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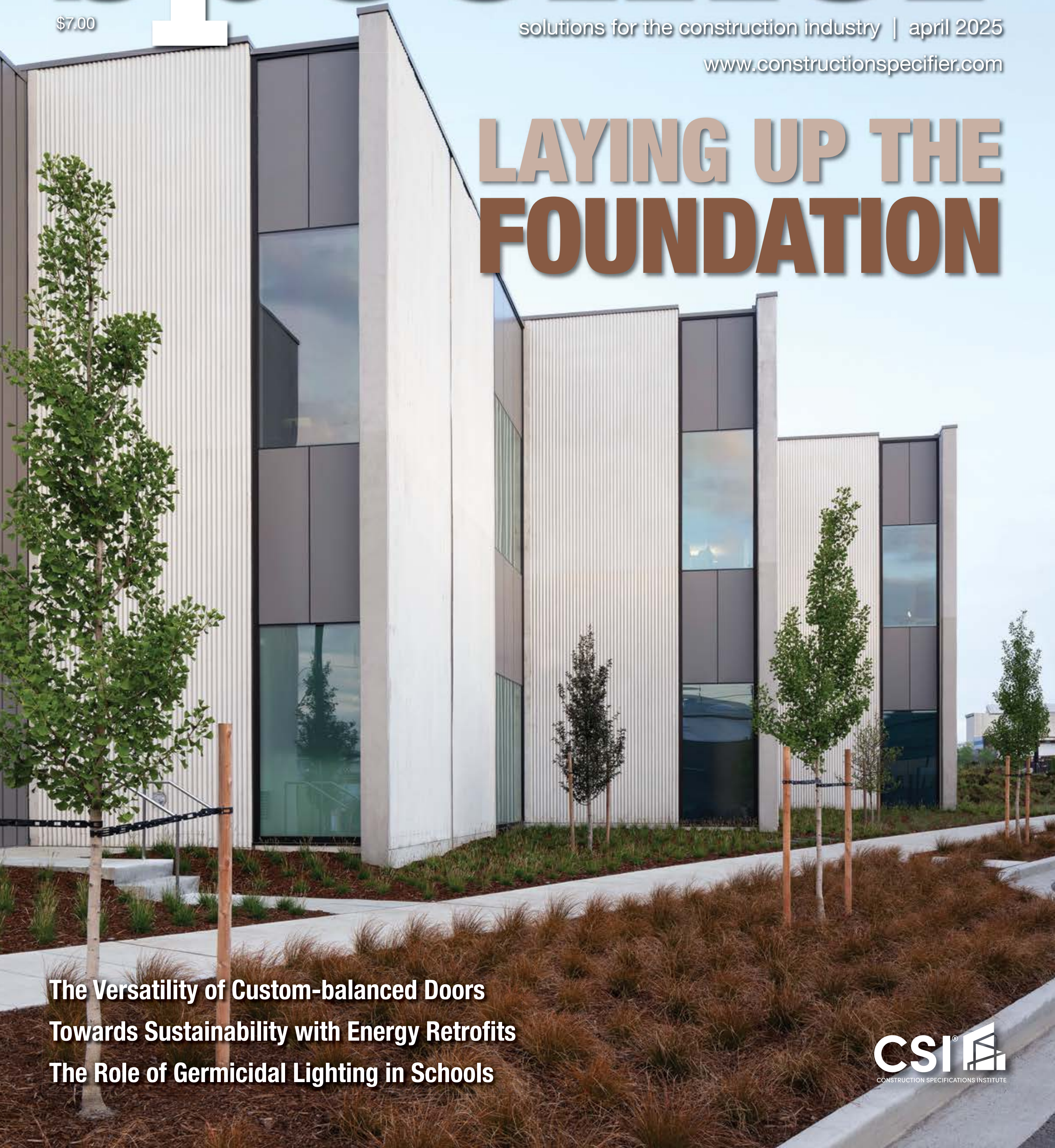

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Photo courtesy ZGF Architects

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How I Earned My CCCA: A Conversation with Viviana Gutierrez-Garcia, CCCA, CDT

Viviana Gutierrez-Garcia, CCCA, CDT didn't have a traditional path for earning her Construction Documents Technologist (CDT) and Certified Construction Contract Administrator (CCCA) certifications from CSI.

Inspired by her husband's extensive experience in the construction industry, Gutierrez-Garcia boldly transitioned from nearly two decades in insurance to mastering the intricacies of construction documents and contract administration.

In this insightful Q&A, she discusses the steps she took and the strategies she used to achieve her goals.

Tell us about your career and why you chose to work in this industry. What made you decide to pursue a CSI certification?

After 19 years in the insurance industry, I shifted to the construction sector, inspired by my husband, who has worked in the architecture and construction industry for 20 years. I started as a construction documents clerk and quickly became interested in expanding my knowledge.

How did you study or prepare for the certification exam?

In August 2023, I began studying for the CDT certification and passed in December. I focused on the AIA A201 - 2017, the Project Delivery Study Workbook, and the Project Delivery Practice Guide. The workbook was extremely helpful, offering an interactive approach that thoroughly prepared me for the exam.

Building on the momentum from earning my CDT, I decided to pursue the CCCA certification while the information was still fresh. I began my studies in February and passed the exam in May. For this certification, I used resources like the Construction Contract Administration Practice Guide, the Construction Contract Administration Study Workbook, online classes from the Los Angeles Chapter of CSI (LACSI), and flashcards available on the CSI website, which were a very useful study tool.

I'm very fortunate to have a supportive supervisor and colleagues who took the time to quiz me with flashcards, which really helped in my preparation for the exams.

How has earning your certification informed how you approach new projects, especially when managing construction documents and administering contracts?

In my role, I work with various project delivery methods, such as design-bid-build, construction manager at risk (CMAR), and design-build. The knowledge I gained from the CDT and CCCA has significantly enhanced my understanding and confidence in processing different project documents.

The Spring CSI Certification cycle closes on April 22. Don't miss your chance to unlock your potential and advance your career goals. Learn more about each certification and register here: csiresources.org/certification **CS**

Addressing misconceptions about polished concrete

After publishing the article, *Refine Versus Shine: Defining and Defending Design Intent with Refined Concrete*, by Kristina Abrams, AIA, LEED AP, CDT, CCS, Chris Bennett, CSC, iSCS, CDT, Bill DuBois, CSI, CCS, AIA, Melody Fontenot, AIA, CSI, CCCA, CCS, Kathryn Marek, AIA, CSI, CCCA, NCARB, SCIP, Keith Robinson, RSW, FCSC, FCSI, LEED AP, Ryan Stoltz, P.E., LEED AP, Vivian Volz, CSI, AIA, LEED AP, SCIP, in the January 2025 issue of *The Construction Specifier*, we received the following letter.

Dear Editor,
We're surprised that the authors' experience with polished concrete has been so negative as to recommend prohibiting it. We, the Concrete Polishing Council (CPC) advisory board of the American Society of Concrete Contractors (ASCC), disagree with this recommendation. While the industry has faced challenges, as described in the article, we have found those to be in the past. The article does refer to the CPC's work, but there is much more to consider that was not described in the article or cited as references, which has been and can be used to minimize negative experiences with polished concrete.

The article states that there is no specification framework that is measurable, verifiable, and defensible. However, nowhere in the article does it refer to ACI-ASCC SPEC 310.1, *Specification for Polished Concrete Slab Finishes,* published by ACI-ASCC 310 committee in 2020.

The ACI-ASCC specification was written to provide a standard that is measurable, verifiable, and defensible. Also, since its inception, there have been millions of square feet of polished concrete successfully installed, in use today, with satisfied owners and architects.

Clark Branum, CPC's polished concrete specialist and chair of ACI 310, worked with Pat Harrison of Structural Services, specialist in advising owners, architects, and contractors on polished concrete and chair of the ACI-ASCC subcommittee on polished concrete finishes—and 27 other committee members over two years to produce this document. In 2020, Harrison described why the specification was needed, what was in the documewnt, and the importance of testing in *Concrete Contractor* magazine.[1]

As an ACI standard specification, ACI-ASCC 310 was put out for public comment to ACI's 30,000 members in 2020. A revision is needed, and we welcome the authors and others to join ACI-ASCC 310 committee members in improving the document to benefit the polished concrete industry.

We agree with the authors that contradictory and weak specification language from manufacturers can be misleading. The ACI-ASCC reference specification provides a rational basis for an architect to write their own specifications. It calls out that a new slab to be polished should have a hardness greater than four on the MOHS scale. It also requires that a mockup be done for reference and to verify the final measurables and appearance of the in-place polished concrete slab. The article also states that a profilometer to be used as a measurement of surface refinement. However, the sample area taken by a profilometer is 19 mm (0.75 in.) by 2.54 μm (10,000 of an inch) measured by a diamond stylus that can be worn or broken. The distinctness-of-image (DOI) meter measures with light and covers an area 1,800 times larger than the roughness average (RA) meter, making it a more reliable measurement for refinement on polished concrete.

DOI, measured in accordance with ASTM D5767,[2] is not a measurement of gloss but rather a refinement of the surface. Specular gloss, measured in accordance with ASTM D523,[3] is useful for maintenance programs and measuring durability but is not a verification of the floor refinement.

Haze, measured in accordance with ASTM D4039,[4] indicates the inclusion of topical products to produce the aesthetic.

The CPC Appearance chart clearly states that gloss and DOI must be measured before any post-polished surface treatments are added. This eliminates the ability of a contractor to use treatments to meet the specification.

