades from cracking and thermal damage, a poorly designed or installed expansion joint can be a major point of failure in the building envelope. Moisture, specifically, becomes a significant issue with expansion joints because these buffers between facade materials are easy access points that often disrupt the continuous building envelope. Because expansion joints can stretch the entire height of the facade, the potential for moisture intrusion across the entire structure becomes a possibility. Moisture can include temperature-induced condensation, fog, drizzle, light-to-moderate rain, and wind-driven rain (thunderstorms, hurricanes, and typhoons.)

Over the past decade or more, there have been increasing instances of dramatic, extreme weather. Certainly, one of the largest and worst examples would be the flooding in Houston during Hurricane Harvey in August 2017. After landfall on August 25, that weather system "hovered" over Houston and southeastern Texas, spanning almost seven days and producing more than 50 inches of rain in some areas. Another would be Ellicott City in suburban Baltimore, which had two 500-year floods in three years.

In Northern regions, for four to five months of the year, moisture means snow. There can be melt that happens as snow comes in contact with a warmer surface, and that water in turn seeks to find its way. In addition, when expansion joints are involved, the weight of snow load is an engineering factor that must be dialed in to the design. Another cold-weather risk is ice damming: water freezing in roofing drainage channels, building up, and forcing liquid water to flow under and around flashings.

Reducing Seismic Risk

Seismic disasters, specifically earthquakes, can take a huge toll on the built environment. The primary damage of earthquakes comes from ground shaking and has many different contributing factors, such as the strength and magnitude of the quake, how close a structure is to the fault, the local geology, and even the soil type. Ground shaking impacts buildings by moving them both laterally and vertically, which can cause the structures to fail from excessive deflection and deformation.

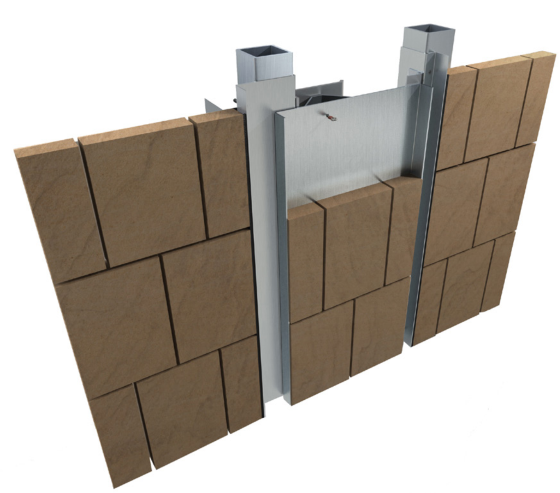


Image courtesy of Inpro

Modern expansion-joint systems employ covers that will completely conceal the joint hardware while still providing for facade movement in a controlled manner.

Current building codes for seismic resilience are designed to protect lives by specifying that buildings stay intact long enough for occupants to safely escape. Specialty architectural products are at the core of resilient building design. Most of these products tend not to be high-profile from an aesthetic sense and may initially be seen as minor design features, but the role they play in keeping buildings safe and secure for occupants can be significant. Expansion joints are structural gaps designed to accommodate the movement of a building in a controlled manner, thus protecting the internal and external finishes from potential damage. Movement may come from one of several different sources, but seismic activity is of serious concern, especially in earthquake-prone areas.

Expansion-joint covers are designed to cover the gap of the expansion joint with minimal interruption to a building's aesthetics and engineered to accommodate the building's movement. In seismic zones, expansion joints are implemented to allow the building to move with little to no damage during a seismic event. These systems are critical for the safe and functional egress of a building's occupants and ingress for first responders during and after an event.

Expansion-joint covers provide a covered transition across the expansion-joint opening and are not affected by movement along the surfaces of either side of the joint. Expansion-joint covers are a standard component for all large-plan buildings.

From a practical standpoint, it is important to specify the correct expansion-joint cover model based on nominal, maximum, and minimum joint size opening, which is typically determined by an engineer. Loading is also a critical component to ensuring the system functions correctly on a day-to-day basis. If these two factors (size and loading) are not correct in the specification, the expansion-joint cover may not be installed correctly and will not function properly as needed.

