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Designed by Kirksey Architecture, this striking new parking garage at Sam Houston State University's College of Osteopathic Medicine blends safety, visibility, and vibrant design. Featuring 1,185 low-glare LED luminaires, dynamic branding, and user-focused wayfinding, the five-level, 983-space garage enhances both campus presence and the daily experience for students, staff, and visitors.

PHOTO COURTESY KENALL MANUFACTURING
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CSI: Setting the Cornerstone for Community and Professional Success

The following is a re-publication of a blog post by Peter Kray, the lead writer for CSI.



In 2022, I was walking back to my hotel from the CSI National Conference

in Denver, the city where I grew up, when I suddenly realized just how much specifiers and the entire architecture, engineering, construction, and owner (AECO) profession have meant to almost every aspect of my life.

"My Matrix Moment" is how I describe it, referencing one of the penultimate scenes in the popular movie series when actor Keanu Reeves' Thomas Anderson character famously takes "the red pill," and sees a new reality everywhere he looks.

Which is exactly what happened as I walked past the high-rise office building where my dad used to work as an attorney, where I would sometimes come to meet him for lunch. Union Station, where I used to ride the ski train to Winter Park. And Coors Field, where in 2007, the beloved but perennially under-performing Colorado Rockies won their one and only National League Pennant.

What I saw was that these are the central locations where people live, work, and create the memories that matter the most. I saw how CSI informs those lives.

A sense of place

Ask CSI who they are, and you can go straight to the boilerplate: "A national not-for-profit association of professionals dedicated to improving the communication of construction information throughout continuous development and transformation of standards and formats, education and certification of professionals to improve project delivery processes."

And, "CSI members work tirelessly to effectively communicate the designers' vision, the material producers' solutions, and the constructors' techniques to create outstanding facilities that meet facility owners' objectives."

Those "facilities" include the schools I attended, meeting my new best friends at every age, and eventually at a university in Upstate, New York, where I met my amazing wife. Also, it is the churches we enjoyed with our two favorite families every Christmas Eve, changing the denomination each year based on who was hosting the dinner that night.

It includes the airport where I caught a flight home after that conference, to Santa Fe, where we fell in love with the adobe houses, the dry air, and that golden Southwestern light.

A nationwide network

What I like most about CSI, is how every member can have their own expertise, but still be dedicated to working together for the success of their colleagues and the project. This is a "diversified membership base of allied professionals involved in the creation and management of the built environment."

I enjoy sharing the stories of certifications, chapters, and community involvement that make it so straightforward for members to steer their own professional development.

Most of all, I like hearing the stories of lifelong friendship, awards and achievements, personal breakthroughs or highlights, and what it is that members do best.

Please help me tell those stories about you, your company, your chapter, or someone who you feel deserves the spotlight. As the lead writer for CSI, I am here to celebrate this community and all of its great work. I can't wait to talk.

You can email me at pkray@csinet.org. 🌈



Codes and Standards of Power-operated Swinging Doors

By Kevin Tish
PHOTOS COURTESY
HAGER COMPANIES

There are several codes and standards to consider when installing power-operated doors in a building. It can get complex when requirements such as accessibility and fire ratings are added. This article specifically covers the American National Standards Institute (ANSI)/Builders Hardware Manufacturers Association (BHMA) A156.10, *Standard for Power Operated Pedestrian Doors*, and A156.19, *Standard for Power Assist and Low Energy Power Operated Swinging Doors*, and the *International Building Code (IBC) 2021 Edition*, Chapter 11: Accessibility.

Historically, power operators have not been required by codes or standards at a national level, but this is set to change as state and local jurisdictions begin adopting the 2021 *IBC*, which requires at least 60 percent of all public entrances

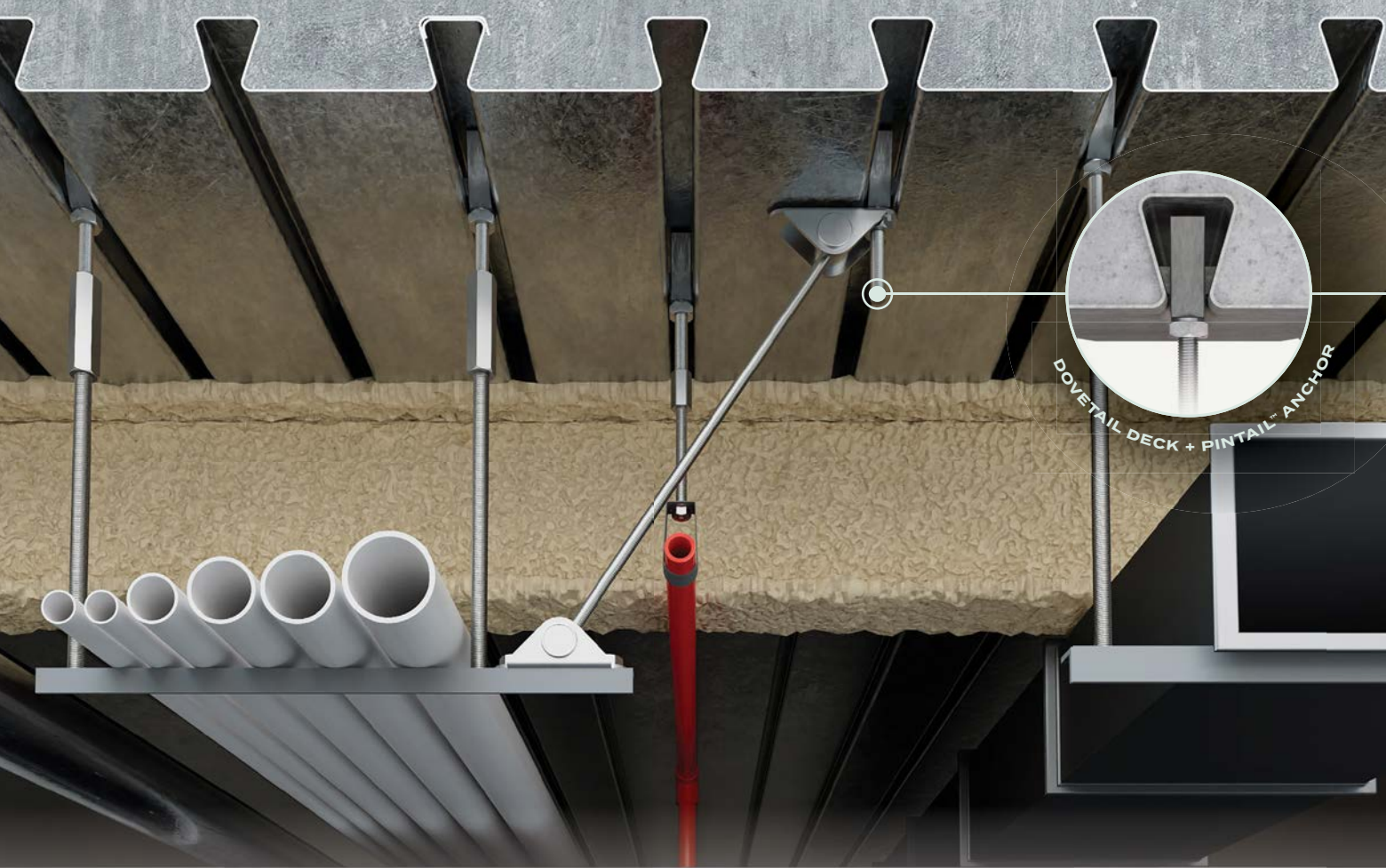
to meet the accessibility requirements. This is detailed below:

Subp. 5. *IBC* Section 1105, Accessible entrances

A. *IBC* Section 1105.1, *Public entrances*, is amended to read as follows:

1105.1, *Public entrances*. In addition to accessible entrances required by Sections 1105.1.2 through 1105.1.5, at least 60 percent of all public entrances shall be accessible.

As of September 2025, the following states have adopted *IBC* 2021 (mostly with amendments): Alabama, Alaska, Arkansas, California, Colorado, Connecticut, Georgia, Hawaii, Louisiana, Maine, Maryland, Massachusetts, Michigan, Montana,



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Table 1

**TABLE 1105.1.1
PUBLIC ENTRANCE WITH POWER-OPERATED DOOR**

Occupancy	Building Occupant Load Greater Than
A-1, A-2, A-3, A-4	300
B, M, R-1	500

a. In mixed-use facilities where the total sum of the building occupant load is greater than those listed, the most restrictive occupant load will apply.



Retail store in
St. Louis, Mo.

New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Ohio, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

As this topic involves many specifics and technical details, excerpts from various publications have been included for clarity, addressing the following questions:

- What is *IBC* 2021, 1105.1.1—Automatic doors?
- How do occupancy loads impact the usage of operators?
- Which type of buildings are affected?
- What are the two main types of automatic operators?
- What are ANSI/BHMA 156.10 and 156.19?
- How are fire-rated and non-fire-rated doors managed?
- How is the required clearance calculated?
- What signage should be used?
- What special features and benefits does a power operator offer?

2021 *IBC—Standard on Automatic and Power-Assisted Doors and Gates*

1105.1.1 Automatic doors. In facilities with the occupancies and building occupant loads indicated in Table 1105.1.1, public entrances that are required to be accessible shall have one door be either a full power-operated or a low-energy power-operated door. Where the public entrance includes a vestibule, at least one door into and one door out of the vestibule shall meet the requirements of this section.

The table lists four occupancies (Assembly [A] has four subcategories) where power-operated doors are required. This requirement applies to public entrances only, and the lists are not exhaustive. *IBC* defines a public entrance as an “entrance that is not a service entrance or a restricted entrance.”

- A-1—Production/performing arts/motion picture facilities such as movie theaters, concert halls, and theaters.
- A-2—Food/drink consumption facilities such as banquet halls, casinos, nightclubs, restaurants, cafeterias, taverns, and bars.
- A-3—Indoor assembly occupancies such as art galleries, bowling alleys, courtrooms, funeral parlors, indoor tennis courts, libraries, museums, places of worship, pool and billiard parlors, and waiting areas in transportation terminals.
- A-4—Indoor sporting events with spectator seating, such as arenas, skating rinks, swimming pools, and tennis courts.
- B—Business occupancies such as animal hospitals, banks, barber and beauty shops, dry cleaning, educational occupancies for students above the 12th grade, cafeterias, and similar dining facilities not more than 232 m² (2,500 sf) in area, laboratories for testing and research, motor vehicle showrooms, post offices, print shops, professional services (architects, attorneys, dentists, physicians, engineers), TV/radio stations, tutoring centers, martial arts studios, and gymnastic studios.
- M—Mercantile occupancies that display and sell merchandise where the public has access, such as department stores, drug stores, markets, greenhouses with public access, motor fuel-dispensing facilities, retail stores, and sales rooms.
- R-1—Hotel occupancies of transient nature, such as boarding houses with more than 10

occupants, congregate living facilities with more than 10 occupants, hotels, and motels.

A-1, A-2, A-3, and A-4 assembly occupancies with an entire building occupant load of 300 people or more are required to have accessible public entrances with at least one fully power-operated door or one set of power-operated doors (the exterior and vestibule). Business, mercantile, and R-1 occupancies with an entire building occupant load of 500 people or more are required to have the same.

When doors are required to be power-operated, the *IBC* references ICC A117.1, 2017 Edition, *Standard for Accessible and Usable Building and Facilities*, and it states:

404.3.1 Public entrances.

Where an automatic door or gate is required at a building or facility public entrance, it shall be a full powered automatic or a low-energy automatic door or gate.

404.3.2 Vestibules.

Where an entrance includes a vestibule, at least one exterior door or gate and one interior door or gate in the vestibule shall have the same type of automatic door or gate opener.

These two statements clarify that power-assisted doors are not to be used to comply with an automatic operator requirement (because they require manual operation). If an automatic operator is required, for whatever reason, only a fully power-operated door or low-energy door can be used. This is further explained in the commentary version of the standard.