ACI-ASCC SPEC 310.1 requires each of these to be measured at three locations for areas up to 93 m^2 (1,000 sf), with one additional test for each 93 m^2 (1,000 sf) or fraction thereof. The tests must be selected randomly in each test area and shall be distributed across the entire polished floor. These tests are measurable, verifiable, and defensible and are required to be performed by the Owner's Testing Agency when the polished work exceeds 465 m^2 (5,000 sf).

The ACI 310.1 specification references the CPC charts for aggregate exposure and appearance, but these charts are for aesthetic callout language to target designers' appearance requirements. Currently, the CPC is preparing a document for measuring polished concrete finishes that will be available on the American Society of Concrete Contractors (ASCC) website in 2025.

Quality assurance (QA) is also addressed in the ACI-ASCC specification in section 1.5. This section requires the contractor to submit or provide the following:

- A quality control plan showing means, methods, products, and equipment to be used to obtain the specified polished concrete finish.
- Documented experience to include a list of five projects performed over the last three years of similar type, size, and complexity.
- Documentation of installer training from the manufacturer of each product used.
- Documentation that a competent supervisor at the project during the work is certified as a craftsman on the basis of work experience and completion of a written examination by the CPC.
- A surface defect repair plan locating and identifying defects to be repaired prior to polishing.
- A crack repair plan locating and identifying cracks to be repaired prior to polishing.
- Manufacturer's technical data and application instructions for each repair product specified or proposed for the work.
- A preconstruction conference with the owner, architect, engineer, or other parties to review project requirements, acceptance criteria, and responsibilities. CPC provides its members a "Checklist for the Polished Concrete PreConstruction Conference" that brings together the owner and representatives of all design and construction participants to assist in the quality assurance process.
- Field mockup to verify submittal product selections, demonstrate aesthetic effects, and compliance with test measurements.

Once these items have been completed and the mockup reviewed and approved by the architect or owner's representative, it becomes the minimum standard for acceptance and the contractor can then proceed with the polished concrete work. If the mockup is not of acceptable quality, the contractor should not be permitted to polish any work. These quality assurance requirements minimize the possibility of poorly polished concrete.

One other item that CPC has found to be especially important is coordinating the concrete specification and the polishing specification. In addition, we recommend that the polisher be required to attend the concrete preconstruction conference to provide input on how the concrete slab contractor's means and methods will affect the polisher's ability to meet their specifications.

CPC also provides its members with a "Supplemental Checklist for Concrete to Receive a Polished Finish" and also cites "Specifying the Concrete Slab to be Polished," published in *The Construction Specifier*, August 2016.

CPC encourages the authors and others to become thoroughly familiar with ACI-ASCC SPEC 310.1-20. We also encourage those who have had negative experiences with polished concrete to reach out to CPC members for advice. To date, millions of square feet of polished concrete have been placed to the satisfaction of owners and architects.

We believe that prohibiting polished concrete is not the appropriate answer. We encourage the authors and others to join CPC to assist us in improving both the design and construction of polished concrete to meet owners' expectations. **CS**

Notes

[1] See Patrick Harrison, "Bringing Polished Concrete up to Spec: Explaining the new ACI Polished Concrete Slab Finishes Specification. But first, why is a specification needed? *Concrete Contractor*, December 2020.

[2] Refer to ASTM D 5767, *Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces*, American Society for Testing and Materials (ASTM), 2018 (2023).

[3] Review ASTM D 523, *Standard Test Method for Specular Gloss*, American Society for Testing and Materials (ASTM), 2014 (2018).

[4] See ASTM D 4039, *Standard Test Method for Haze of High-Gloss Surfaces*, American Society for Testing and Materials (ASTM), 2009 (2023).

Ryan Klacking, president, Concrete Polishing Council (CPC) advisory board and Clark Branum, CPC polished concrete specialist and chair, ACI-ASCC 310, on behalf of the 22-member Concrete Polishing Council (CPC) Advisory Board

Response

Polished Concrete or Just a Shine? Clarifying Terminology in the Industry

It appears that the Concrete Polishing Council (CPC) may have misunderstood the intent and scope of the original article, "Refine Versus Shine: Defining and Defending Design Intent with Refined Concrete," and has instead reacted based on assumptions that misalign with what was actually stated.

We would like to take this opportunity to clarify and expand upon on key issues raised by the CPC, particularly concerning terminology, industry standards, and performance expectations.

Terminology and misinterpretations

The root of the disagreement lies largely in how the term "polished concrete" is used and interpreted within the industry. It is essential to recognize that there are seemingly endless types of finishes marketed as "polished," but not all of them achieve the same outcomes in terms of durability, maintenance ease, or performance.

Historically, polished concrete has been understood as a mechanical process of grinding concrete with progressively finer grits to achieve a smooth, durable, and reflective surface. However, this process has been blurred by the introduction of various coatings and resin-based products, which provide a shine but do not represent true refinement, lower-cost maintenance, or long lifecycles.

This is evident not only in the continued use of grout coats and sealers but also in chemical suppliers requiring resin-bond tooling as part of their "polishing" process. It is well known that some products are even called "pay me juice" by contractors specifically because these liquid-applied products can achieve distinctness of image (DOI) gloss levels with or without refinement taking place.

We agree with the CPC that surface refinement is central to achieving the desired appearance in concrete, but the issue is how we define and describe that refinement. The use of inconsistent terms such as "polished finish," "grind and seal finish," "burnished finish," and "coated finish" can and do lead to confusion and miscommunication.

The main point of contention lies in the industry's tendency to lump all these products together under the umbrella term "polished," which fails to acknowledge the underlying differences in performance, longevity, and maintenance requirements. In short, they are different work products that share the same name.

This lack of basic nomenclature puts owners and their AEC vendors at risk because design intent and owner needs are never fully understood. This leads to confrontation and confusion when something is overlooked, or expectations are not met, and the floor the owner actually wanted was not included in the contract sum.

Owners and their design and builder teams bear the brunt of the financial impact from loss of contingencies, protracted schedules, tarnished reputations, and legal disputes.

Challenges with standards and specifications

The CPC references ACI-ASCC SPEC 310.1-20 as a measurable, verifiable, and defensible standard for polished concrete. While the existence of such standards is valuable, the larger issue is how these standards are applied in real-world specifications. Many contractors, designers, and specifiers still face confusion regarding the correct application of these standards, largely due to unclear language and an over-reliance on qualitative descriptions.

The CPC argues that the ACI-ASCC specification addresses this gap, but the reality is that specifications like ACI-ASCC SPEC 310.1-20 still leave much to be desired in terms of clarity. This is particularly clear when it comes to evaluating the degree of surface refinement. The measurement tool mentioned, the DOI gloss meter, is useful but does not completely resolve the issue of how to distinguish between truly refined concrete and high-build coatings that simply provide an appearance of shine.

Further, the CPC's call for more education in specifying polished concrete is a valid point. However, the solution is not to simply blame specifiers or designers for lack of knowledge; it is about making the available documentation clearer and more usable. The existing documents, though informative, often fail to provide actionable, practical guidelines that can prevent the costly errors seen on many projects.

Despite calls for clarity for well over a decade, the CPC has not addressed this issue.

Hardness and performance concerns

The discussion around the MOHS scale of hardness and its role in surface durability is another area of concern. The CPC asserts that concrete with a MOHS hardness of four is acceptable for polished concrete, but this significantly compromises the long-term performance of the finish. Concrete with a lower MOHS hardness is prone to faster wear and tear, which could be an issue, particularly in high-traffic areas. This is why we suggested a minimum of seven MOHS in our article. The natural MOHS hardness of concrete typically ranges between six and eight, and any product that falls below this threshold will require more frequent maintenance and reapplication of protective coatings. By allowing products with lower MOHS ratings to be classified as "polished finishes," we risk creating long-term performance issues that are often only recognized after the product is already installed.

As our own experiences show, a misunderstanding of hardness and surface durability can result in disastrous outcomes. A retail client of one of the authors once chose an alternative product labeled as a "polished finish" but was later faced with premature wear and maintenance costs. This was a direct result of a substitution made without consulting the specifications and without fully understanding the product's limitations. However, the DOI gloss language for both what was specified and the substituted coating were identical, protecting the unauthorized substitution instead of the intended design, and leaving the design firm to pay a seven-figure bill to the owner. This example is not an anomaly, but unfortunately all too common as the authors and many others have experienced.

Clarifying gloss and DOI

The CPC's assertion that DOI, measured according to ASTM D5767-18, *Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces*, is not a measurement of gloss but a "refinement of the surface" is another area where we disagree. The ASTM D5767 standard is, in fact, focused on measuring gloss as it relates to the clarity of reflected images on a surface, which is a key factor in assessing the quality of a polished floor.

While surface refinement can be a component of the process, gloss and DOI are essential in defining the final outcome. The door is left open for anything that will achieve those benchmarks. The CPC's assertion that DOI is not related to gloss, despite the wording of the standard, reflects a misunderstanding of its purpose and application.

The bigger picture: Clarification and education

The heart of this debate is not about whether polished concrete is good or bad—it is about how we, as an industry, define and communicate the qualities of these finishes. There is a wide variety of products available, each with its own benefits and drawbacks, and the challenge lies in accurately conveying these differences. The CPC's attempt to defend a broad definition of "polished concrete" serves to obscure the reality that different products have vastly different performance and maintenance characteristics.