Covering the Bases

While the design of a facade will continue to be, as Morgan suggested, the visual voice for the building, there is more to this conversation than just aesthetics. Ensuring that the project is protected from the elements and potential damage from seismic events also plays a key role in creating a durable and comfortable building. With the ever-expanding list of options available to architects when it comes time to design the optimal facade, it is critical that the basics of building science be employed. Satisfying the client's desire for beauty must be matched with responsible, durable, and energy-efficient technologies. The good news for architects is that these options are getting easier to both discover and specify.

image to be insert on online verison in Can You See Clearly Now? section

Photos courtesy of Vitro Architectural Glass

Even with low-e coatings, low-iron glasses provide a significant improvement in clarity compared to conventional clear glass.

QUIZ

1. Which of the following is a benefit of modern thermal-barrier aluminum framing?
   a. Flexibility, which allows for unique shapes and narrow sightlines
   b. Heavy weight for additional security
   c. Iron-like appearance
   d. Easy installation

2. What can coiled wire fabric be utilized for in elevated areas?
   a. Walking-bridge material
   b. Blast protection
   c. Fall protection
   d. Lightning-rod material

3. Which is one of the positive attributes of compression expansion joints?
   a. They have nearly silent operation.
   b. They require little electricity.
   c. They are easy to install.
   d. The covers can be flush mounted.

4. What is the primary purpose of installing expansion joints in the facade?
   a. To control swelling and contraction during temperature changes
   b. To prepare the building for additional construction
   c. To allow for a rapid change out of facade materials
   d. To minimize heat loss through the building envelope

5. When shown under light, what color does “clear” glass traditionally display?
   a. Blue
   b. Green
   c. Yellow
   d. Pink

6. Which heat-transfer method does the “pour-and-debridge” technology disrupt?
   a. Radiation
   b. Conduction
   c. Convection
   d. Evaporation

7. In parking-garage facades, which of the following is a benefit of coiled wire fabric?
   a. Natural ventilation of exhaust fumes
   b. Crime prevention
   c. Noise prevention
   d. Opaque coverings for openings

8. What metal can be removed from “clear” glass to improve daylighting?
   a. Copper
   b. Tin
   c. Lead
   d. Iron

9. Which of the following can be a significant challenge for expansion joints?
   a. Exposure to high voltage
   b. Moisture intrusion
   c. Criminal access or trespassing
   d. Solar heat gain

10. Why were low-e coating developed?
    a. To strengthen the metal frame of a window
    b. To reduce condensation between panes of glass
    c. To minimize the amount infrared light passing through the glass
    d. To enhance the beauty of insulated glass units (IGUs)

ASSESSMENT

1. Intelligent facades heavily relay on which form of on-site energy generation?
   A.) Wind
   B.) Micro-hydro
   C.) Solar
   D.) Biofuel

- Incorrect: A – While possible, wind-power generation is not usually part of an intelligent facade design.
- Incorrect: B – Micro-hydro power generation is not typically utilized in commercial projects.
- Correct: C – Photovoltaic solar panels are the most common choice for on-site power generation for intelligent facade designs.
- Incorrect: D – Generators that use biofuels as a fuel source are not usually part of an intelligent facade design.

2. When considering specifying low-e windows, what part of the light spectrum is associated with heat energy?
   A.) Infrared
   B.) Microwave
   C.) Ultraviolet
   D.) X-rays

- Correct: A – Infrared is defined as the frequency of the light spectrum that conveys heat energy.
- Incorrect: B – Microwaves can excite materials to create heat but do not convey heat energy.
- Incorrect: C – Ultraviolet light can fade and damage materials but does not convey heat energy.
- Incorrect: D – Over exposure to x-rays may pose a health risk, but they do not convey heat energy.

3. What is one of the main tenents for current seismic building codes?
   A.) Buildings must suffer zero damage from earthquakes.
   B.) Buildings must stay intact long enough for occupants to escape during an earthquake.
   C.) Buildings must remain intact to the point that they will not damage any structures around them during an earthquake.
   D.) Buildings must be able to withstand, without damage, a "reasonable" earthquake and all aftershocks.

- Incorrect: A – Buildings are likely to suffer damage during earthquakes.
- Correct: B – Buildings must provide enough durability to allow for the safe exit of occupants during and after an earthquake.
- Incorrect: C – Inadvertent damage to other buildings is not a primary concern of current seismic building code.
- Incorrect: D – Currently, buildings are expected to endure damage from earthquakes and still provide protection for occupants.