Only if a project is required to comply with 2021 *IBC* and a public entrance is required to be accessible, the use group is one of those listed above, and the occupant load is greater than 300 or 500 (depending on the group), then it must comply with this new automatic operator requirement.

Now that the *IBC* 2021 Edition requires power-operated doors, let's look at the two main types to understand how to choose the correct operation for the application.

Two main types of power-operated doors

High-energy power-operated doors

Fully automatic doors, also referred to as high-



energy, often use a sensor to start the opening cycle of the doors. This sensor can be a motion-type device, mounted over the door opening or a floor mat with a built-in switch, which is activated when someone approaches the opening. The user does not have to think about how to open the door. Instead, they step into the activation field of the motion sensor, and the doors automatically open, allowing the user to enter or exit the building. Door openings with fully automatic doors are often found in large retail and grocery stores.

"This type of power-operated opening will require sensors to ensure that the door does not create a hazard to persons standing in the path of travel of the door," says James Stokes, director of corporate training, Hager Companies. "Guide rails, safety mats, presence sensors, or other safety devices must be mounted around these doors to prevent accidents."

A "knowing act" switch can be used, but due to the opening speed and force, added safety sensors would be required. In addition, certified installers must install and service these operators to ensure that the safety sensors, mats, and other products are calibrated and all the codes and standards are followed.

Low-energy power-operated doors and power-assisted doors

Low-energy doors are not subject to such strict requirements due to their slower opening speed and lower opening force. Door initiation is

Healthcare facility
in Henderson, Nev.



Traditional wheelchair sign and forward motion wheelchair sign.

another key factor, as they do not open without a specific act to set them in motion, which is referred to as a “knowing act.”

- ANSI/BHMA A156.19-2019—1.1 Requirements in this standard apply only to swing door operators. The operator types are power assist and low-energy power operators for pedestrian use and some small vehicular use. It does not address doors, finishes, or hardware. The activation of all doors described in this standard requires a knowing act. Included are provisions intended to reduce the chance of user injury or entrapment. These products are intended to improve accessibility.
- ANSI/BHMA 156.19-2019—4.1 Activation: The operator shall be activated by a knowing act.

There are many options that can be used as “a knowing act.” The 2019 edition of ANSI/BHMA A156.19 defines a knowing act as:

Any conscious action with the expected result of opening a door. This includes but is not limited to: wall or jamb-mounted contact switches such as push plates; the action of manual opening (pushing or pulling) a door; and controlled access devices such as keypads, card readers, wireless transmitters and key switches.

To further explain this definition, look at this in application. The remote switch (sometimes placed in a post or bollard on the exterior) or jamb-mounted switch (mounted directly onto the frame) is usually labeled with a wheelchair symbol or text that may read “push to open.” This switch is depressed to open the door. COVID-19 brought forth the need for contactless switch options, also considered a knowing act switch. These have a short-range motion sensor so that a hand directly in front of it, without actual physical contact, activates the switch and opens the door.

Where an access-controlled door is always closed and in the locked position, a valid credential

presented to a reader can be used to unlock the door and signal the low-energy operator to open the door. This also qualifies as a knowing act.

Another option is referred to as “power-assist” or “push-and-go.” A user sets the door in motion, and then the low-energy operator takes over to complete the opening cycle. Examples of these opening types can be found in many facilities, including schools, hospitals, office buildings, and public restrooms.

Additionally, the A156.19 4.2 standard recommends the mounting location of a knowing act switch. Actuation switches should be located:

- A maximum of 3.7 m (12 ft) from the center of the door (0.3 to 1.5 m [1 to 5 ft] is preferred)—when further, the recommended increased hold-open time is one additional second per 0.3 m (1 ft) of distance:
 - Where the switch remains accessible when the door is opened, and the user can see the door when activating the switch.
 - In a location where the user would not be in the path of the moving door; and at an installation height of 864 mm (34 in.) minimum and 1,219 mm (48 in.) maximum above the floor.

Geographical specifics of knowing act switches

As noted at the beginning of this article, specifying the correct hardware can become complex when multiple requirements, such as accessibility and fire ratings, are added. However, the differences between national, state, and local codes also need to be considered.

For example, while ANSI/BHMA A156.19 only requires one actuator, the *California Building Code (CBC)* requires two push plate actuators. One is mounted between 178 mm (7 in.) minimum and 203 (8 in.) maximum from the floor or ground surface to the centerline of the switch, and the second is mounted between 762 mm (30 in.) minimum and 1,118 mm (44 in.) maximum above the floor to the centerline of the switch. The *CBC* allows vertical actuation bars to be used in place of two separate actuators. However, the operable portion of the bar must be mounted, “so the bottom is 5 inches (127 mm) maximum above the floor or ground surface, and the top is 35 inches (889 mm) minimum above the floor or ground surface.” The bar must also be a minimum of 51 mm (2 in.) wide.

Opening and closing speeds and hold-open timings

ANSI/BHMA A156.19

4.3 Opening: Doors shall open from closed to back check, or 80 degrees whichever occurs first, in 3 seconds or longer as required in Table 1. Backcheck shall not occur before 60 degrees. Total opening time to 90 degrees shall be as in Table II. If the door opens more than 90 degrees, it shall continue at the same rate as backcheck speed.

4.4 Time Delay: When powered open, the door shall remain at the fully open position for not less than 5 seconds. Exception: When push-pull activation is used, the door shall remain at the fully open position for not less than 3 seconds.

4.5 Closing: Doors shall close from 90 degrees to 10 degrees in 3 seconds or longer as required in Table 1. Doors shall close from 10 degrees to fully closed in not less than 1.5 seconds.

Due to slower opening and closing speeds, built-in safety features, and knowing act switches, power-assist doors and low-energy doors do not require any additional safety sensors.

Power-operated doors and maneuvering requirements

Generally, a power-operated or low-energy door is not required to meet maneuvering clearance requirements for entry. However, if the door is being used to meet accessible means of egress, maneuvering clearance is required in case it loses power. Maneuvering clearance requirements can be exempted if loss of power is addressed with battery backup, if doors remain in the open position upon loss of power, or if a break-away feature is included. Power-assist doors, on the other hand, require maneuvering clearances.

ICC A117.1

404.3.3 Clear width.

Doorways shall have a clear opening width of 32 inches (815 mm) in power-on and power-off mode. The minimum

clear opening width for automatic door systems shall be based on the clear opening width provided with all leaves in the open position.

404.3.4 Maneuvering clearances.

Maneuvering clearances at power-assisted doors and gates shall comply with Section 404.2.3. Maneuvering clearances complying with Section 404.2.3 shall be provided on the egress side of low-energy automatic and full power automatic doors and gates that serve as part of an accessible means of egress.

404.2.3 Maneuvering clearances.

Minimum maneuvering clearances at doors and gates shall comply with Section 404.2.3. Maneuvering clearances shall include the full clear opening width of the doorway and the required latch-side or hinge-side clearance.

Signage

Doors complying with ANSI/BHMA A156.10-2017 section 11 signage “shall be equipped with signage visible from both sides reading ‘AUTOMATIC

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Fast food restroom
in Kingston,
Ont., Canada.

DOOR' with letters 13 mm (0.5 in.) high minimum." There are also additional signage requirements depending on specific applications.

ANSI/BHMA A156.19-2019, chapter 6, requires signage on both sides of the opening that clearly instructs the user about the door's operation and function. The lettering must be a minimum of 16 mm (0.625 in.) high, and the signs must be mounted 1,270 mm (50 in.) $\pm$ 305 mm (12 in.) from the floor to the sign's center line.

Power assist doors (6.3) using a separate wall switch require signage noting "Easy Open Door—Activate Switch Then Open Door." The standard even states that the "lettering shall be white, and the background shall be blue."

Low-energy doors (6.4) states, "All low energy doors shall be marked with signage visible from both sides of the door with the words 'CAUTION AUTOMATIC DOOR' and include the sign requirements." Additional requirements are also added for knowing act switches and push/pull doors.

The traditional handicapped wheelchair sign has been updated to show a more dynamic, forward-moving image. New York and Connecticut have already adopted this new symbol.

Variations when fire codes are required

When power-operated doors are fire-rated, they must be equipped with a device that automatically releases, thus disconnecting the power to the operator at the time of fire. This allows the doors to self-close and positively latch.

Push and pull plates on doors

Openings with push-and-pull bars or plates do not have latches to keep the door shut or prevent the opener from working, so they can be activated at all times and allow the operator to work easily.

Exit devices can have the latches mechanically retracted (dogging the device). Dogging doors makes this basically a push/pull type of door. This is often done at the main entrance of a public space, such as the lobby of an office or a retail space. During business hours, the doors are unlocked and can be used manually or by pressing the actuator to open the door. In this scenario, though, when the door is latched, the operator should be turned off or disabled. This is often done with a key switch to interrupt the circuit from the actuator to the operator, thus eliminating damage that occurs when an operator tries to open the door and is not able to because of the latch being engaged.

Electrified and latch retraction locking devices

Electrifying the locking device can provide more options and flexibility. With this, the door can be used even when it is latched and/or locked.

Brian Clarke, director of specifications, Hager Companies, notes, "This is a better solution for exterior openings as these doors often have HVAC pressures or wind conditions that can push or pull the door open when it is not latched."

This also allows the inside button to be active at all times (even when the door is locked), and then a key switch, timer, or access control system is used to disable the outside button when the door is locked to allow for security. With an access control system or a timer, the doors can be set to lock and unlock on a programmed schedule. This provides greater security and allows the operator to be used after business hours to exit the building.

Sequencing

There are times when an exterior and vestibule door are desired to work together, allowing a

person to press one button and have both doors in the series open, rather than individual presses of a button for each. This would be the same for exiting. This sequencing is done either through the logic boards in the operator or a relay board called a sequencer. It is a desirable feature for areas that have individuals with physical difficulties or where deliveries occur, to allow easier use of the openings. Some examples include physical rehabilitation clinics, assisted living facilities, and entrances leading to package rooms or bicycle storage areas.

Barrier-free restrooms

These are not currently required by code in the U.S., but could be soon. Canada now requires these systems to be installed in public buildings. Special relay boards are used to create a specific operation. A user presses an actuator, located outside the restroom, which activates the automatic opener. If there is someone already using the facility, the door will remain closed. Once in the restroom, there is either an electrified lock or strike that is activated by a push button inside the restroom. This button will have a visual indicator or lettering that states “push to lock.” This button signals to the relay board that the room is in use, thus locking the electrified locking device and disabling the operator, preventing others from entering from the outside. This feature is automatically reset when the door is opened (generally by a door

position switch, a request to exit switch, or activation by an inside button of the operator), allowing other users to enter.

Smoke evacuation functions

There are situations where a large atrium is required to have a smoke evacuation system. For the system to get enough airflow to work properly, the outside doors must automatically open and stay open to allow airflow. Operators can be used in this situation. They would be activated by the smoke detection system and open these doors. When fully opened, the doors would then send a signal to the smoke evacuation system, allowing the necessary fans to be activated.

Conclusion

The adoption of *IBC* 2021 Chapter 11 has had, and will continue to have, a significant impact on the embracement of automatic operators. With the many new features available with relay boards and selective programming, low-energy automatic operators can not only fulfill the remits of accessibility but also offer extensive convenience and security benefits for building owners and users.

Always be sure to consult with your Authority Having Jurisdiction (AHJ) when designing a system involving automatic operators to ensure your solution meets their expectations and the local codes. 🚪



additional information

AUTHOR



Kevin Tish, AOC, CFDAI, DHC, DHT, CDT, has been involved in many aspects of the building industry. He is currently the manager of the Architectural Specification Writers. He has credentials from both the Construction Specifications Institute (CSI) and Door and Hardware Institute (DHI). He

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KEY TAKEAWAYS

The 2021 *International Building Code (IBC)* introduces major accessibility requirements, mandating power-operated doors at 60 percent of public entrances in many occupancies. Compliance involves navigating ANSI/BHMA A156.10 and A156.19 standards, occupancy thresholds, and safety features. Understanding distinctions between high-energy and low-energy operators,

signage, fire code implications, and local amendments is essential for proper specification and code alignment.