Rather than engaging in a defensive argument over terminology, time could have been spent working together over the last decade to create clearer, more precise guidelines that help designers, specifiers, contractors, and owners make informed decisions. But this was not the case, and we have therefore called for clarity ourselves, as expressed in the January 2025 issue of *The Construction Specifier*. If we want the concrete industry to improve and evolve, we must encourage transparency and clarity. This discussion, though challenging, is necessary to advance the understanding of all exposed concrete finishes—whether polished, sealed, or refined—and ensure that future projects meet the expectations of owners and designers alike.

This debate is not one of opposing positions but rather an opportunity for the industry to reach a common understanding of how to communicate and specify what should be done. We need to focus on improving the clarity of our standards, and we agree with the CPC that educating all stakeholders is important, ultimately ensuring that the concrete finishes we specify meet aesthetic, durability, and safety expectations. Attempting to discredit much-needed corrections in terminology is not appropriate. Clarification of terminology should not be seen as a threat to anyone, and no market is the exclusive domain of any trade organization.

Specifiers can and will create the best contracts possible with all of the tools available. We are glad to see this long-overdue conversation finally coming around and encourage all parties to engage with an open mind and a goal of improvement. Owners simply cannot afford to pay for the defense of the status quo. **CS**

Kristina Abrams, AIA, iSCS, LEED AP, CDT, CCS | director of specifications at O'Connell Robertson; **Chris Bennett**, CSC, iSCS, CDT | concrete consultant, Bennett Build; **Bill DuBois**, AIA, CSI, CCS | architect; **Melody Fontenot**, AIA, CSI, CCCA, CCS, iSCS, SCIP | senior specification writer, Conspectus Inc.; **Kathryn Marek**, AIA, CSI, CCCA, NCARB, SCIP | principal, KM Architectural Consulting and SCIP president; **Keith Robinson**, RSW, FCSC, FCS | architect, specifier, University of Alberta instructor, construction group advisor, and member of standards review committees for ASTM and the National Fire Protection Association (NFPA); **Ryan Stoltz**, P.E., iSCS, LEED AP | licensed structural engineer, LEED accredited professional, and associate principal, Structures; and **Vivian Volz**, AIA, CSI, LEED AP, SCIP | independent specifier for commercial, public, and multifamily projects, local and national leader in the Construction Specifications Institute (CSI) and SCIP past president

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By Aubrey Smading and Lionel Lemay

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WITH FOUR WNBA TITLES, THE SEATTLE STORM ARE USED TO EXCELLENCE ON THE COURT. THESE WINNING WAYS HAVE NOW EXTENDED BEYOND THE COURT AS THE TEAM'S NEW $64-MILLION TRAINING FACILITY—THE SEATTLE STORM CENTER FOR BASKETBALL PERFORMANCE—WAS NAMED A WINNER IN THE NATIONAL READY MIXED CONCRETE ASSOCIATION'S (NRMCA) 2024 CONCRETE INNOVATION AWARDS.

The award, announced in March, was given in recognition of the 4,645-m^2 (50,000-sf) project, achieving a significant reduction in greenhouse gas (GHG) emissions from the concrete. It achieved 52.4 percent embodied carbon savings compared to the regional industry average 28-day standard-cured compressive strength, rising to as much as 68 percent with specific applications in the building. The facility was designed by architects Shive-Hattery and ZGF Architects and built by Sellen Construction. An NRMCA member supplied the low-carbon concrete required to meet the project's sustainability goals.

For a team that plays in the Climate Pledge Arena (the first net-zero carbon-certified arena in the world) in a city that passed new building performance standards to reach net-zero by 2050, reducing the carbon footprint of the Storm's training facility was a key consideration from the earliest stages of the project's conception. In addition, the project targeted LEED Gold certification to qualify for the city of Seattle's Priority Green expedited program. These stipulations meant emissions reduction was a key driver of decisions throughout the design and construction processes.

A three-pronged approach

To meet this low-carbon need, the architects and concrete supplier adopted three key strategies: deploying strength requirements based on concrete compressive strength tests at 56 days instead of a typical 28-day test age for specific applications, using higher slag cement replacement of between 50 and 80 percent, and implementing Type IL portland-limestone cement (PLC).

The design and construction teams worked closely to identify parts of the project that could be specified with a design strength of 56 days rather than the typical 28 days. The longer curing schedule allows for reduced embodied carbon and a lower global warming potential (GWP) of the completed building by reducing the need for high amounts of cementitious materials to achieve the required strength. In appropriate locations, specifying strength requirements at 56 days rather than 28 days should have little or no effect on the final strength and performance. With the strategic selection of project areas for a 56-day curing schedule, the team was able to minimize impacts on the construction time and cost.

Sections of the project, such as the foundations and the tilt-up walls, were identified as appropriate for specifying the design strength at 56 days. The project was fortunate that the Seattle area has extensive experience working with 56-day design strength, as

Teams anchor foam between panels after placing beauty panels.

Photos courtesy Stoneway Concrete

it has been common in the city since the 1980s. To allow crews to get on the slab quickly, the concrete supplier adjusted the admixture by minimizing the amount of water reducer and using a superplasticizer and a viscosity modifier—producing an admixture that met the approval of the project's finishers.

The design called for lighter, whiter concrete for the structure. Two initial options were considered, but they were either too expensive or had a high carbon footprint. Adding titanium dioxide as a color additive was cost-prohibitive, and getting white cement meant transporting a specific cement across the country.

The solution was using high slag cement content in the concrete. Mix designs that use 50 percent slag have been developed regularly for other construction projects, such as the Microsoft Campus refresh currently underway in Redmond, WA. Mix designs of up to 80 percent were used on The Spheres at Amazon's corporate office in downtown Seattle, producing a very light color after drying.

In total, 27 percent of the Storm Center's concrete used 80 percent slag cement; 64 percent used 50 percent slag cement. Initial issues with cracking due to set times were resolved quickly, so the admixture combinations were adjusted to reduce set time. Tilt walls were designed for 41,368 kPa (6,000 psi) at

Exterior shot of the facility as work progresses.

Region	San Francisco/ Los Angeles, CA	Portland, OR/ Seattle, WA	STONEWAY Seattle, WA
Concrete Compressive Strength	Embodied carbon limits (kg CO_2e/m^3)	Embodied carbon limits (kg CO_2e/m^3)	Embodied carbon limits (kg CO_2e/m^3)
0-2500 psi	260	266	
2501-3000 psi	298	291	117 – 80% slag mix
3001-4000 psi	313	343	159 – 50% slag mix
4001-5000 psi	338	406	182 – 50% slag mix 256 – 18% slag mix
5001-6000 psi	358	429	277 – 18% slag mix
6001-8000 psi	394	498	156 – 80% slag mix 155 – 80% slag mix
>8001 psi			

The project's global warming potential (GWP) table.

56 days and used 80 percent slag replacement, but they were still able to achieve 27,579 kPa (4,000 psi) within three days to comply with the placement schedule. To achieve this, wireless maturity sensors were used to confirm the strength requirements were met within three days.

Slag cement also brought environmental and sustainability benefits that contributed to the overall GWP and embodied carbon reductions of the project. Not only does replacing a portion of portland cement with slag cement hold the potential to reduce the environmental impact of the concrete significantly, but it also requires nearly 90 percent less energy to produce than portland cement. According to the Slag Cement Association, using 50 percent of slag in the cementitious content can reduce GHGs by more than 40 percent and lower the embodied energy of concrete by more than 30 percent.

The Storm Center's GWP requirements were met, along with maximum cement content. In addition, all the cement used was Type IL: the project used ASTM C595 Type IL portland-limestone cement (PLC). As PLC uses a higher blend of limestone, it can result in carbon savings of up to 10 percent across the lifecycle of a project. As the concrete supplier successfully used this mix design on a previous project, the team was confident that performance requirements would be met. In general, the company has found success with the use of Type IL through testing, mockups, and appropriate mixture adjustments.

In addition, the project used ready-mix admixture and fiber technologies to help exceed the specified embodied carbon limits and overall performance. The teams collaborated to identify the best low-carbon mixes for each intended application throughout the design and construction process.

Creating a healthy and productive building

As a sports training facility for elite athletes, there was a strong desire to prioritize health and wellness in design, construction, and operation. As a result, rather than just resting at LEED Gold, the client, contractors, and architects were keen to push further and reduce operational carbon emissions resulting from the energy used to operate the facility. The commitments made by the City of Seattle and Washington State to transition to all-electric systems for decarbonizing the building stock created a smoother path for the project team to achieve these goals than other regions might face.

Moreover, the local utility the project is connected to already sources most of its power from renewables. More than 80 percent of Seattle City Light's power comes from hydroelectric projects on the Skagit and Pend Oreille Rivers. In addition, the city required the project to install photovoltaics (PV) on the building's roof. Low-volatile organic compound (VOC) materials were used inside the building to reduce the carbon and wider GHG impacts on the interiors and the players themselves.

Meeting the tight timeline

Speed was also of the essence for this project. Construction of the facility began in spring 2023, and the team wanted to be in the building by the start of the 2024 season in late April. The project's sustainability commitments helped them in this regard: The City of Seattle's Department of Construction and Inspections runs a program called Priority Green Expedited, which reduces permitting wait times in exchange for meeting a green building certification and other criteria.

As the building was chasing LEED Gold and similar sustainability goals, the project qualified for Priority Green Expedited, which aims to shorten initial plan review times by at least 50 percent. As a result, the project was given crucial extra time back to focus on construction.

A collective commitment to low-carbon

The combination of approaches resulted in a project that met and exceeded its GWP and embodied carbon goals. Overall, the project exceeded a 50 percent reduction compared to typical average mixes in the region and achieved 80 percent of the 2030 targeted reductions of the World Economic Forum's First Movers Coalition for "near zero carbon: concrete."

The achievement was a team effort and the result of implementing an early collaborative process with the contractor, architect, and design and project teams that identified what objectives were required to meet or exceed the client's sustainability goals. Architects ZGF noted these carbon reductions are the highest they had seen on a project.

The thermal buffering provided by the exposed concrete has a particularly pronounced effect on the building's energy efficiency and GWP over its lifetime. The concrete absorbs heat in warmer weather to minimize its impact on indoor temperatures and releases that heat when temperatures cool down. Strategic placement of this thermal buffering—such as in the walls, as is the case with the Storm Center—is a strong, long-term step toward reducing the building's operation carbon and GWP.

Other design decisions specific to buildings of this type further helped the project meet its energy efficiency and GWP goals. Since the practice courts require consistent lighting, large parts of the building's exterior have a very low window-to-wall ratio. In this case, it was approximately 6 percent compared to a more typical 30 or 40 percent. As windows are traditionally the weak link in a thermal envelope, this design consideration specific to a basketball practice facility will help the Storm Center reduce energy consumption and costs. When taken into consideration alongside the PV solar array installed on the roof of the building, the full suite of operational efficiencies has enabled the Storm Center to reduce its energy costs by 46 percent compared to the LEED energy baseline.

Keeping carbon reduction at the core

Ultimately, ensuring a project stays true to the principles of carbon neutrality rests on the client's motivations. It is common for professionals in the industry to rely on tried, tested, and trusted techniques and mixtures that have proven effective for specific buildings and other infrastructure. While the project's

An exterior shot of the finished facility.

low-carbon concrete mixtures were not experimental as they had been previously deployed on other projects, they remained largely outside the industry norms. A client that is invested in keeping the project tied to its low-carbon goals and partners across the project that are experienced and committed to doing the same will make sure that design and construction decisions have sustainability as a key metric in addition to the usual pillars of safety, reliability, durability, and cost.

From training in a university sports hall that was only available from 10 a.m. to 2 p.m. to have its own state-of-the-art facility that exceeds LEED Gold, the Seattle Storm are setting new standards on and off the court. Much of this is due to the commitment of professionals to devise solutions to meet their long-term, low-carbon needs. **CS**

ADDITIONAL **INFORMATION**

Authors


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Key Takeaways

The Seattle Storm Center for Basketball Performance, a $64-million, 4,645-m^2 (50,000-sf) facility, won the 2024 Concrete Innovation Award for its low-carbon design. It achieved 52.4 percent embodied carbon savings using 56-day strength testing, up to 80 percent slag cement replacement, and Type IL portland-limestone cement.

The project also integrated solar panels, low volatile organic compound (VOC) materials, and energy-efficient design to exceed LEED Gold standards. By aligning with Seattle's net-zero goals, the facility demonstrates innovative sustainability in sports construction, setting a new standard for environmentally responsible athletic centers.

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Sustainability

Deep Energy Retrofits

The Future of Sustainable Buildings

By David Hutchinson and Chuck Bundrick

Photos and illustrations courtesy Tremco CPG Inc.

AS THE GLOBAL FOCUS ON SUSTAINABILITY AND CLIMATE CHANGE INTENSIFIES, THE UNITED STATES IS SEEING A NEW TREND IN BUILDING RESTORATION-DEEP ENERGY RETROFITS. THE LARGEST CONTRIBUTOR TO GREENHOUSE GAS (GHG) EMISSIONS IN THE U.S., BUILDINGS ACCOUNT FOR NEARLY 50 PERCENT OF ENERGY CONSUMPTION AND 35 PERCENT OF TOTAL ENERGY-RELATED EMISSIONS.

Therefore, existing structures have been targeted for renovations to improve energy efficiency and reduce carbon emissions.

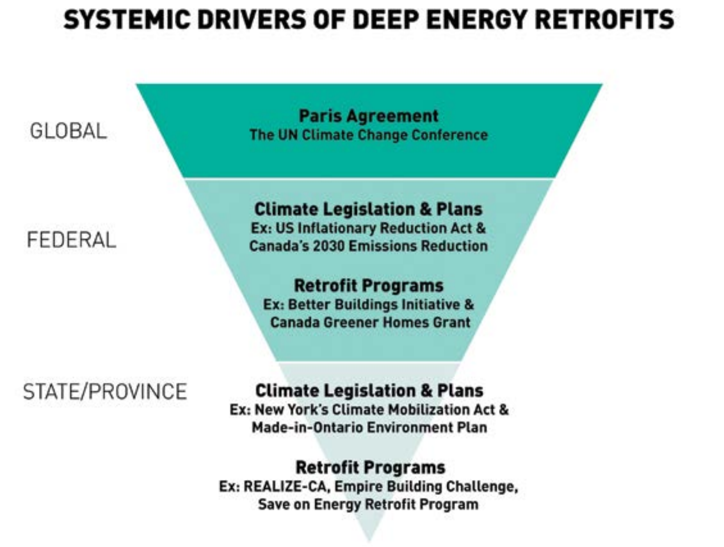
However, restoring buildings with energy conservation in mind is not only a massive undertaking; it also requires a holistic approach to develop actionable solutions that decrease their carbon footprint while minimizing disruption to current occupants. These collective actions make up deep energy retrofits, which renovate buildings to reduce energy use by at least 40 percent.

With legislative measures at all levels of government spurring the adoption of energy-efficient initiatives, local programs are incentivizing and supporting building owners, architects, and contractors in implementing deep energy retrofits.

Likewise, the construction and design industries seek to ease this process for stakeholders by introducing sustainable building technologies to accomplish these retrofits more efficiently.

This article reviews the drivers (Figure 1) behind energy performance regulations, how the building sector plays into reaching key milestones, and tactics to streamline the adoption of deep energy retrofits.

Figure 1



From global to localized programs, numerous parties are driving deep energy retrofits of existing buildings.

Setting the stage for energy conservation and reduction

Designated as a global emergency by the United Nations, the pollution from GHG emissions, which include CO2, methane, and other harmful gases, have led to substantial, often irreversible, environmental damage. In 2015, the historic *Paris Agreement* was ratified by world leaders at the UN Climate Change Conference to commit to a collective climate action to reduce emissions and limit the Earth's temperature increase to "1.5 C above pre-industrial levels."[1] The agreement was enacted in 2016. Today, 195 parties have signed onto this legally binding international treaty. To accomplish this climate action agreement, global greenhouse gas emissions need to reach net-zero by 2050.

Net-zero means cutting emissions and replacing coal, gas, and oil-powered energy sources with more renewable energy sources such as wind and solar. Although additional work can be done to increase renewable energy sources beyond wind and solar to augment carbon energy consumption. At this stage, it is difficult to predict how this will unfold under the current administration. Carbon neutrality refers to reducing carbon emissions and offsetting or "neutralizing" them by producing clean energy. Net-zero is the primary objective necessary for climate management.

The Paris Agreement increased sustainable policies worldwide to attain these goals. The first global stocktake in 2023 analyzed countries' progress toward these markers and chart solutions moving forward, with subsequent reviews occurring every five years after that.[2]

In the meantime, federal and state programs are assisting with the practical and financial implications of these energy-saving measures and emission reduction plans. In 2022, former president Joe Biden signed the *Inflation Reduction Act* into law, "marking the most significant action Congress has taken on clean energy and climate change in the nation's history."[3] This act allocates $369 billion to invest in its Energy Security and Climate Change program, which is spearheading an increase in clean energy, climate mitigation, and infrastructure resilience.

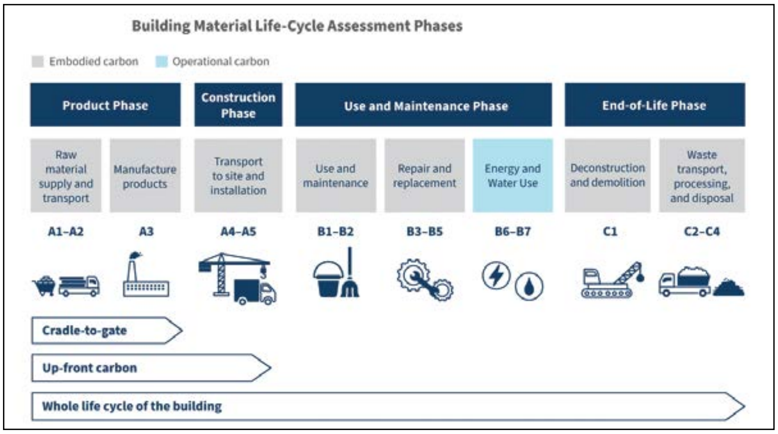
More than $2 billion of this is geared towards making new and existing buildings more energy-efficient, including grants to state and local governments to update their building codes with more stringent energy standards.

Similarly, the National Building Performance Standards Coalition (BPS) was established to assist local entities in improving the performance of their buildings and lowering their emissions through overall efficiency and using clean energy sources. BPS helps states and local governments that strive to establish building performance standards by identifying federal and state resources available for energy efficiency programs and leveraging education of best practices to aggregate and ramp up adoption.

New York and California were early adopters at the state level, employing programs such as RetrofitNY and REALIZE-CA to kickstart financing for energy-efficient adaptations to the existing building stock.[4,5]

How buildings impact carbon emissions

Building renovations, especially in densely populated areas, are pivotal in reducing embodied and operational carbon emissions. The term 'embodied carbon' refers to the sum of CO2 emissions tied to



The stages of a structure's lifecycle, from building material extraction to demolition, and the carbon emissions levels involved.

material extraction, manufacturing, transportation, and installation throughout the construction process and lifecycle of a building. Operational carbon emissions are those generated throughout the building's ongoing use and maintenance, such as heating and cooling.