MASTERFORMAT NO.

01 41 00—Regulatory Requirements
08 71 00—Door Hardware
08 71 13—Power Door Operators
08 74 00—Non-Integrated Access Control Hardware
28 10 00—Access Control

UNIFORMAT NO.

B2050.90—Exterior Door Supplementary Components
C1030.90—Interior Door Supplementary Components
D7010.10—Access Control

KEYWORDS

Division 01, 08, 28 Power-operated doors

Ask The Expert

Do you have a question regarding the specific use of a product, material, or technique for a project that you are currently working on?

If so, these experts may have the answers you are looking for. These leading manufacturers and suppliers have provided solutions to some of the more common questions asked by AECO community. From the simplest questions relating to which

product may be best suited for inclusion in specifications to how materials can assist in achieving green certification, you will find the answers here. In addition, you can also discover best practices related to installation to ensure product longevity.

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Q: What are the benefits of your sublimation process on Mosaic Planks & Battens?

A: Our proprietary sublimation process embeds the woodgrain or any of the numerous finishes available, directly into the powder-coated finish, rather than applying ink with a clear UV topcoat. This produces a surface that is more realistic in appearance and highly resistant to scratching, fading, and weathering. Because the finish is baked into the coating, it performs consistently over time, which is why Mosaic products carry a standard 15-year finish warranty, with a 20-year specialty option available.

Q: How does the design of Mosaic Planks allow for simple installation?

A: Mosaic Planks use precision-engineered interlocking profiles that align quickly in the field. Stainless steel clips are supplied with every order to accommodate thermal expansion and moisture drainage. The system can be installed over open framing or solid

substrate, in multiple orientations, top-down, bottom-up, or side-to-side. We also manufacture matching extruded and sublimated trims and flashings to ensure complete design continuity.

Q: What advantage does the Mosaic Batten System provide architects?

A: The Mosaic Batten line includes a wide range of profiles, from solid battens to assembled and L-Connect options. Concealed fastening options allow for

clean, uninterrupted lines, while exposed bracket systems deliver a more industrial aesthetic. This flexibility enables architects to achieve both functional performance and creative design expression.

Q: Can Mosaic planks be installed directly to a substrate?

A: Mosaic planks are a rainscreen system and can be installed directly to a substrate, however a hat channel is recommended to allow for better moisture weep.

author information



Cheryle Mundy is the Business Development Manager for the East Coast with Lumabuilt. Starting her career as an Interior Designer with an Interior Design degree from Florida

State University. Cheryle's career has been focused on Business Development in the commercial design and construction product industry for the past 25 years. Cheryle is a results-driven professional, with a proven track record of increasing market share by understanding client needs and delivering expert product knowledge and excellent customer service.



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Q: When specifying heavy timber for a project, what are the most critical factors architects and specifiers should consider?

A: The most important step is making sure the design goals match the project's structural and environmental needs from the start. Heavy timber serves both purposes—it's part of the structure and part of the architecture—so involving a timber fabricator early is key. Choices like wood species and how the pieces connect affect how the building looks and how it performs. Moisture control should also be planned early, both during construction and throughout the building's life, through proper detailing, finishes, and ventilation. Unlike steel or concrete, timber performs best when it can stay balanced with its environment. When everyone works together early, the result is a structure that's strong, durable, and beautiful.

Q: How can specifiers balance heavy timber's visual appeal with building performance and code requirements?

A: Heavy timber already supports many sustainability and energy goals, but meeting code means understanding its rated assemblies and connection details. Many tested systems are available that

meet fire and structural standards while keeping the timber exposed. Specifying these systems early helps avoid redesigns later and ensures compliance from the start. Working with a fabricator familiar with these details lets architects keep the warmth and beauty of wood without compromising safety or performance.

author information

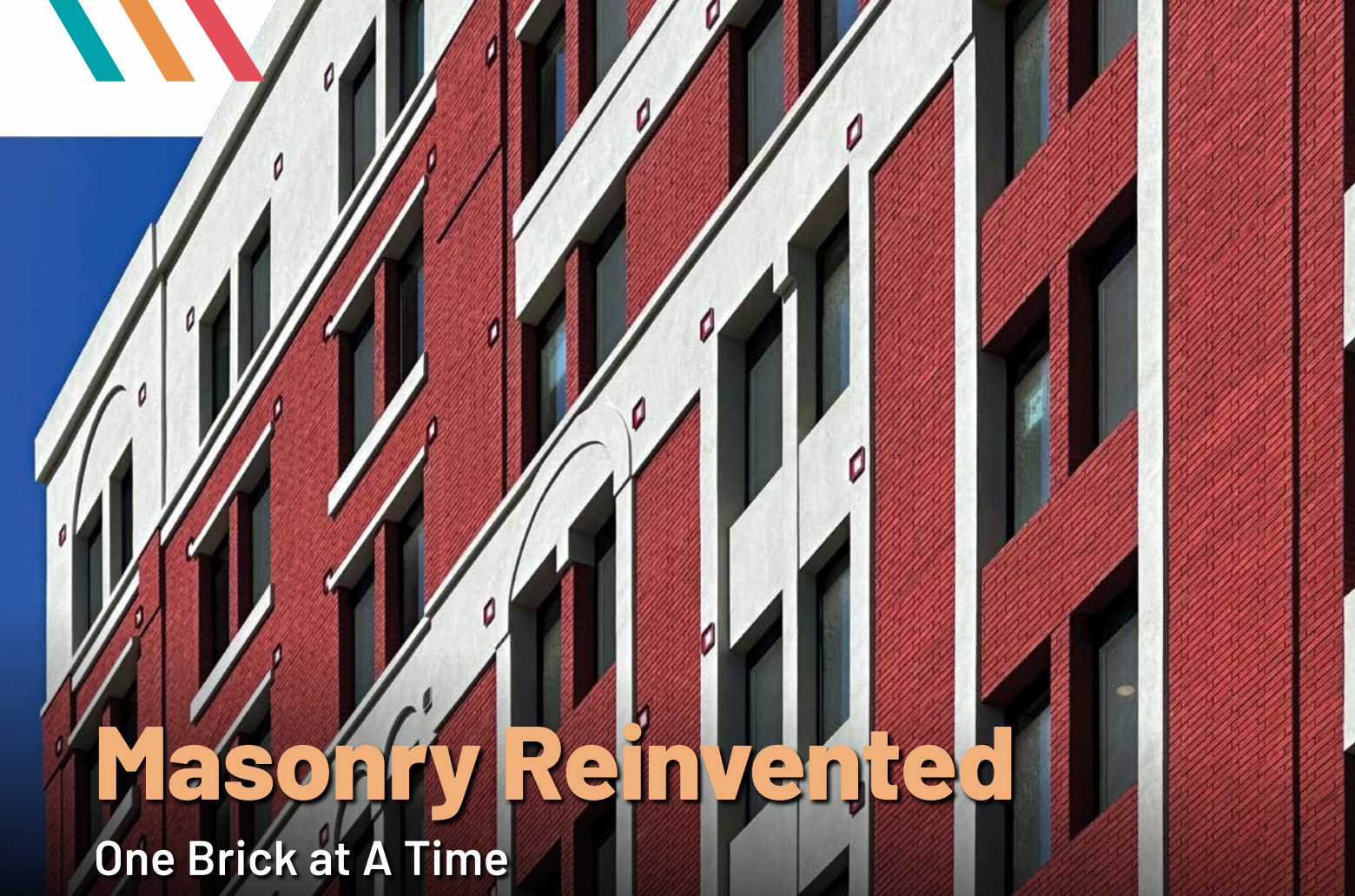


Mike Banta
From a young age, Mike was fascinated by the exposed structural elements of timber framing and admired the longevity and character of the timbers. For nearly 20 years,

he has been designing timber frame structures and enjoys sharing his expertise in structural steel and other architectural materials, including cross-laminated timber, glue-laminated timber, and reclaimed and recycled timber. He also has experience in mechanical, restorative, and sustainable design, as well as technical drafting and detailing, CNC programming, prototyping, and quality control.



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Masonry Reinvented

One Brick at A Time

By Karine Galla

PHOTOS COURTESY STO CORP.

Brick has been a staple in construction for thousands of years, celebrated for its durability, character, and timeless aesthetic.

First used around 7000 BC near Jericho, bricks were made by hand and heated in the sun to harden. But around 3500 BC, fired brick was invented, and its popularity spread quickly, even into cooler climates. Romans then introduced mobile kilns, allowing them to use their inventive round, square, oblong, triangular, and rectangular-shaped bricks throughout the empire. And in 1925, a brickmaking machine increased production from 36,000 handmade bricks per week to 12,000 machine-made bricks per day.¹ A benefit of well-constructed brick masonry is its durability, as it can last for centuries if properly maintained.

While the fundamental appearance of brick has remained iconic, its construction and application methods have evolved significantly over time. The introduction of thin brick veneers in the '50s offered a lighter-weight solution for renovation and retrofit projects, preserving the aesthetic of full-depth masonry without the structural demands. More recently, resin-cast brick has emerged as a next-generation alternative, gaining popularity in Europe since

the '80s and now expanding in use across North America. As design priorities increasingly focus on performance, sustainability, and constructability, these innovations, alongside other engineered solutions, are helping to overcome the limitations of traditional masonry. This article explores those challenges and the modern systems now enabling specifiers and designers to achieve a brick aesthetic without compromising on performance, budget, or environmental considerations.

Understanding the constraints of traditional brick

Despite its visual appeal and durability, traditional brick presents notable challenges on modern job sites, particularly when project requirements include high-performance enclosures, energy efficiency, or accelerated construction timelines. Traditional masonry bricks function as a reservoir cladding due to their porous nature, absorbing and retaining water that must be managed through proper drainage and ventilation within the wall assembly to avoid issues such as rot, mold, or condensation. While external insulation can be added to improve thermal performance, it typically must be mechanically attached to the sheathing, followed by additional anchors to secure the brick. These penetrations not only increase the risk of moisture intrusion but also create thermal bridges that reduce the overall effectiveness of the insulation.



A lightweight, energy-efficient prefabricated exterior wall panels were used on this hospital expansion, combining the warmth of a brick aesthetic with faster installation, reduced on-site labor, and consistent quality control.

Bricks are heavy and bulky, making them labor-intensive to work with, and they require skilled masons for proper installation. However, beyond those obvious drawbacks, traditional brick masonry presents additional complexities. It typically involves full-depth bricks laid with mortar, either as load-bearing construction or as a veneer over a structural backup wall. These assemblies demand not only experienced labor but also extensive material handling and detailed support systems, which can increase cost, extend timelines, and complicate coordination on modern job sites. Key limitations include:

Limited structural flexibility

Brick is well-suited for low-rise and modular construction. However, recent trends have shifted toward more open spaces with fewer walls. Unfortunately, traditional brick masonry makes it challenging to achieve openings with wide spans without the use of support beams or columns.

Moisture management challenges

Bricks are porous and therefore retain moisture, which often leads to cracking, spalling, and efflorescence.

Environmental impact

Clay is a finite resource that must be mined and transported. Additionally, bricks are fired in fossil fuel-powered kilns that are major contributors to climate change and a significant source of CO₂ emissions, greenhouse gas (GHG) emissions, and short-lived climate pollutants (SLCPs).²

According to The Climate and Clean Air Coalition (CCAC), “Brick kilns are recognized as one of the largest stationary sources of black carbon, which, along with iron and steel production, contribute 20% of total black carbon emissions.”

In addition to emissions from the firing process, the heavyweight of traditional brick increases fuel consumption during transportation and often leads to greater material waste on job sites due to breakage or overage.

Now that the need for modern alternatives is understood, let’s discuss some of the options that have emerged over the past few years.

Meeting performance goals with brick alternatives

Unlike traditional masonry that is assembled on-site brick by brick with mortar joints, modern alternatives prioritize ease of installation, thermal performance, and weight reduction. These options span from lightweight veneers and resin-cast finishes to prefabricated panel systems, all designed to replicate the look of brick without the structural, labor, and energy drawbacks.