While optimizing new construction elements is important, it is a difficult initiative due to the countless variables associated with erecting a building. Retrofitting occupied buildings, on the other hand, saves between 50 and 75 percent of embodied carbon emissions compared to constructing the same structure new.

In either case, strategies to reduce embodied carbons in building design and construction extend to reducing waste, incorporating recycled or reclaimed products, and using low-carbon, carbon-neutral or carbon-storing materials. Together, the tangible improvements of deep energy retrofits can lead to dramatic urban transformation, and, as the Rocky Mountain Institute (RMI) describes, help cities "move from climate commitment to climate action."[6]

Actuating these plans requires buy-in from stakeholders across the construction and design fields, including architects, contractors, engineers, building material manufacturers, and tradespeople. Therefore, industry associations, independent researchers, and nonprofit organizations are backing these decarbonization and retrofit strategies with data, training, and financing to ease the learning curve and project deployment. Some, like the International Institute of Building Enclosure Consultants (IIBEC) and the National Institute of Building Sciences (NIBS), focus on education and advocacy related to the design and implementation of high-performing buildings. In contrast, others take a regional approach or tackle more specific areas such as HVAC optimization, energy auditing, or solar power.

New York's approach to emission reduction

In April 2019, New York City's *Climate Mobilization Act* launched a range of initiatives to reduce energy consumption and carbon emissions.[7] Targets include a 40 percent reduction by 2030 and an 80 percent reduction by 2050. Entities such as Syracuse University and the New York City Housing Authority (NYCHA) take these goals seriously, emphasizing comprehensive and long-term energy solutions (*e.g.* Empire Building Challenge, Syracuse deep-energy retrofit lab) instead of one-off fixes.

One key measure of the *Climate Mobilization Act* is *Local Law 95*, which introduced energy efficiency ratings for buildings, much like health ratings for restaurants. This transparency of sustainability data might discourage potential tenants, such as a business or apartment seeker, from selecting those buildings, a motivator for their owner to change their carbon footprint or risk vacancies and decreased revenue.

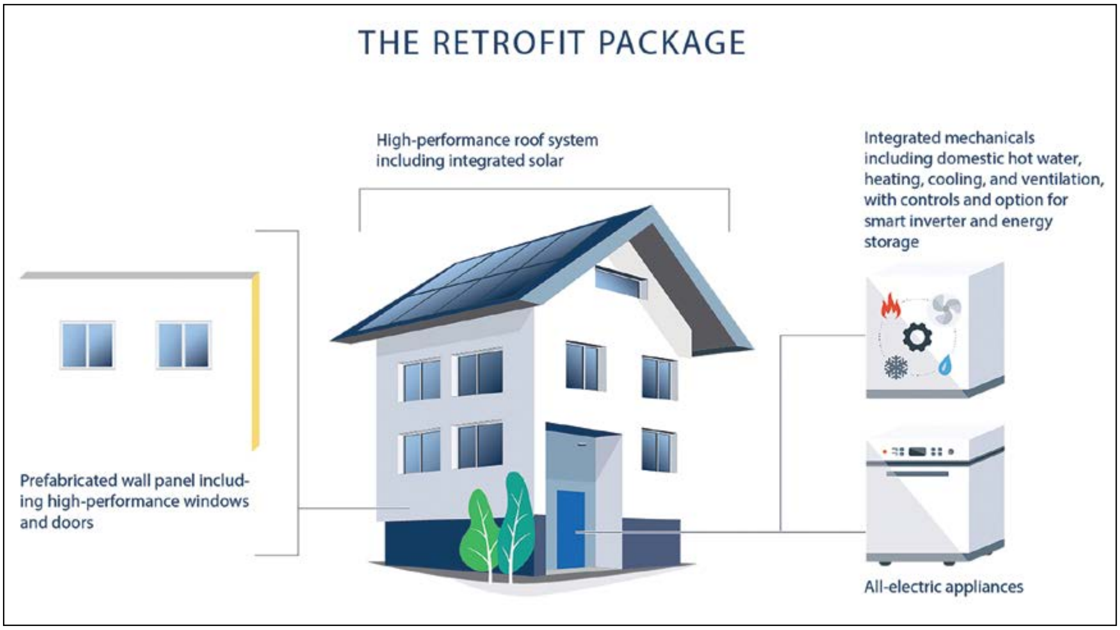
Local Law 97, which applies to buildings more than 2,322 m^2 (25,000 sf) in New York City, imposes penalties for structures exceeding emissions limits or failing to comply with reporting requirements beginning in 2024. This legislation has serious implications for building owners, developers, designers, and engineers, and will likely spark a boom in the retrofitting industry.

For architects and construction professionals working across state lines, New York and Massachusetts strive for consistency in their energy efficiency codes to streamline the process. Empire Building Challenge and REALIZE-MA are leading the way in meeting climate targets and paying attention to often overlooked buildings, such as affordable housing.[8,9] These programs offer design assistance and gap funding to encourage building owners to invest in energy-efficient solutions, as well as retrofits.

John Mandyck, CEO of the New York City-based Urban Green Council, notes, "Most buildings have done the easy stuff already so if you're not going to pay for it now, you better take a look at where the law is going and where the carbon emissions are going, because maybe now is the time to electrify to future proof the building."[10]

California and energy equity

California has an ambitious energy management plan. It strives to reach carbon neutrality by 2045, five years ahead of the *Paris Agreement* target. From there, it aims to double energy efficiency in state



The building elements included in REALIZE-CA's proposed retrofit package.

buildings, achieve zero emissions, and maintain net-negative emissions thereafter.

However, California's energy-saving programs tackle the restoration of existing buildings and establish more sustainable models for new construction projects. Since new builds require added energy consumption, the *Zero Code for California*, developed with AIA California, dictates that new non-residential commercial, high-rise residential, and hotel/motel buildings must offset the load through renewable energy production.[11] Using their prescribed strategies to optimize clean energy usage throughout the build process can result in near-zero carbon impact.

Under the California Energy Commission (CEC), the Equitable Building Decarbonization Program provides low- or no-cost retrofits for homes and incentives to drive greater use of low-carbon technologies.[12] The program also prioritizes construction to improve resiliency to extreme heat, indoor air quality (IAQ), and energy affordability to make sustainable, safe homes more accessible to low- and moderate-income (LMI) households.

This consideration for energy equity is also being taken by the REALIZE-CA program, which advocates for using deep energy retrofits in the affordable housing sector to reach California's aggressive energy goals.[13] They recognize that "low-income residents face a disproportionate energy burden," so innovative technologies and multi-disciplinary programs are necessary to expand these environmentally friendly strategies to vulnerable populations. The Low-Income Energy Affordability Data (LEAD) Tool from the U.S. Department of Energy (DOE) allows stakeholders to visualize the intersection of housing, income, and energy data in a geographic region to assess the energy challenges across the country.[14]

REALIZE-CA is working to standardize the retrofit process so these modifications can be easily deployed and scaled while minimizing disruption to tenants. The program engages with building owners, manufacturers, community leaders, and policymakers to show that deep energy retrofits are both attainable and a viable solution for reducing carbon emissions state-wide. The focus (and pledge) of this program is directed towards building owners and local municipalities, as well as manufacturers developing retrofit solutions.

While the road to achieving California's lofty climate goals is challenging, collaborative partnerships and new technologies are being used to make strides toward carbon-free buildings in the state. Other examples include: *California Energy Code* (California Code of Regulations, Title 24), *New York City Energy Conservation Code* (*NYCECC*), Vermont Commercial Building Energy Standards (CBES), and *Washington State Energy Code* (*WSEC*).

The importance of the building envelope in deep energy retrofits

Reducing emissions at the rate needed to hit the global milestones requires drastic changes to the aggregate building stock. Minor building repairs and upgrading interior elements, such as lighting, mechanical systems, and appliances, are not sufficient. While quick wins are helpful, their energy conservation is not substantial enough to meet the required international standards in the given timeframe.

Prefabricated wall panels are assembled in a controlled environment to streamline deep energy retrofits, ensuring high-quality, airtight, and energy-efficient building envelopes.

Deep energy retrofits involve these advancements plus more extensive changes to the exterior shell of a building and renewable energy sources such as solar or wind to improve building performance. Inevitably, retrofits are more efficient and produce more sizable and long-lasting results, but they are also more expensive and have a longer return on investment (ROI) periods.

Retrofitting for energy efficiency is complex because it takes a whole-building approach. These adaptations look to optimize all the structure's unique facets, which vary depending on the building typology, location, construction materials and occupancy. The goal of most retrofits is to execute all improvements in a short period to minimize wasted time, space, effort, and cost. The preference is not to remove the cladding, but rather to over-clad, which can be challenging for rainscreens. Further, rainscreens, by their very nature, are intended to be open joints, which promotes air drying and, consequently, thermal bridging, thus reducing the effective potential R-value of the proposed objective.

REALIZE-CA's proposed retrofit package includes prefabricated wall panels, high-performance windows, doors, and roofs, solar power, as well as all-electric appliances and more efficient mechanical systems.

This comprehensive lens to retrofits highlights the importance of the entire building envelope as the primary barrier between the interior and exterior environments.