Growing concerns about sustainability have further accelerated demand for these alternatives. In a national survey conducted by Talker Research on behalf of Glen-Gery, it was found that 78 percent of architects and 58 percent of homeowners expressed concern about sustainability in new project designs or renovations, with 60 percent of architects stating that sustainability has a major influence on their choice of brand or product.

As a result, manufacturers have made a concerted effort to reduce the construction industry’s “embodied carbon,” which refers to the greenhouse gas emissions associated with every stage of a building’s construction, from manufacturing to demolition. Brick alternatives have been created from virtually every imaginable material, such as expanded cork, construction waste, and mineral fibers.

MIT engineers are also helping to solve the problem. They are developing a new kind of reconfigurable masonry made



Lightweight brick integrated into a complete, warrantied wall system—delivering thermal performance, moisture control, while resembling traditional masonry.



from 3D-printed, recycled glass. These strong, multilayered glass bricks, each in the shape of a figure eight, are designed to interlock, much like LEGO bricks.³

Here is a roundup of some of the most popular brick alternatives on the market today.⁴

Thin brick

Thin brick is a lightweight, decorative brick veneer that resembles traditional brick, but with reduced structural weight and cost. Thin bricks can be made from clay or concrete and are typically applied to both interior and exterior surfaces. On the exterior, thin brick can be adhered to a wide variety of substrates, including exterior insulation and finish system (EIFS), stucco assemblies, fiber cement board, cement plaster, rainscreen systems, and prefabricated panelized systems.

Unlike full-depth masonry, thin brick is applied using adhesives or mechanical systems over a backup wall, reducing structural demands and installation time. Many modern rainscreen systems are now designed to integrate thin brick, further streamlining installation and reducing dead load on the structure.

When installed over approved substrates, thin brick adhesives—typically polymer-modified mortars or epoxy-based systems—provide long-term bond strength and durability. These adhesives are engineered to meet ASTM

standards for shear and tensile strength, and to withstand thermal movement, freeze-thaw cycles, and moisture exposure. Some systems also incorporate mechanical attachments or mesh-backing for enhanced security. Properly specified and installed, these adhesives are designed to last the lifetime of the building. The Environmental Product Declaration (EPD) for one proprietary integrally colored organic mortar for example, lists a 75-year Reference Service Life (RSL).

These versatile applications make thin brick a practical solution for cladding on multifamily housing, commercial buildings, institutional projects, and retrofit work where full-depth masonry is not feasible. Interior uses range from feature walls and receipt areas to retail environments, offering a traditional aesthetic with minimal impact on structural design or wall depth.

Faux brick panels

Faux brick panels are typically made from lightweight materials, such as polyurethane or composite materials, and are designed to replicate the appearance of brick. They can be easily installed over existing surfaces, offering a DIY-friendly option for adding a brick-like aesthetic. However, due to the materials used in their composition, faux brick panels may be limited to combustible construction types. Specifiers should review fire performance data, such as ASTM E84, surface burning characteristics, and verify code compliance for use in exterior or noncombustible assemblies.

Engineered brick

Some companies have developed engineered brick products that offer a combination of brick aesthetics and performance benefits. These include lightweight, insulated brick veneers and even brick-like materials made from reclaimed or recycled materials, such as waste-based bricks. These products are commonly used in sustainable construction project applications where reducing embodied carbon or structural load is a priority.

Installation methods vary by product. Some engineered bricks are adhered directly to prepared substrates using specialized mortars or panelized mounting systems, similar to the installation of thin brick. Others are factory-applied to prefabricated wall panels and installed as part of a complete exterior assembly. Unlike conventional brick masonry, these solutions typically eliminate the need for on-site bricklaying or mortar joints, enabling faster installation and less labor-intensive execution.

It is worth noting that “engineered brick” may also refer to engineering bricks, a traditional product known for high compressive strength, low water absorption, and durability. These dense, kiln-fired bricks are typically used in structural



A thin brick cladding installed over continuous insulation (c.i.) in a rainscreen assembly, offering design flexibility without compromising energy efficiency.

applications such as foundations, retaining walls, and damp-proof courses. However, they are distinct from the modern cladding systems described above, which are designed for aesthetic flexibility and envelope performance rather than structural load-bearing.

3D printed glass bricks

Engineers have also developed a new kind of reconfigurable masonry using 3D-printed, recycled glass, offering a sustainable and reusable option for building facades and internal walls.

Brick sheets

Thin bricks are adhered to a webbing/mesh layer to form a small brick panel, with the bricks already laid out in specific patterns. This allows for quicker installation and is ideal for DIY applications.

Resin-cast bricks

These are precision-molded bricks made from high-performance resin materials. They offer exceptional consistency, low weight, and design versatility—including the ability to match legacy brick profiles, textures, and colors. Resin-cast bricks are ideal for both interior and exterior applications where weight or substrate constraints make traditional brick or even thin brick impractical. They can also be integrated into exterior cladding systems when installed over compatible substrates. Many resin-cast brick solutions are fully tested to meet fire safety standards, making them suitable for use in code-compliant wall assemblies across various construction types.

A brick aesthetic that integrates seamlessly across systems

Modern brick-alternative finishes are no longer limited to standalone cladding products—they can now be fully integrated into complete, warrantied wall systems that

address both performance and design objectives. Whether used in rainscreen assemblies, stucco applications, continuous insulation (c.i.) systems, cement board installations, or direct-applied finishes, these solutions allow specifiers to achieve a realistic brick aesthetic without compromising on thermal performance, moisture management, or constructability.

These systems typically consist of multiple coordinated layers that function together as a high-performing building envelope. Common components include a liquid-applied or sheet-based air and water-resistive barrier (AWRB), c.i. for thermal control, drainage or ventilation cavities, and a lightweight cladding finish such as resin-cast or thin brick. Unlike assemblies where individual components are selected and installed separately, integrated systems are tested and warranted as a whole, ensuring compatibility across layers, streamlining specifications, and reducing risk for the design and construction team.

These integrated systems provide a range of benefits:

- Lightweight construction that reduces structural load and eases transportation
- Embodied carbon is lower compared to traditional masonry assemblies
- Improved jobsite safety, especially when working at height
- Enhanced design flexibility, supporting custom bond patterns, textures, and color matching
- Energy-efficient retrofits, enabling upgrades to existing facades without major structural modification
- Single-source warranties, offering assurance of system compatibility across air/moisture barriers, insulation, and finish layers

By embedding the aesthetic within a complete wall assembly, these solutions support holistic building envelope performance, meeting evolving code requirements while delivering the timeless look of brick.



Field-application showing brick paneling, joint layout, and color range—an essential step for visual approval and quality control.

Code compliance and testing standards

When specifying brick alternatives, especially those integrated into wall systems, code compliance must extend beyond aesthetics. Performance testing plays a critical role in ensuring these assemblies meet both prescriptive and performance-based requirements in energy and building codes.

Assemblies with integrated insulation and finishes are typically tested under:

- ASTM E2357 for air leakage
- ASTM E331 for water penetration
- ASTM E84 and NFPA 285 for fire performance
- ASTM E2485 for impact resistance
- ASTM C1388 for finish durability

In hurricane-prone areas, assemblies may also need approval under Miami-Dade Notice of Acceptance (NOA) or Florida Product Approval, demonstrating resistance to wind-driven rain and cyclic loading. Systems that have passed full-scale testing under these standards help reduce liability and streamline the approval process with Authorities Having Jurisdiction (AHJs). Verifying these results through system-level testing, not just component performance, is essential for ensuring building envelope integrity.

Specification guidance for brick aesthetic systems

To ensure constructability and performance, specifications for brick-alternative systems should clearly define system scope and performance requirements under Divisions 04 or 07, depending on classification. Key elements to include:

- Mockups—Require field-constructed mockups for visual approval, joint layout, and finish confirmation.
- Substrate requirements—Clarify acceptable backup materials, fastener types, and surface prep conditions.
- Thermal and moisture performance—Specify c.i. values (e.g. R-13+ c.i.), compatibility with air and water-resistive barriers (AWRBs), and flashing integration.

- Finish requirements—Define acceptable texture, joint pattern, color range, and dimensional tolerances.
- Installer qualifications—Require installers to be trained or certified by the system manufacturer, when applicable, to ensure quality assurance.
- Warranties and compliance documentation—Request documentation, including third-party test reports, Environmental Product Declarations (EPDs), Health Product Declarations (HPDs), and installation guidelines.

Coordination between specifications for cladding, insulation, and waterproofing is critical, especially at transition details such as parapets, windows, and expansion joints. A well-written spec can reduce RFIs, streamline bidding, and promote long-term performance.

Case study

A 13-story affordable housing project in Brooklyn, N.Y., presented a unique challenge: deliver high energy performance, maintain a classic brick aesthetic, and stay on a compressed timeline—all within the constraints of a modular construction approach. The design team, collaborating with the developer and architect, pivoted from a traditional site-built process to a volumetric modular strategy to streamline scheduling and minimize neighborhood disruption.

To meet Passive House standards, the project required a highly insulated, airtight facade system that could adapt to imperfections in the modular substrate. To meet thermal goals while honoring the surrounding area's traditional architectural character, a c.i. wall system with a thin, resin-cast brick aesthetic was selected.

The exterior cladding, integrated as part of a full system that included air and moisture control layers, was chosen for its lightweight properties. This made it easier to transport and install across 18 pre-built modules per floor. The consistent, factory-applied insulation provided a level substrate, allowing installers to overcome irregularities between modules on-site.

The thin brick finish offered the tactile realism of traditional brick without the structural weight or emissions tied to kiln-fired masonry. Its molded, lightweight composition made it easier to apply around architectural features like columns and returns, while supporting faster installation and long-term durability.

This project highlights how integrated wall systems can bridge the gap between traditional aesthetics and next-generation performance. It illustrates how today's brick alternatives can meet energy codes, project budgets, and visual goals, especially in high-density, urban multifamily construction.

Designing for the next generation

The desire for brick is not fading; it is evolving. Today's specifiers are balancing historical context and visual intent with performance demands and climate goals. By embracing modern brick alternatives, design teams can maintain architectural continuity while advancing toward energy-efficient, low-carbon building envelopes.

With systems that offer greater control, customization, and compatibility, the next era of brick aesthetic is not only more adaptable—it is smarter. 🌈

Notes

¹See notes online at [constructionspecifier.com/masonry-reinvented](https://www.constructionspecifier.com/masonry-reinvented)

additional information

AUTHOR



Karine Galla is the director, product management for Sto Corp. She has more than 20 years of experience in product marketing in exterior insulation and finish systems (EIFS), stucco, air and moisture barriers, and other materials. Galla has a master's degree from the University of Lyon, France. She is multilingual and holds the Association of the Wall and Ceiling Industry's (AWCI's) EIFS Doing it Right and Building Envelope Doing it Right certifications, as well as the ISO internal lead auditor certification from Georgia Tech.

KEY TAKEAWAYS

Brick remains a timeless aesthetic, but modern construction demands lighter, sustainable alternatives. Innovations like thin brick, resin-cast units, faux panels, and 3D-printed glass enable

faster installation, lower structural loads, and reduced carbon emissions. Integrated wall systems now balance performance, moisture control, energy efficiency, and design flexibility for next-generation, high-density construction.

MASTERFORMAT NO.

04 20 00—Unit Masonry

UNIFORMAT NO.

B2010—Exterior Walls

B2020—Exterior Wall Finishes

KEYWORDS

Division 04

Brick alternatives

Masonry



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product spotlight



Glow and Behold

LEDs Meet Innovation



By Anthony Sarti
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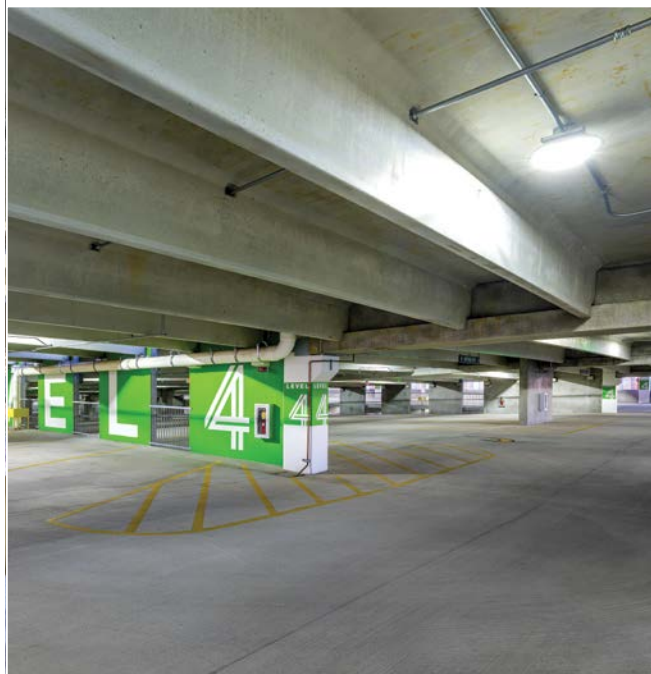
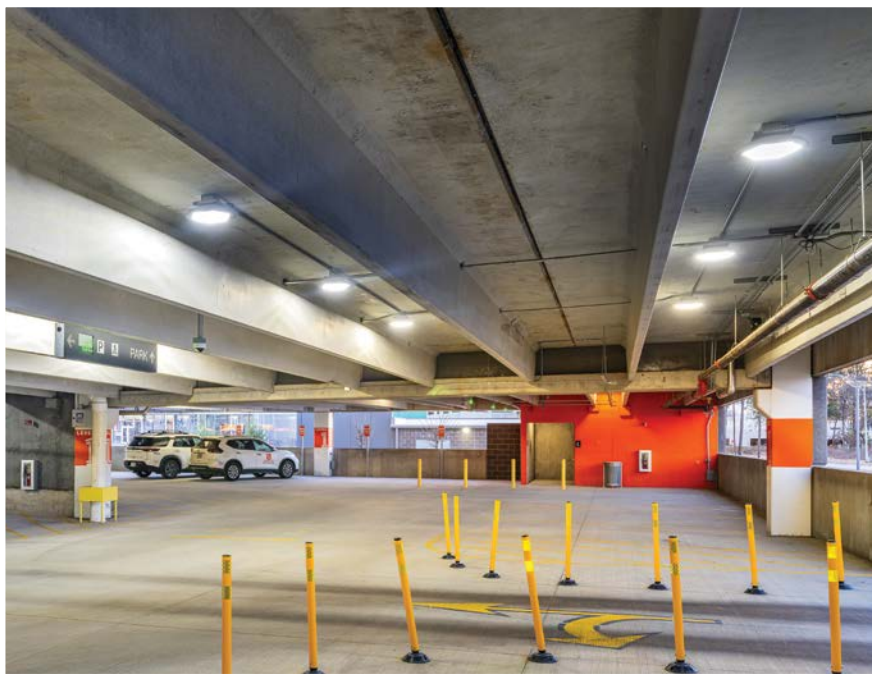
In fall 2024, the College of Osteopathic Medicine (COM) within Sam Houston State University completed a 30,467-m² (328,000-sf) parking garage that accentuates the college's presence in Conroe, Tex., about 64 km (40 miles) north of Houston. The five-level garage offers 983 parking spaces in a highly visible structure that acts as a billboard for those traveling on Interstate 45.

The structure provides additional parking for COM's students, faculty, and staff, as well as parking for a four-story health profession building currently under construction. Designed with end users in mind, the facility boasts

multiple features, including lighting, that were selected for their ability to improve the experience for garage patrons.

Stabilizing the structure

The project is located on sandy soils once occupied by the West Fork of the San Jacinto River. While sand is an effective natural solution for stormwater runoff, the construction team had to employ a ground improvement system. The piers were installed 3 to 3.6 m (10 to 12 ft) beneath the surface to stabilize the structure in the sandy terrain. This enhanced the soil



strength by compacting the aggregate tightly within the piers, thereby reducing settlement and improving support for the structure. The process involved drilling deep holes into the ground and filling them with layers of aggregate material. Each layer was meticulously compacted using a specialized ramming tool, resulting in a dense and stable column that could support the garage's weight. This technique not only improved the load-bearing capacity of the soil but also mitigated potential settlement issues that could arise from the unpredictable nature of the sandy riverbed.

"The use of the proprietary ground improvement system exemplifies the project's commitment to employing sustainable and innovative construction practices, ultimately enhancing the overall integrity and longevity of the parking garage," said Lance Smith, project executive for Hoar Construction, the general contractor on the project.

Enhancing the user experience

The exterior of the structure includes backlit, vertical, colored fabric panels that depict abstract DNA sequencing, supporting the design language of the existing campus while also providing essential ventilation. To enhance the connection to the COM and the visibility of the garage, this exterior lighting can change colors for special occasions and national holidays via programmable luminaires. Leveraging views from the freeway, two light boxes showcase the Sam Houston State University logo on the north and east facades.

Additionally, wayfinding and branding graphics help visitors easily find stairways and elevators once inside the garage. The main set of stairs employs a unique design that showcases a health-inspired graphic combining university brand colors, DNA sequencing, and images related to human health.

To enhance the user experience, the garage employs gateless parking access, license plate recognition cameras, and a parking guidance system. Electric vehicle charging stations are an added convenience for faculty, staff, students, and visitors.

This vertical lighting fixture improves illumination to help drivers identify oncoming pedestrians, safely enter and exit vehicles, and enhance visibility of objects, such as columns, within the garage.

The fixture's sleek architectural design complements the structure, and its lightweight construction—around 3 kg (7 lb)—made installation easier for the contractor.

Installed inside the garage, these luminaires provide uniform, bright light to help students, staff, and visitors feel safe.

PROJECT DETAILS

Owner: Sam Houston State University's College of Osteopathic Medicine

Architect, branding, and graphics provider: Kirksey Architecture

Parking consultant: Walter P Moore

Structural and civil engineer: Dally + Associates

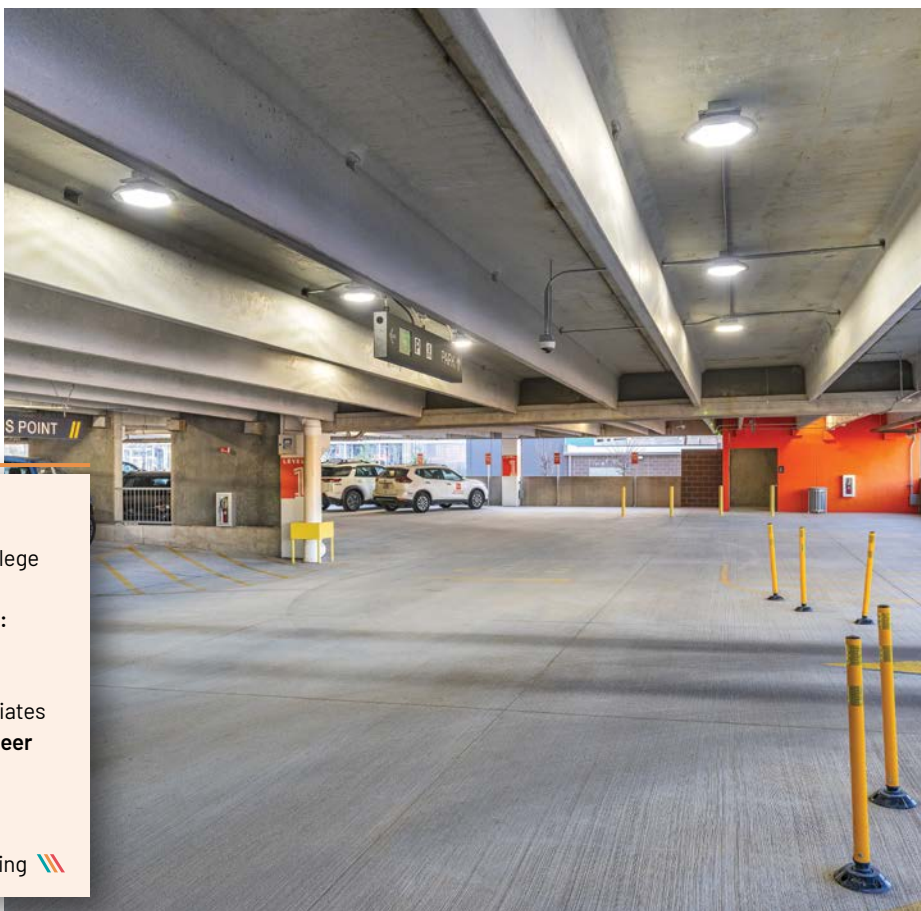
Mechanical, electrical, and plumbing engineer

and technology consultant: Teliosity

General contractor: Hoar Construction

Landscape architect: Asakura Robinson

Parking garage lighting: Kenall Manufacturing



“Since the parking structure opened, everyone has reacted very positively to its unique design features, which were incorporated to enhance users’ experiences and help ensure positive impressions,” said Amy Huddleston, the project manager for facilities management at Sam Houston State University.

Illumination’s importance

Lighting is an important feature in parking garages, especially since most fixtures are on continuously. The lighting must accommodate vehicular and pedestrian traffic, endure harsh operating environments, and address public safety considerations. Bright, uniform illumination helps with visibility and security. Recognizing the importance of first impressions, well-designed lighting helps patrons feel more comfortable and confident as they enter the garage.

Well-designed exterior lighting can also increase the feeling of security, help prevent injury to patrons, and play a critical role in the prevention and deterrence of crime. Security is one of the most critical issues facing owners and operators of parking facilities today. According to a report from the U.S. Department of Justice,

lighting is one of the best ways to increase safety and reduce crime in parking structures.¹ This report also emphasized the importance of uniformity: “Passing from light to dark areas creates problems for drivers because of the eye’s inability to adjust rapidly. It is also imperative to illuminate the edges of parking stalls, rather than just the driving aisles. Maintaining an appropriate uniformity ratio avoids these problems.”

Addressing visibility and glare

Another key lighting consideration is glare, which reduces the contrast of an object against its background, making it difficult for the eye to perceive depth accurately. Glare is a potential hazard for all drivers, but is particularly dangerous for senior citizens and other individuals with weak or impaired vision.

Kirksey Architecture, the architectural firm on the project, reached out to a representative from the lighting manufacturer to discuss the lighting design strategy for the structure. Since the building code required interior fixtures to include dimming capabilities, the team selected a lightweight, architectural LED luminaire designed for parking garages. Its modern design



Performance and installation best-practice considerations

The parking structure is equipped with 1,185 LED luminaires, ranging from 40 to 70 watts. These low-glare fixtures play a critical role in enhancing driver visibility, improving vertical illumination to help identify pedestrians, ensuring safe vehicle entry, and making columns and other structural elements more visible.

Despite its lighter construction—less than half of the weight of comparable fixtures—the LED luminaire includes features specifiers expect from a high-efficacy, durable product, including an IP66 rating, occupancy sensing, daylight harvesting, multiple optical distributions, and 3G vibration compliance, all important qualities for a parking structure. The ceiling-mounted luminaire is designed for quick installation and can be specified with a simple, wireless, zonal lighting controls option that requires no commissioning, although this feature was not utilized on this project. System adjustments can be managed through an intuitive mobile application. The luminaire provides a nominal output range of 4,000 to 12,000 lumens.

“Because we incorporated many forward-thinking features to enhance the user experience, we wanted a lighting solution that was easy to install, provided uniform, bright light, and helped students, staff, and visitors feel safe,” says Paul Newsoroff, partner and director of commercial practice for Kirksey Architecture. “The selected fixtures deliver excellent glare control without compromising light levels.”

Notes

¹ View the full report at ojp.gov/pdffiles/cptedpkg.pdf

The parking structure's LED luminaires provide bright, uniform illumination to enhance visibility and safety for both drivers and pedestrians.

complements the structure, while the fixture's low weight—around 3 kg (7 lb)—made it economical to ship and installation easier for the contractor. The luminaire's light weight has another benefit—installation can be done by an individual, rather than a crew, further saving time and money.