The external building performance impacts the ultimate effectiveness of the structure's internal heating and cooling mechanisms. Positive environmental impacts of an energy-efficient HVAC system are essentially negated if the building envelope has significant thermal bridging and air infiltration and exfiltration. Air leakage alone is responsible for six percent of the energy used by commercial buildings in the U.S.[15]

A high-performance building envelope is dictated by numerous factors, including the wall systems' thermal mass, quality and continuity of insulation, airtightness, and watertightness. The National Institute of Standards and Technology, in partnership with ASHRAE, Oak Ridge National Laboratory and the Air Barrier Association of America (ABAA), cited that improving airtightness is one of the most cost-effective ways to decrease energy loads.[16]

To help measure this ROI, whole-building air-leakage testing, such as through ASTM E-779-19, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*, can be conducted before and after the retrofit to quantify these improvements.[17]

Panelized cladding solutions to speed energy savings

Deep energy retrofits incorporate exterior penalization for air- and water-tight facades with increased R-value to alleviate the threat of wasted energy in the building enclosure. The over-clad system comprises a framing material, drainage, insulation, and a durable architectural finish that is prefabricated and assembled in a factory so it can be quickly shipped and installed on the building without removing the preexisting cladding. Once brackets are mechanically attached to the slab in the field, the panels are ready to be hung in place. Then, installers mount and detail the window assemblies. Expansion joints are sealed with a flexible thermal barrier to accommodate any slight building movement or irregularities in the masonry. With respect to long-term benefits, the panels are made from recycled materials and can also be broken down and recycled.

Prefabricated wall panels can eliminate harmful thermal bridging, maximizing operational efficiency, decreasing occupant disruption, and reducing ongoing utility costs. Panels used for deep-energy retrofits are airtight and effectively manage moisture with a greater than 90 percent efficiency.

Panelized wall systems also have infinite artistic possibilities, giving architects complete design versatility to refresh the building's appearance to the owner's desired aesthetic.

The off-site construction method also allows year-round restorations and minimizes weather-related delays. The exterior wall panels are built indoors in a consistent environment for greater quality control and can be shipped to the job site whenever the project is ready. This speed enables the buildings to be closed in with an air- and water-tight envelope almost immediately after hanging the panels.

With repeatable buildings, such as those common in affordable housing complexes or university dormitories, the wall panels can be assembled en masse to allow for simultaneous retrofits of multiple structures.

This process can be streamlined further by consolidating scopes of work with design, construction, and building material partners who understand the interconnected facets of energy-conscious renovations. Using reliable companies for panel design, fabrication, and installation will enable faster, more efficient retrofits, which can reduce costs for all parties. Projects can also use manufacturers who offer products suitable throughout the building envelope to ensure material compatibility, effective joint connections, and long-lasting thermal performance to meet the energy code requirements. As of today, some panels meet the goals for a deep energy retrofit program, yet they offer a wide variety of aesthetic options. Often, a hybrid approach of two types of panels can be used on one project. The integration of a retrofit panel, in most cases, will involve a structural engineer. An envelope consultant would also be brought in to ensure the project meets its goals.

A deep energy retrofit transforms an aging multifamily housing complex with prefabricated wall panels, enhancing energy efficiency, aesthetics, and sustainability while reducing carbon emissions.

Case study: Retrofit success in California

Bundrick was heavily involved in the exterior panelization solution successfully deployed in California in 2023. Two buildings in the affordable multi-family housing development of Corona del Rey were identified as candidates for a deep energy retrofit as part of a research-driven project by the CEC and REALIZE-CA. These structures were more than 70 years old and required updates to their heating and cooling systems, plumbing, insulation, roof, and facade. Instead of tearing off the existing stucco, prefabricated wall panels were incorporated to overclad the exterior. The assemblies accommodated the structures' limited load capacity and logistical parameters. The offsite construction approach rapidly insulated and sealed the building, which minimized tenant disruption and improved the structures' energy efficiency, aesthetics, and comfort, in a matter of weeks.

Financial factors and opportunities

After understanding the logistics of a deep energy retrofit, the next question is always about fiscal feasibility. Funding streams are available through various federal and state-sponsored agencies, as well as third-party institutions and insurers. These can come as grants, rebates, loans, and tax reductions. Rainscreen systems, in particular, may be challenged to meet the high energy efficiency goals of a deep energy retrofit project and, therefore, would be difficult to qualify for funding programs that outline minimum energy improvements.

The DOE continues to fund technology advancements and pilot projects to bring these retrofits to fruition. Local jurisdictions are taking their own approaches to accelerate these climate mitigation efforts and accommodate the economic factors involved. Some municipalities extend tax incentives and gap funding for owners and developers who implement these energy-saving measures; while others threaten fines for those whose buildings do not attain a certain level of energy performance.

Property Assessed Clean Energy (PACE) programs offer financing for energy efficiency and renewable energy improvements on commercial and residential properties.[18] Regarding funding for additional testing (*e.g.* air leakage) and consultants (*e.g.* building envelope), depending on the financial metrics for the project against the goals, these services might be included in the project.

Even if an owner does not have the capital up-front, they can participate and repay their loan across upwards of 20 years. A noteworthy element of PACE programs is that the debt is tied to the property, not the owner, so any repayment obligations can be transferred if the ownership changes. The program for commercial properties, or C-PACE, is accessible in more than 37 states plus Washington D.C., while residential PACE is currently only available in California, Florida, and Missouri.

The Better Buildings Solution Center is a helpful resource for finding eligible financing options based on the property's location, size, type of ownership, and other features.[19] Their financial opportunities can help owners and developers measure their ROI at the onset of a project and see the deep energy retrofit through to completion.

Conclusion

The push to achieve net-zero carbon emissions by 2050 requires focusing on operational carbon within existing buildings. State and national organizations are driving local efforts with tactical and economic backing to support the distinct needs of the design and construction professionals, owners, community leaders, and households.

To meet these goals within the tight timeframe, deep energy retrofits and prefabricated solutions, such as exterior wall panels, are vital to streamlining the process for all stakeholders.

New York and California are leading the pack in retrofit adoption. They are pioneering energy efficiency programs with ambitious goals for reduced carbon emissions. While monetary and logistical challenges persist, various programs can help incentivize and aid the undertaking of these massive upgrades. As these states continue leading the way, their experiences serve as valuable blueprints for others to pursue greater sustainability and energy equity in their markets.

Overall, the success of such climate management programs depends on a multifaceted approach that combines technological innovation, financial and logistical viability, and long-term performance durability of energy-efficient building materials. **CS**

Notes

[1] See the notes online at constructionspecifier.com/deep-energy-retrofits/

ADDITIONAL **INFORMATION**

Authors

David Hutchinson is an expert in retrofit solution generation for the constantly aging existing building stock. Leading the Tremco CPG Deep Energy Retrofit Development program, he works with building owners and architects to bring turnkey solutions to the market and address the challenges facing carbon reduction. Additionally, Hutchinson is the founder and director of the Tremco CPG Rising Stars Program, which focuses on creating opportunities for diverse workforce development through training, education, and networking.

Chuck Bundrick, CSI, LEED GA, is a veteran of the exterior insulation and finish system (EIFS) and construction industry with more than 30 years of experience in senior sales and business management roles. He assists a team of professionals who help building owners, architects, and their design and engineering consultants consider prefabricated solutions for their projects. This team helps address the critical issues associated with building with building envelope renovations, including making decisions about improving building performance and transformation of the building exterior. Bundrick also helps owners access the specialized services often needed in prefabrication and renovations, such as fabricators, third-party inspectors, forensic engineers, and energy analysts.

Key Takeaways

As the urgency for sustainability and carbon reduction grows, deep energy retrofits are emerging as a critical solution in the U.S. building sector. Buildings account for nearly 50 percent of energy consumption and 35 percent of emissions, making them a priority for energy-efficient upgrades. Legislative measures, such as the *Inflation Reduction Act* and state programs in New York and California, drive these retrofits through funding and regulations. Key strategies include prefabricated building envelope solutions, low-carbon materials, and HVAC optimizations. With incentives and industry collaboration, deep energy retrofits offer a scalable path toward net-zero emissions and long-term energy efficiency.

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Z1020–Sustainability Requirements

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Energy efficiency
Net-zero
Prefabricated panels
Sustainability

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Powered by Light

A New Era of School Health

By Keren Imberg, PhD, MBA

Photos courtesy Hughes General Contractors

SCHOOLS ARE CONSIDERED HIGH-RISK ENVIRONMENTS FOR TRANSMITTING INFECTIOUS DISEASES DUE TO THE CLOSE AND FREQUENT CONTACT AND COMMUNICATION BETWEEN STUDENTS AND TEACHERS. THESE TYPICALLY INCLUDE THE COMMON COLD, INFLUENZA, STREP THROAT, STOMACH FLU, MONONUCLEOSIS, AND CONJUNCTIVITIS.[1]

Environments such as athletic training rooms, gymnasiums, cafeterias, and classrooms can act as sources for spreading infection. Following the historic disruption of the COVID-19 pandemic, the education sector is now focused on enhancing health and safety measures to support uninterrupted learning for all.

Several studies and surveys have documented the presence of excessive bacterial burden in high school and collegiate training room facilities. Additional studies have confirmed higher rates of nasal carriers of methicillin-sensitive *Staphylococcus aureus* (MRSA) and MRSA in contact sport athletes compared to the general population, with the athletic training room as a likely transmission source.[2] Athletic training rooms have a high prevalence of bacteria, including multidrug-resistant organisms, increasing the risk for both local and systematic infections in athletes. Adaptation of a hygiene protocol would lead to a reduction in bacterial and viral pathogen counts in these spaces where close contact among athletes and the presence of poor hygiene and contamination can predispose athletes to infection. While there is limited data outlining formal protocols or standardized programs to reduce bacterial and viral burden in training rooms as a means of decreasing infection rates at the collegiate and high school levels, the authors of a study hypothesized that the adaptation of a hygiene protocol would lead to a reduction in bacterial and viral pathogen counts in athletic training rooms.[3] This study looked at specific athletic training rooms. However, these same protocols can be applied to other areas of the athletic campus frequented by student-athletes, like locker rooms and weight rooms.