Being mindful of the university's budget, the lighting fixture was selected because it is long-lasting and virtually maintenance-free. Additionally, the unique hexagonal light guide, featuring an edge-lit LED light engine, provides three distribution options: Type V, Rectangular, and Drive Lane. The flat illuminance plane offers superior, glare-free lighting performance.

Specifiers sought to avoid the cascading effect, a common issue in garages where fixtures are installed in a row or pattern, which can create overlapping shadows or bright spots, making it uncomfortable for drivers because the light appears to ripple or step unnaturally. However, the selected luminaire's optical distribution eliminates this issue. With extensive experience using similar high-quality lighting products, the team determined that this solution would be effective for the project.

additional information

AUTHOR



Anthony Sarti is the southern regional sales manager at Kenall Manufacturing. He may be reached at anthony.sarti@kenall.com.

KEY TAKEAWAYS

Sam Houston State University's new 30,467-m² (328,000-sf) parking garage combines structural innovation, user-focused design, and advanced LED lighting. Stabilized on sandy soils with deep piers, the five-level garage offers 983 spaces, enhanced visibility, safety, and branding, while integrated features such as electric vehicle (EV) charging, intuitive wayfinding,

and programmable exterior illumination create a modern, secure, and welcoming experience.

MASTERFORMAT NO.

13 34 19—Parking Structures
26 51 00—Interior Lighting

UNIFORMAT NO.

C20—Exterior Enclosure

KEYWORDS

Division 13, 26
Lighting



Modern Defense

Access Control for Critical Sites



By Guerry Bruner

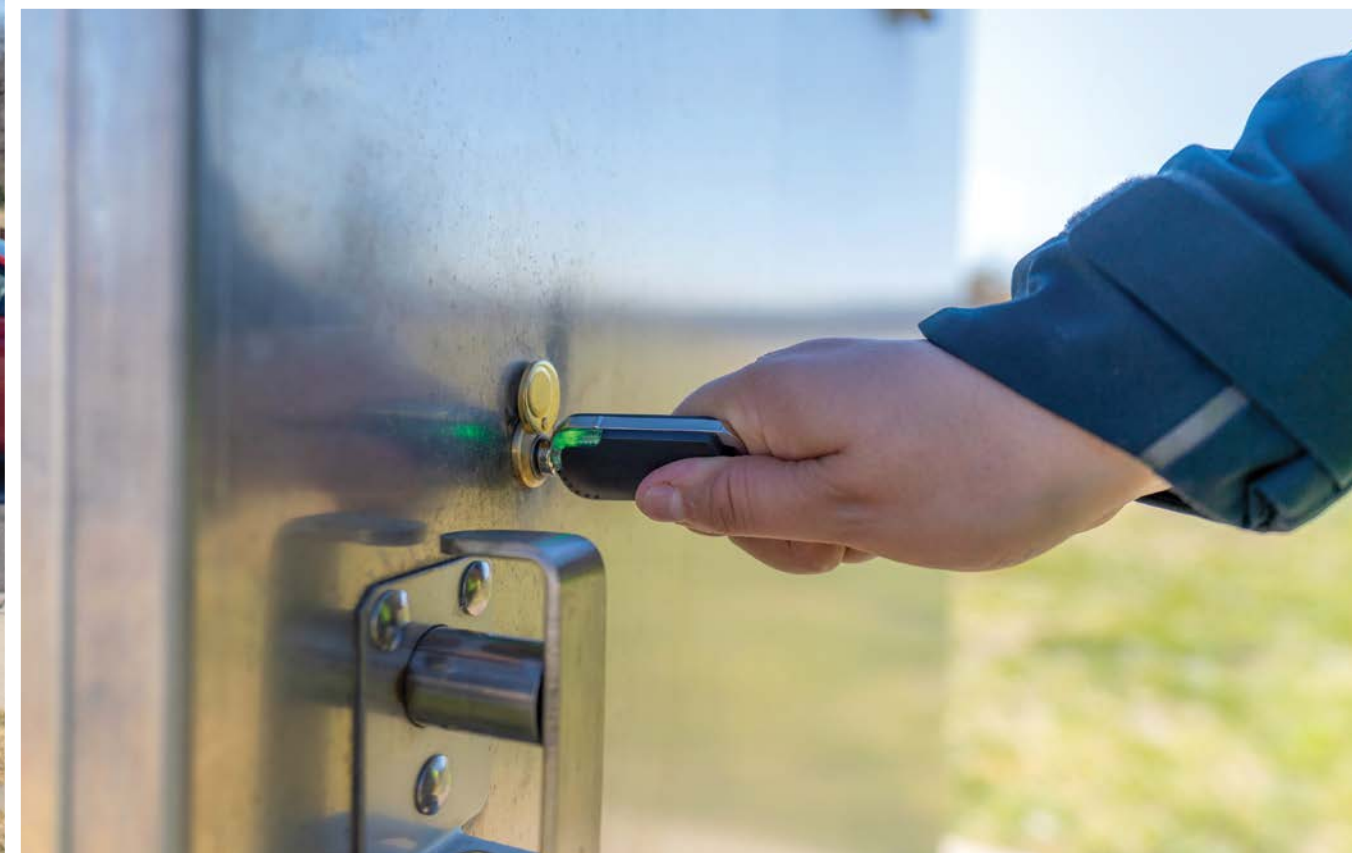
PHOTOS COURTESY
ASSA ABLOY OPENING
SOLUTIONS

When many people think of perimeter security, they often envision chain-link fences, barbed or razor wire, and padlocks. Mission accomplished, right? However, that is hardly the extent of what is needed to keep unstaffed infrastructure facilities secure (such as cabinet doors for electrical equipment), while still being accessible to those authorized to be on-site.

The term “critical infrastructure” encompasses a wide range of facilities, including water treatment plants, hydroelectric dams, wind

farms, electric substations, cell towers, data centers, and other similar facilities, collectively numbering in the hundreds of thousands. For instance, in 2022, the Wireless Infrastructure Association (WIA) published a definitive look at the wireless infrastructure landscape in the U.S. at the time, identifying 142,100 cell towers (those 15 m [50 ft] or taller).

Securing critical infrastructure is a top priority for many industry and government organizations, including the National Electrical Manufacturers



Association (NEMA), the Telecommunications Industry Association (TIA), and the Cybersecurity and Infrastructure Security Agency (CISA), among others. While much of their emphasis has been on cybersecurity, which is imperative, physical security is equally important.

The evolution of physical access control

Simply put, robust physical access control is about allowing authorized individuals to enter while preventing unauthorized individuals from

gaining entry. It does not refer to stopping Bond-esque supervillains intent on world domination. In most cases, unauthorized physical access stems from theft, vandalism, or simple curiosity—individuals wanting to see what is behind a restricted door. Expensive batteries, fuel, and valuable metals are often stored at unstaffed sites, providing a strong incentive for theft.

In brief, today's physical security at unstaffed infrastructure sites is far from ideal. There are usually multiple technology service providers with access, fuel contractors for backup generators, and even landscapers in some cases. There may be a series of padlocks on the gate, with each company having its own antiquated lock and key that were developed 50 years ago and are still in use. In some cases, it might be a combination lock. As contractors move between companies, they end up learning each other's codes. Former employees often still have access to sites, so security is mediocre at best.

However, security is improving. Smart locks with intelligent keys and card access systems are becoming more prominent at infrastructure sites of all sizes. Smart locks and remote access systems reduce the number of keys in circulation, resulting

Intelligent keys replace mechanical locks, are easy to install, and provide a straightforward approach to controlling access.

Table 1

Traditional versus Intelligent Access Control

CATEGORY	TRADITIONAL SYSTEMS	INTELLIGENT SYSTEMS
Access method	Padlocks, mechanical keys, or combination locks	Electronic keys, smart locks, radio-frequency identification (RFID), or biometrics
Accountability	Limited or none; shared codes and lost keys	Audit trails and traceable user access
Administration	Manual control; separate keys per contractor	Centralized dashboard for granting or revoking access
Security risk	Keys easily copied; former employees retain access	Encrypted credentials; keys cannot be duplicated
Installation power	None (mechanical only)	Self-powered keys; no hard-wiring required
Compliance	Inconsistent, outdated systems	Meets NEMA TS2 and cybersecurity standards



High-technology cabinets like this one with network connectivity must be protected and monitored in real-time to detect unauthorized openings.

in lower risk for unauthorized access. For those who need access quickly and do not have an intelligent key, remote access can be granted from a centralized management dashboard. This same system gives an audit trail for every individual who has accessed the locking mechanism. While still not ideal, since intelligent keys and access cards can be lost or stolen, they are considerably more secure than older methods.

Case study: Virginia Department of Transportation

The Virginia Department of Transportation (VDOT) maintains thousands of traffic cabinets across the state and has recently conducted a security assessment focusing on cybersecurity, risk compliance, and network resilience. Findings showed that their traffic-related infrastructure was indeed vulnerable to these risks—a very common situation given the rapid rise in technology over the past few years.

State officials needed a way to control access better and improve security without hindering the support and operation of the traffic system. That presented a huge challenge, considering the more than 6,000 traffic cabinets across nine districts and the numerous personnel who routinely work on and support the state's systems.

After a thorough review of available access control technologies, VDOT management determined that an electronic key-controlled access system was the best solution for the state. The system uses programmable keys that operate with intelligent electronic cylinders, allowing administrators to grant, revoke, and schedule access through web-based management software. The software also generates audit reports. Since power is contained within the key, no hard-wiring is required to the cabinet. The system complies with NEMA TS2 standard for traffic control assemblies, ensuring high network reliability for remote, outdoor enclosures exposed to wide temperature and humidity ranges.



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THE EVOLUTION OF PHYSICAL ACCESS CONTROL

Traditional security

- Relied on chain-link fences, padlocks, and mechanical keys
- Multiple contractors often shared access using old locks and codes
- Former employees sometimes retained access, weakening site security

Modern improvements

- Smart locks with programmable keys reduce keys in circulation
- Remote access can be granted through centralized dashboards
- Audit trails record every access event for greater accountability

Future direction

- Biometric authentication and radio-frequency identification (RFID) padlocks are emerging
- Cloud connectivity allows real-time monitoring and control
- Artificial intelligence (AI) may detect anomalies and flag suspicious access activity

Roadside cabinets contain not only traffic signal technology but also network connectivity to the city, county, or state where they are in use. This technology requires both physical and cybersecurity protection to ensure proper accessibility and resilience against attacks.



Specialty locks like this one for a traffic cabinet are growing in popularity to secure varied types of operational technology cabinets.

Intelligent locks and keys provide administrators with total visibility and control over employee and contractor access, offering programmable keys and detailed audit reports. VDOT can take comfort knowing its keys cannot be duplicated or purchased online.

Dwayne Cook, regional operations director at VDOT, says, "As a result of the incredible support and collaboration we received from our partners, we are much better equipped to prevent cyberattacks and enjoy traceability for all individuals who access our traffic assets."

Securing the future

Traditional mechanical keys, key fobs, access cards, and any other items that can be easily lost, stolen, or duplicated will be replaced by electronic access control systems that integrate biometric authentication, encrypted credentials, and centralized management platforms. Radio-frequency identification (RFID) padlocks are already in development that will allow contractors to access facilities via their phones. Similarly, facial identification systems are now readily available and affordable for mass deployments, providing both convenience and robust protection against unauthorized access. These systems will also be cloud-connected, enabling real-time monitoring and remote access control. Artificial intelligence (AI) may play a role in detecting access anomalies, automatically flagging or denying suspicious behavior.

Additionally, these technologies will support audit trails and compliance reporting, which are essential for regulated sectors such as energy, water, and transportation. Resilience against cyber threats will also be a key focus, with end-



Powered “on-line” locks connected to access control systems provide not only instant notification of door open/close and lock secure/unsecure, but also provide remote control from the security operations center.

to-end encryption and redundant backups becoming standard.