Despite the potential for infection in the athletic training room, athletes, parents, and athletic trainers may not be fully informed about best practices to limit the spread of disease. To that end, schools are including advanced technologies such as ventilation, filtration, and lighting to help reduce infection-causing bacteria more continuously and automatically in occupied spaces.

Granite School District

Granite School District, located in the Salt Lake Valley, is the third-largest district in Utah and ranks among the largest public school districts in the nation. Its boundary encompasses 666 km^2 (257 mi^2), in which 57 elementary schools, 15 junior high schools, eight high schools, and other special schools and programs operate. With more than 60,000 students enrolled and aging school buildings dating back more than 100 years, structural issues posed significant safety and maintenance challenges. Aging school infrastructure is a nationwide challenge, highlighted in a national report. The American Society of Civil Engineers gave U.S. school infrastructure a grade of D+. It is not just cosmetics: aging school buildings could pose a risk to student health and safety.[4]

To address the problem of outdated and unsafe buildings, voters in the Granite School District approved a $238-million bond in 2017 to fund the rebuilding and renovation of 31 schools over 10 years. Along with rebuilds and remodels, the bond also allows for seismic, security, and maintenance upgrades for every school in the district. According to a district study, about half of Granite schools need repairs and updates to more than 75 percent of their facilities. In May 2019, the district announced site layouts for constructing modern high schools to help students prepare for college, careers, and community engagement. Skyline and Cyprus High Schools, located in Millcreek and Magna, Utah, are included in the major strategic plans.

To ensure fair development across two school sites, architectural firms Fanning Howey and Naylor Wentworth Lund designed a program based on Granite's core vision of adaptable learning environments, allowing site-specific customization. The new facilities will emphasize collaborative spaces, flexible learning environments, enhanced security, and the ability to adapt to educational needs for decades. Work began with Skyline first, followed by Cyprus.

Skyline High School, built in 1962, serves 2,156 students. To prevent student displacement, new construction and demolition are occurring in phases on the current campus. Work began in November 2019 and is scheduled to finish in December 2026, continuing throughout the school year.

Opened in 1918, Cyprus High School has served generations of students, but with an enrollment of 2,650, it now requires a modern rebuild to meet current educational needs. The school is being rebuilt on a 24-ha (60-acre) location near Salt Lake Valley's western foothills and is set to open in fall 2025. The district has worked with contractors for environmental remediation, geotechnical investigations, and utilities planning at the site. Phase one began in November 2021.

In Cyprus, the existing soil was found to be highly collapsible and could not support building loads, particularly if it became wet after excavation. To address this, 3 m (10 ft) of soil was removed across the site, some of which was treated with a stability additive. It was then put back as fill material where needed during construction; the remainder was taken off-site to a disposal area.

With mountains behind the school and barely any vegetation on the grounds, snow and rain runoff needed to be addressed. This included drainage systems to protect the site and the surrounding residential developments that dramatically increased throughout the new school's development.

Since the site is only a mile from a bomb factory and barely within the safety radius, all exterior structural design, including curtain wall systems, is needed to address the overpressure from any accidental explosion.

Additional remediation efforts compass cleanup of the former gun club, including lead shot and clay pigeons.

Moving forward

Over several months, architectural firms Fanning Howey and Naylor Wentworth Lund worked to redefine the district's approach to high school education with similar plans for Skyline and Cyprus high schools. The Granite School District devoted up to 84 m^2 (900 sf) for each of the numerous collaborative spaces included in Skyline and Cyprus. Glass walls that surround these spaces not only let more natural light into the adjacent classrooms but provide safety and security with "adult visual control" of each room. The schools include flexible learning environments, enhanced security, and the ability to adapt to educational needs for decades.

Additionally, after seeing an increase in vandalism spurred by social media trends, Granite School District has designed bathrooms in both high schools to allow for enhanced safety and supervision. For example, there are small individual rooms with toilets featuring floor-to-ceiling doors and walls connected to a shared handwashing area entirely open to the hallway. While traditional restrooms will remain on the same floors, school officials hope the new designs will curb issues such as vaping and harassment, which unfortunately occur most often in traditionally designed restrooms.

"Early visioning and planning sessions involved District administrators, as well as leaders and faculty from both schools, to build a common vision," says Michael Hall, AIA, lead architect at Fanning Howey.

Over several months, Fanning Howey and Naylor Wentworth Lund created a program focused on Granite's central vision of flexibility while allowing for customization at each site.

"The design allows Granite to continue its departmental approach to high school education, but with an emphasis on next-generation learning."

In a break from the district's traditional, double-loaded corridor schools, the design creates flexible, open space at the center of each learning community. The design also increases the visibility of the school's media program by positioning it next to a study cafe directly on the public square of the building.

Changes in how students learn and the opportunities technology will offer teachers in delivery and presentation will impact traditional classroom size and functionality. Easily changing the size and shape of various learning studios will better support the effective functionality and life of a new school building.[5]

Hallway or corridor space is required to support circulation through large educational facilities. Traditionally, that space has only been used to support circulation, but with minor functional changes, it can enhance learning by supporting "break-out" activity. By widening the typical hallway and enhancing finishes within the space, student collaboration outside the classroom offers strengthened learning opportunities. It is important to carefully evaluate the furniture used in these new "break-out" zones. Flexibility and ease of re-configuring layout is critical.[6]

The resulting design creates flexible, open space at the center of each learning community. The team's focus on flexibility continues in the athletic portions of the high schools. Instead of a traditional gymnasium, the design team created large fieldhouses with four courts, partitions, and upper-level running tracks. Each high school will also have an eight-lane, 23-m (25-yd) competition pool with seating for 500.

Athletic programs play a vital role in the schools' educational missions, promoting teamwork, discipline, and student development beyond the classroom. Renovation plans include upgrades for the athletic program—new grass and turf fields, tennis courts, pool, stadium, baseball stadium, and new athletics buildings at each high school.

Added technology improves health

A state-of-the-art athletics building at Skyline High School was completed in late 2021, and a similar building is currently under construction at the new Cyprus High School campus. To help reduce the spread of potential infection in the spaces, each athletic building includes the installation of disinfecting lighting that uses safe, visible light to kill harmful viruses and bacteria automatically and continuously in the air and on surfaces.

Germicidal lighting was specified and installed to help protect students and staff in the Granite School District from illness.

The 405-nm technology was specifically chosen for its environmental disinfection system that employs blended white and indigo light via a lighting control system to disinfect spaces. Unlike ultraviolet light, 405-nm luminaires pose no health risks to room occupants.

These specific luminaires were selected to reduce bacteria and viruses in the new athletics buildings, as these areas are more prone to such challenges. The proven effectiveness of 405-nm technology in mitigating pathogens ensures that this lighting installation actively contributes to reducing illnesses in schools.

The installation includes 405 nm linear surface-mounted fixtures in locker rooms and pendant-mounted fixtures in the weight room and wrestling room.

"To complement the school's forward-thinking design, we knew it was important to upgrade the lighting technology from what was in the previous athletic building. The germicidal 405-nm luminaires provide bright illumination, and the sealed enclosure housing prevents harboring of bacteria inside the luminaires," says Philip Borup, associate project manager at Envision Engineering.

Due to space limitations, germicidal downlights were selected for the toilet stalls, dressing rooms, and shower stalls. The 405-nm recessed, 1x4 fixtures were chosen for the cardio room, which supports installation into the existing lay-in grid ceiling.

The specific germicidal lighting installed in this project provides continuous disinfection technology. It is patented and clinically shown to kill harmful viruses, such as SARS-CoV-2 and Influenza-A, and bacteria linked to healthcare-associated infections (HAIs). Using a combination of 405-nm indigo and white LEDs, the technology emits a narrow spectrum, 405-nm wavelength of light that kills viruses and bacteria while also providing ambient illumination for the space. **CS**

Notes

[1] See the notes online at constructionspecifier.com/new-era-for-school-health

ADDITIONAL **INFORMATION**

Author

Keren Imberg, chief scientist and head of clinical affairs for Kenall Manufacturing, can be reached at keren.imberg@kenall.com. Kenall was founded in Chicago, Illinois, in 1963 and has built a reputation for durable lighting solutions of superior quality and exceptional value. Today, the company creates unique solutions for parking, healthcare, cleanroom/containment, food processing, transportation, high abuse, and correctional lighting markets. Kenall luminaires are designed and built in Kenosha, Wisconsin.

Key Takeaways

Granite School District integrates advanced lighting solutions to modernize its high schools, addressing educational and health priorities. Utilizing 405-nm germicidal technology, new athletic facilities promote safer, cleaner environments by reducing bacteria and viruses, enhancing wellness for students and staff.