Overall, the future of door locking solutions for critical infrastructure will be defined by

intelligent, adaptive systems that integrate cybersecurity with physical security, ensuring safe and controlled access without compromising operational efficiency. 🚦

additional information

AUTHOR



Guerry Bruner is program manager for Intelligent Transportation Systems (ITS) and Unmanned Infrastructure Solutions at ASSA ABLOY Opening Solutions. He oversees the development and implementation of secure access technologies for critical and remote infrastructure applications

across the transportation sector.

KEY TAKEAWAYS

Securing critical infrastructure requires more than fences and padlocks. With unstaffed sites, such as substations and data centers, vulnerable to theft and tampering, agencies are turning to intelligent access control systems. Electronic keys, programmable cylinders, and cloud-based management platforms offer audit trails, real-time monitoring, and remote access control. The Virginia Department of Transportation’s (VDOT) adoption of such technology underscores the shift toward integrated physical and

cybersecurity measures aimed at enhancing safety, accountability, and operational resilience.

MASTERFORMAT NO.

08 71 00—Door Hardware
08 74 00—Access Control Hardware
28 13 00—Access Control

UNIFORMAT NO.

D5020—Lighting and Branch Wiring
D5030—Communications and Security
D5090—Other Electrical Systems

KEYWORDS

Division 08, 28

Access control

Critical infrastructure

Cybersecurity

Intelligent keys

Physical security

Smart locks



Building Faster

The Role of Smart Coatings



By Mark Wafford

PHOTOS COURTESY SHERWIN-WILLIAMS PROTECTIVE & MARINE (SWPM)

As the global demand for semiconductors continues to accelerate, general contractors (GCs) are being tasked with building some of the most complex facilities in the world—and doing it faster than ever before. These fabrication plants are high-stakes endeavors, where every delay can cost millions and impact critical supply chains. A recent survey revealed that 87 percent of construction professionals identified delays as the single most significant obstacle in delivering these facilities on time.¹

These projects are anything but standard. They are sprawling, multi-billion-dollar campuses built to accommodate highly sensitive technologies in controlled environments. From ISO-certified clean zones to utility floors housing high-

performance systems, every square foot must be built to exacting standards. For GCs, this means coordinating trades, navigating strict specifications, and managing timelines with precision. Any misstep can have negative impacts across the project, causing costly rework, safety risks, and missed deadlines.

Three pressures GCs face on advanced manufacturing construction jobs

In the author's experience across various advanced manufacturing industries, including the semiconductor industry, they have seen three core issues consistently challenge GCs:

- **Schedule pressure**—Owners expect speed and certainty. With massive investments on



Coatings systems have to be designed with these challenges in mind. Coating solutions should be engineered to not just meet specs, but to help GCs overcome friction and keep projects moving.

Large prefabricated steel truss structure assembled on a semiconductor fabrication plant construction site, ready for installation.

More than paint: Coatings as a construction tool

Coatings are often seen as a finishing touch applied at the end of the build. However, in semiconductor fabrication construction, coatings play a far more critical role. High-performance coatings protect clean zones, structural steel, and critical substrates from corrosion, chemical exposure, and premature wear. Just as importantly, they can significantly impact construction timelines with their ability to be applied offsite. When using offsite shop-applied fireproofing, steel erection time can be significantly reduced.

By engaging early with design and construction teams, the right partner can help GCs streamline workflows, minimize rework, and reduce trade stacking. It is important to have systems that are engineered not just for protection, but for real-world construction, supporting faster builds, safer sites, and better project outcomes.

Offsite application: Shifting the schedule

One of the most effective ways to decrease risk in a project is through offsite application of coatings. With shop-application, coatings are applied in

the line, even minor delays can push back production timelines by months, costing millions in lost productivity.

- **Labor shortages**—Skilled tradespeople with experience in these types of facilities are hard to come by. In the same research survey mentioned previously, 36 percent of construction professionals identified labor shortages as one of the biggest challenges facing their mega construction projects. Projects need systems that reduce the learning curve, simplify application, and demand less specialized labor.
- **Complex coordination**—Advanced manufacturing projects require tight coordination across trades. Misalignment leads to delays, rework, and added cost.



Interior view of waffle slab at semiconductor fabrication facility.

controlled environments before the substrates arrive on site. This eliminates weather-related delays, improves quality assurance, and reduces congestion at the jobsite.

For semiconductor fabrication facilities, the most common offsite applications include high-performance coatings such as epoxies, urethanes, and polysiloxanes, as well as epoxy intumescent fireproofing. The key consideration in selecting these systems is durability—not only their ability to perform in the service environment and meet the expected lifecycle, but also their resilience during loading, transport, storage, and erection. If a coating system requires extensive repair after installation, any potential time or cost savings are quickly lost.

For GCs, this translates into a smoother construction sequence. Pre-coated steel or concrete components arrive ready for installation, enabling parallel workflows and limiting the bottlenecks that typically slow down progress.

These applications may be performed at the steel fabricator, in specialized coating facilities

dedicated to surface preparation and high-performance application, or in temporary enclosures set up on or near the jobsite. In each case, the goal is to maintain a controlled environment that allows coating work to proceed without disrupting the broader construction process. It is a shift to a method that is already accelerating schedules on some of the world's largest manufacturing builds.

Zone-specific solutions for every part of the build

There is no one-size-fits-all solution in semiconductor fabrication facility construction. Each zone within a fabrication has unique performance demands and the coatings must be tailored accordingly. Some examples include:

- Low-VOC, contamination-resistant coatings that support ISO cleanroom standards.
- Chemical-resistant tank linings that help manage wastewater and maintain environmental compliance.
- Fireproofing systems that meet rigorous safety standards without delaying on-site construction.



steel fabricators, and coating applicators have successfully integrated offsite manufacturing (OSM) into their plans from the outset. In other situations, OSM has been introduced later in the process, with workable solutions still being developed even just before steel erection. Offsite surface preparation and coating can also be carried out in temporary enclosures near the building footprint, providing flexibility when early planning is not feasible. This approach results in fewer changes down the line, reduced challenges on site, and improved coordination with other trades.

Concrete columns are being installed at the semiconductor fabrication construction site.

The right manufacturer also helps evaluate trade-offs, for example, how a coating choice may impact drying times, environmental conditions, or substrate compatibility. It is this level of planning that helps avoid schedule slips and keeps momentum strong throughout the build.

The ROI of smarter coating strategies

Investing in high-performance coatings reduces long-term maintenance costs, directly improving the ability to hit milestones, meet safety and compliance standards, and turn over the facility on time. When coatings are easy to apply, do not require excessive prep work, and integrate cleanly into the construction timeline, the benefits are felt across the value chain.

Do not let the finish line be the bottleneck

While one may not think of coatings as the biggest part of their project, it can be one of the smartest ways to keep it on schedule. The right coatings provider can simplify construction and

Each coating system should be validated through real-world application and supported by experts who understand how to integrate these tailored systems into the construction process with minimal disruption.

When durable coating systems are selected to withstand loading, transport, and erection, the need for touch-ups in the field is typically minimal. That said, a repair plan should always be in place. The coatings manufacturer should provide guidance on proper repair procedures, and responsibility for carrying out those repairs should be clearly assigned in advance to the party owning that scope of work.

Why early involvement matters

The earlier the right partner is involved, the better. By consulting the coatings manufacturer during preconstruction, they can help identify coatings solutions that align with sequencing, labor availability, and performance specs.

The earlier these elements are specified, the better, although early coordination is not always possible. In many cases, general contractors,

Large prefabricated steel truss structure assembled on a semiconductor fabrication plant construction site, ready for installation.



Steel framework of industrial water treatment under construction at a semiconductor fabrication plant.

help GCs deliver these critical projects with confidence. In the competitive world of semiconductor fabrication construction, getting a facility online faster can mean everything.

In addition, because certain coatings systems can be designed with sustainability in mind, such as low-VOC formulas and durable linings that reduce lifecycle impact, they help GCs support the environmental commitments of their clients. 🌈

Notes

¹ See the survey at industrial.sherwin-williams.com/na/us/en/protective-marine/industry-solutions/manufacturing-processing/construction-solutions/construction-solutions-industry-insights-report.html

additional information

AUTHOR



Mark Wafford is a construction solutions executive dedicated to the semiconductor manufacturing market at Sherwin-Williams Protective & Marine (SWPM). He has spent 23 years in the coatings industry with Sherwin-Williams, with over 10 of those years focused on protective coatings, and he is an Association for Materials Protection and Performance (AMPP) senior certified coatings inspector. His primary focus in this role is to establish strong relationships with general contractors, architects, and engineers active in this market.

KEY TAKEAWAYS

Semiconductor fabrication facilities are complex, high-stakes projects where delays cost millions. General contractors face pressure from tight schedules, labor shortages, and coordination challenges. High-performance coatings—especially when applied offsite—streamline workflows by reducing rework, avoiding weather delays, and enabling faster installation. Zone-specific

solutions, including cleanroom finishes, chemical-resistant linings, and fireproofing, must be planned early. Durable, low-maintenance coatings not only protect assets but also improve safety, efficiency, and on-time delivery of advanced manufacturing facilities.

MASTERFORMAT NO.

05 12 00—Structural Steel Framing
07 81 00—Applied Fireproofing
09 97 00—Special Coatings

UNIFORMAT NO.

B2010—Exterior Walls
B2020—Exterior Windows
C3030—Ceiling Finishes

KEYWORDS

Division 05, 07, 09
High-performance coatings
Semiconductor fabrication



Building Science on Roofing

Barriers Guide Modern Design

As many building restoration consultants and contractors will attest, the design and construction of roof replacements have evolved substantially over the last 20 years. Contractors and roof designers can no longer rely on habitually selecting favorite roof solutions, and one roof system or assembly can no longer be considered suitable for all buildings. There is no longer one material manufacturer that can supply all the solutions. New roof designs have increased demands from building owners for roofs that offer complete sustainable solutions, not just waterproof protection.

Evolution of roof construction practices

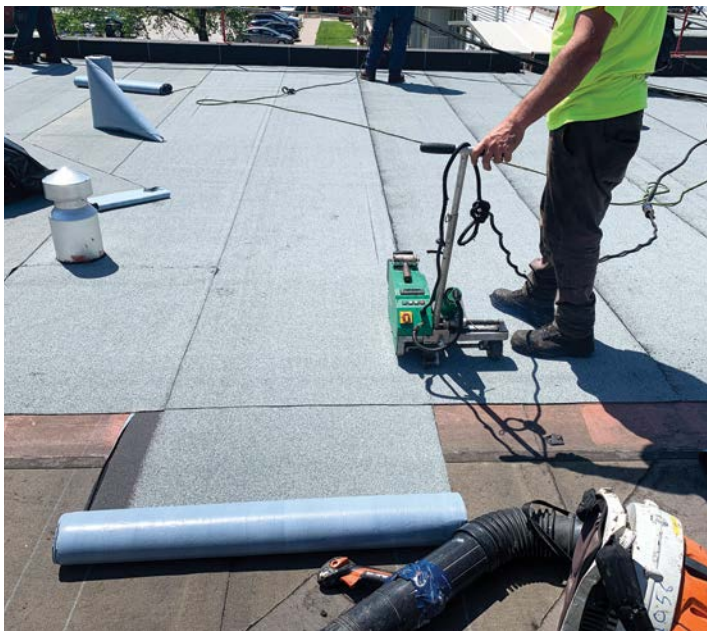
Roof construction in the mid-'80s was a predictable practice. Roofing crews would leave their place of business to work on projects where the only installation instruction required was the amount of roof work expected to be completed that day. There was no question of what type of roof system was to be installed, no concern about how much or what kind of insulation was required, and no consideration of how to ensure continuity of the air barrier, vapor retarder, tie-ins, adhesive rates, mechanical fastening patterns, material

lists, or shop drawings. The practice proved effective, with roofing contractors installing watertight solutions that typically provided long-lasting, effective results. Roofing technicians were craftsmen often trained through apprenticeship and generational-type training. They were successful in their trade primarily due to the predictable and repetitive nature of working with built-up roof assemblies, which had few variables and a sole objective: keeping precipitation out. There was very little consideration given to using roof assemblies for anything other than waterproofing.

Modern construction practices and increased building code demands have undergone substantial transformations since the 1980s, primarily to provide better environmental separation between interior and exterior climates, enhance interior comfort, and reduce energy costs. There are no longer umbrella-type covers on buildings; instead, there are impermeable solutions that attempt to control or eliminate thermal, moisture, and airflow migration. Early attempts with what seemed to be revolutionary materials, including new membranes and insulations designed to provide



By Michael Hensen
PHOTOS BY CHRIS DAWSON



Above: Cold process modified bitumen membrane built-up roof installation.



Right: Thermo-fused modified bitumen membrane built-up roof replacement.

improved roof performance, brought mixed results. Roofers and designers alike experienced roof system failures, often due to a lack of understanding regarding the installation of roofs using new products and a lack of knowledge about the application of building science principles to roofing design and installations.

Challenges with early insulated roof systems

The early versions of insulated roof systems introduced new issues, including vapor drive and thermal bridging, which led to uncontrolled deterioration and premature failures of roofs, making them unable to provide the desired improved protection. The moisture-related deterioration included a reduction in anticipated thermal resistance values, mysterious leaks, emulsifying adhesives, metal corrosion, and mold issues. Membrane technology also changed as new membrane types were developed to improve performance and (hopefully) provide reliability in an insulated roof system. Roof membrane system types included single- and multi-ply assemblies incorporated in built-up (membrane over insulation) or inverted (membrane under insulation) formats. The unfortunate part of the new membrane and insulation trend was that the roofing industry was unsure about how to install and detail the new roof assemblies. Roofing contractors would rely on their workers, who had traditional built-up roof training, habits, and equipment, to install new single- or multi-ply systems by trial and

error. As time progressed, some membrane manufacturers collaborated with contractors and industry organizations to develop best practice methodologies and achieve reasonable confidence in providing long-term solutions.

There is no denying that historically, owner roof replacement decisions were often swayed by selecting roof membrane systems from persuasive material sales staff offering extraordinary solutions and services, the attempt to save money by choosing an inexpensive solution, price, or choosing what appeared to be a too-good-to-be-true warranty. The bottom line is no sales pitch can guarantee success, the best price does not ensure a successful solution, and no warranty has ever improved the performance of a roof assembly. A well-designed and installed roof system deserves warranties issued by the contractor and membrane manufacturer as a gesture of quality, not as a guarantee that the roof system is a suitable solution for waterproofing and energy management, or that it meets building codes.

Modern designs account for the difficulty of installing roofs (the art) to meet raised expectations of building performance (the science) and, of course, all within governing building code requirements. The practicality of installing membrane and insulation continuity can sometimes resemble a game of “Twister” that requires coordination between the roofing contractor and representatives of other trades, including mechanical, electrical, plumbing, fenestration, cladding, and insulation contractors, during new build construction projects. In a roof



replacement project, roofing contractors are often hired as general contractors, subcontracting other trades, as the only way to complete a roof replacement without risking water infiltration.

Before designing a roof replacement, it is essential to understand the existing building's construction, including the type of structure and roof deck, existing mechanical and plumbing systems, parapet and adjacent wall construction, rooftop equipment, and penetrations. It is counterproductive to design a roof incompatible with existing materials or building detailing, as the connections could fail, allowing for air and moisture infiltration (resulting in energy loss and leaks). Removing wall parapet claddings to ensure continuous barrier membrane and insulation transitions, lifting mechanical units to complete curb detailing, and ensuring sufficient drainage capacity and strategy are all steps that must be intentionally and carefully detailed and performed to ensure a successful roof replacement.

Relying on the roofing contractor's technician to design the transition between adjacent wall and parapet detailing, building materials, and roof accessories without professional direction creates the possibility that the installation may not meet building codes and building science best practices. This is not a slight towards a roofing technician's ability, but is an acknowledgement of the cooperative approach between the roofing contractor and design professional that roof replacement work should follow. In turn, the designer must be mindful of the difficulties, limitations, and obstacles

associated with roof construction, as well as the notion that what may look good on paper may not be possible or practical to install. Weather conditions, safety, accessibility, and material limitations could all transform what initially appeared to be a good design idea into an impossible or costly endeavor.

Modern roofing practices and responsibilities

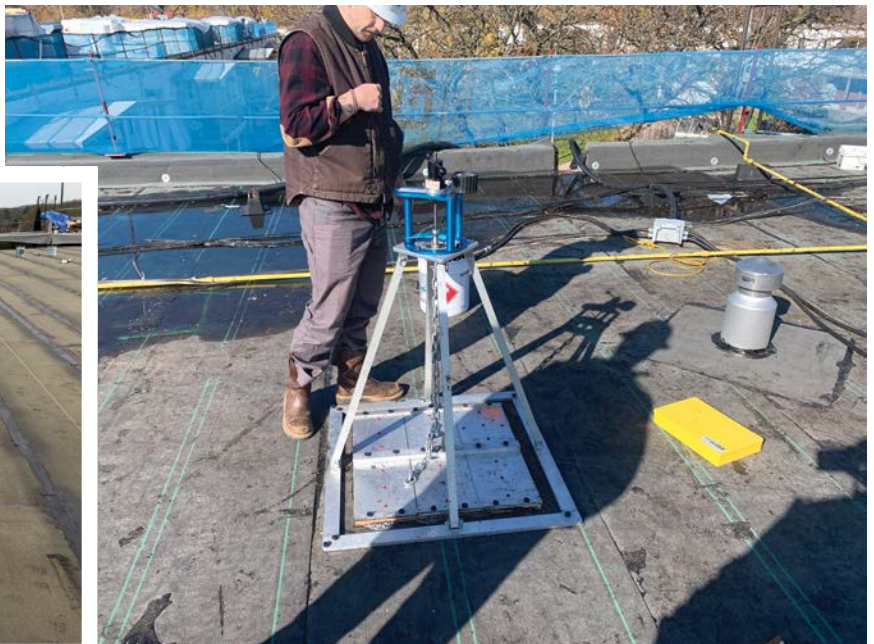
Today's roofing contractors have, for the most part, adapted to the modern ways of roofing. They send their crews to project sites with material safety data sheets, life safety and rescue equipment, and plans, engineered shop drawings for scaffolding and fencing, building and road closure permits, and tapered insulation drawings. Today's roofing technicians are trained to install multiple types of roof membranes and incorporate them with insulation in various configurations of roof systems. How they incorporate their ability to work with roofing materials into the entire building envelope is where accurate contract documentation and site review of work in progress by a design professional lead to successful roof installations.

With the trend toward municipalities and jurisdictions requiring building permits for roof replacement work, designers are reminded of their obligation to incorporate current building codes and municipal requirements into their designs. Considerations for structural loading, wind uplift resistance, roof drainage, insulation values, and building occupancy have always been

Left: Completed modified bitumen membrane built-up roof replacement at a municipal fire hall.

Above: Cold process roof replacement on an industrial building. Replacing a wind-damaged roof.

Bonded up-lift test to confirm roof application and performance to resist code-prescribed wind loading.



Mechanical fastener securement of metal deck overlay board, primer application, and self-adhered vapor barrier installation at a municipal arena.

required; however, they are not often accurately analyzed or calculated.

Balancing design and practicality

In recent years, increased demands have also risen from the way roofs are used. Some view roofs as prime opportunities to implement landscaping, additional building mechanical and operational equipment, stormwater retention systems, and energy production equipment (solar and wind). Some of these have become requirements and are included in municipal codes to “green” the roof surfaces and reduce the negative aspects of large, low-slope roof spaces. How roof design and construction are with these new demands on roof space is a challenge from a roofing design and

engineering perspective. Providing viable solutions to roofing contractors to accommodate these innovations in the roof space must be the objective of the roof design professional.

Looking to the future of roof construction practice, designers must be able to continuously identify solutions that balance roof installation with sound building science and engineering principles. With the most recent demands by governments for decarbonization, CO2 reductions, energy consumption reductions, and sustainable land and building stewardship, owners are more motivated than ever to engage professionals with proven experience in balancing the arts and sciences of roof design and installations. 🌈

additional information

AUTHOR



Michael Hensen is a professional engineer and a registered roof consultant with the International Institute of Building Enclosure Consultants (IIBEC). His technical duties for Rimkus include engineering and leadership of the building enclosure consulting practice.

KEY TAKEAWAYS

Roof replacement has shifted from simple waterproofing to complex, building science-driven systems that integrate air, moisture, and thermal control. Modern roofing requires careful design, adherence to building codes, and effective coordination among trades to ensure optimal performance and durability. Early insulated systems revealed issues such as vapor drive and thermal bridging, highlighting the need for improved materials and installation practices. Today, designers must balance practical

installation challenges with evolving demands for sustainability, energy efficiency, and the multifunctional use of roofs.

MASTERFORMAT NO.

07 50 00–Membrane Roofing
07 21 00–Thermal Insulation
07 92 00–Joint Sealants

UNIFORMAT NO.

B3010–Roof Coverings
B3020–Roof Openings
C3020–Roof Decks

KEYWORDS

Division 07	Roofing
Air barrier	Vapor barrier
Insulation	Waterproofing
Membranes	



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Making the Connection: Field Joints in Prefabricated Walls

Prefabricated exterior wall panels or unitized systems consist of prefabricated modules that include framing, insulation, air barriers, cladding, and glazing components. These modules are manufactured in a factory, transported to the site, and attached to the building structure. While these systems were traditionally limited to curtain walls, a variety of cladding systems, such as EIFS, thin brick, and metal panels, are now available. These systems can provide more consistent performance and a higher level of quality control for the building envelope, while also significantly reducing construction time. However, the modular nature of the system requires careful consideration of the joints between units, which are addressed during the installation process. Gaskets and/or sealant are often used to bridge these gaps and create the final building enclosure. Two recent projects demonstrate the challenges that can arise at field joinery locations.

In the first project, the panelized assembly included an EIFS cladding system supported on cold-formed metal studs. The design incorporated a drainage plane behind the EIFS with integrated through-wall flashings above window openings and at the base of the wall. The joints between the modular panels were sealed with a two-stage sealant joint, with the interior (primary) seal interfacing with the air and water barrier at the drainage plane. This design also required the primary seal to offset toward the interior at fenestration systems to interface with the primary window seal. Unfortunately, due to the depth of the drainage plane compared to the exposed face of the panels, access in the field to install the primary seal in the correct position was challenging. In several locations, a gap inadvertently formed where the horizontal and vertical primary seals met, allowing water and air leakage through the assembly (Figure 1).

In the second project, metal panels were incorporated into a unitized curtain wall system with the air and water barrier and mineral wool insulation positioned behind the metal panel. The primary air and water seal was located inboard of the metal panels; however, the outer exterior joint between metal panels was detailed with factory-installed elastomeric gaskets at the perimeter of each module to form a weather

 figure 1

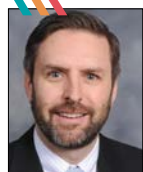
Fig 1: This panelized assembly required two-stage sealant joints between panels; inadvertent gaps (arrow) occurred between horizontal and vertical seals at multiple locations, due to the difficulty of properly positioning the sealant.

 figure 2

Fig 2: The gaskets intended to provide an exterior weather seal between metal panels were not properly installed and began to displace.

seal when compressed against the adjacent module during field installation. Unfortunately, due to a missed quality control step during fabrication, the gaskets were not crimped into the raceway that secures them in place. With normal thermal cycling of the assembly, many gaskets began to displace and fall out of the joints (Figure 2).

Prefabricated cladding systems can provide faster construction and consistent quality control; however, achieving high performance with these systems requires careful design of the joints between modules. These joints must accommodate the tolerances inherent in the underlying structure and allow access for field installation of seals. The perimeter configuration of each module must consider practical methods for field installation of sealant, gaskets, or other transition strips during construction. 



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