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Custom-balanced Doors

Step into Universal Design

By Tracy Hultin

Photos courtesy Jackson & Ryan Architects

AT THE INTERSECTION OF ADVANCED TECHNOLOGY AND INCLUSIVE DESIGN PRINCIPLES LIES A NEAR-CENTURY-OLD INVENTION CALLED THE CUSTOM-BALANCED DOOR. CUSTOM-BALANCED DOORS ARE INTELLIGENTLY ENGINEERED WITH ACCESSIBILITY AND SUSTAINABILITY IN MIND. IN ADDITION, THESE DOORS ARE BEING INCORPORATED INTO MODERN BUILDINGS WITH OTHER SMART TECHNOLOGIES, SUCH AS TOUCHLESS ACTIVATION SWITCHES, ELECTRIC STRIKES FOR CARD READERS, AND POWER OPERATION SYSTEMS, TO ENHANCE USER EXPERIENCE AND SECURITY.

A custom-balanced door is an ideal solution for oversized doors or those constructed from specific materials. This specialized door incorporates a balanced mechanism that minimizes opening effort by strategically distributing its weight. A larger portion of the door swings outward, effectively leveraging wind and air pressure to assist with opening, which is particularly advantageous in high-wind areas or high-rise buildings. A custom-balanced door is a bespoke door featuring integrated, precision-balanced opening mechanics, often allowing for customization of design and materials to meet specific project requirements.

Custom-balanced doors are also increasingly being specified for designs that require compliance with the latest version of *Americans with Disabilities Act* (*ADA*) standards and other universal design principles that ensure accessibility for everyone.

Understanding custom-balanced doors

Custom-balanced doors offer a unique solution for architectural entrances, balancing form and function. Unlike traditional doors, balanced doors are engineered to pivot around their center of gravity, which sets them apart from other types of doors. This design allows for smoother operation and minimal user effort.

Bronze custom-balanced doors (formed bronze) installed at Market Square Tower in Houston, Tex.

In terms of operation, the fulcrum point of a balanced door is positioned at one-third of its width, which means one-third of the door leaf recesses into the building when opened. This arrangement creates a much more balanced pivot point, ensuring better weight distribution and fewer doors projecting onto a sidewalk, which is critical for busy city streets such as New York City. Despite the inset fulcrum, a balanced door does provide a similar opening space to conventional butt-, continuous-, and pivot-hinged doors.

Leading balanced door manufacturers also offer customization options that allow architects and designers to tailor these doors to meet specific project requirements, ensuring seamless integration into the building's overall design and aesthetic.

A quick history

The balanced door was invented in 1932 when Edward and Oliver Ellison recognized the need for a better door design. Entering what ended up being a five-year research and development process, the Ellison brothers had their sights set on delivering the most intelligent door design to date. Since taller and more tightly compressed buildings were becoming the norm, there arose a need for a door that could more easily overcome external wind pressure and internal stack pressure, among other benefits.

The design also needed to render the door size and weight inconsequential to ease of operation and longevity of service life. This combination of solid, durable materials paired with reliable, long-lasting performance would be the recipe for success for the world's first balanced door.

Intelligently designed

A balanced door's components work harmoniously together to ensure the doors open effortlessly and close reliably. Here are the core components:

Materials

Balanced door assemblies are available in various materials, such as formed bronze, formed stainless steel, extruded aluminum, wood, and tempered glass, offering both durability and timeless aesthetic appeal. Care must be taken to address the installation and co-ordination of the adjacent materials and frame and the verification of loads for the custom doors.

In terms of size and dimensions, narrow stile balanced doors feature thin stiles that are popular among architects to achieve a modern, sleek design. Slim 29-mm (1.15-in.) stiles are available in bronze or stainless steel. For architects and designers who prefer an even thinner stile, 25.4-mm (1-in.)-wide stiles are available on extruded aluminum doors.

Formed bronze and formed stainless steel balanced door dimensions may vary, but stile width minimums are typically set at 70 mm (2.75 in.) (89 mm [3.5 in.] preferred) with a minimum top rail height of 70 mm (2.75 in.) (89 mm [3.5 in.] preferred) and a minimum bottom rail height of 152 mm (6 in.) (254 mm [10 in.] recommended to comply with *ADA* standards). In most cases, the minimum face width of the frame material is 76 mm (3 in.) with frame depth at a minimum of 127 mm (5 in.); for these formed bronze and steel doors, glass and glass thickness may vary.

Extruded aluminum balanced doors have a similar structural appearance to formed stainless steel or bronze balanced doors, but with aluminum extrusions instead of formed metal. Stiles are internally fastened to the top and bottom rails during fabrication for these doors. Stile widths range from 63 mm (2.5 in.) to 114 mm (4.5 in.), with top rails usually measuring from 63 mm (2.5 in.) to 127 mm (5 in.). For the bottom rails, manufacturers aim for at least 152 mm (6 in.) but will make them taller (254 mm [10 in.] or greater) if protective dress plates are added to the bottom of the frame.

Tempered glass balanced doors are "all glass" doors that feature a top and bottom rail that secures the glass to the hinging mechanism. Rails can be made of stainless steel, bronze, or aluminum. Bronze and stainless steel rails are typically a

Many balanced doors consist of heavy and robust components but can still be opened with ease due to their design, which distributes weight so it requires little effort to open.

Bronze custom-balanced doors (formed stainless steel with tempered glass and narrow stile) installed at 125 Summer Street in Boston, Mass.

Photos by Bill Horsman

minimum of 121 mm (4.75 in.) in height, and standard aluminum rails are between 121 mm (4.75 in.) and 254 mm (10 in.) in height for tempered glass doors. A 13 mm (0.5 in.) tempered glass is used for balanced doors from 2.4- to 2.7-m (8- to 9-ft)-tall, and 19-mm (0.75-in.) tempered glass on doors taller than 2.7 m (9 ft).

Torsion bar spring

The torsion bar spring provides the closing force for the door and is designed specifically for heavy doors and traffic. The shaft containing the torsion bar closer spring can be concealed or exposed within the formed bronze frame.

Check and guide channel assembly

Located in the frame header above the door, this component provides a path for the door's closing and latching speeds. It contains hydraulic fluid and two valves to adjust speed to ensure smooth operation. As an added benefit for installers and owners, it allows for maintenance from the underside without removing the door, which is crucial when working with large and heavy doors. This item requires coordination for the custom door to ensure that all elements fit within the frame properly, considering the provided dimensions and structure.

Door roller guide

The roller guide in the top rail serves as the door's fulcrum. It should be made with robust materials, such as cast manganese alloy housing, because it absorbs a shock when the door opens and closes. This component also features a sealed roller bearing that facilitates the smooth movement of the door by simply rolling along the guide channel it sits in.

Top arm and top pivot bearing

Found in the top rail, the top arm connects the top of the door with a 25.4 mm (1-in.) diameter stainless-steel pivot pin that sits in the top pivot bearing. Once assembled on the building, this connects the top of the door to the top of the shaft and finally to the top of the arm, supporting the lateral weight of the door's top portion and rolling when the door opens and closes.

Bottom arm

The top and bottom arms are welded to a heavy-duty, full-height steel tube shaft that spans the entire height of the door. The bottom arm, located at the base of the door, is thicker and heavier than the top arm because it carries the weight of the frame. Both arms (top and bottom) feature four heavy penetration welds holding the shaft, giving the door long-term strength and durability.

Bottom pivot component

Unlike the top pivot bearing, the bottom pivot's bearing is made of a plastic self-lubricating component to minimize corrosion. This is because the bottom bearing is more susceptible to contaminants (*e.g.* salt, snow melt, cleaning solutions, water, dirt, etc.) due to its location on the ground. The bearing at the top of the door is less exposed to these contaminants, so it is made of stainless steel. However, a stainless-steel pin is inserted into this portion of the bottom arm, allowing for operation.

This is another coordination item for the custom door, considering how elements fit in the proposed floor finishes for weight, accessibility, and floor structure considerations, as well as how much space is required for installation and the depth of the floor materials.

Floor box

The pivot shaft assembly of a balanced door sits on a 13-mm (0.5-in.) thick floor box base plate that spans from the interior to the exterior side of the door. The floor box is designed specifically not to rust or corrode and eliminates the need for a floor cutout. The weight of a balanced door is transferred down into this heavy-duty floor box.

Instead of pivoting from a single side like traditional hinge doors, balanced doors turn from an inset pivot point located at two-thirds width of the door leaf.

Photo courtesy Ellison Bronze

These intelligently designed components create a balanced door system renowned for its longevity, strength, and durability.

Meeting *ADA* standards

Balanced doors have become a go-to choice for architects designing *ADA*-compliant entrances.

According to the Pew Research Center, 42.5 million Americans have disabilities, which is approximately 13 percent of the civilian population.[1] This statistic highlights the importance of designing entrances that adhere to *ADA* standards, which can be aided by the specification of custom-balanced doors. Not only is it a legal requirement in many circumstances, but designing to *ADA* standards is a fundamental step towards fostering inclusivity in public spaces, providing equal access to all individuals. This ensures everyone can easily navigate public spaces regardless of physical ability.

However, generally, the accessible guidelines are just that: guidelines. If adopted by a state, county, or city, they can become part of the code, and many jurisdictions have done that. Accessibility guidelines can be State or local adopted codes, A117.1 (*IBC*-based codes) or *ADA* standards for accessible design (for federal-based projects).

The most recent version of the *ADA* guidelines (published by the Department of Justice) was introduced on September 15, 2010. These revised, enforceable accessibility standards set minimum requirements for newly designed and constructed or altered state and local government facilities, public accommodations, and commercial facilities to be readily accessible to and usable by individuals with disabilities. The A117.1 has been updated from 2009 to 2017 with new requirements for clearances and turning dimensions.

Under the guidelines, at least 60 percent of common entrances must be accessible in new construction, including entrances directly serving tenancies, parking facilities, pedestrian tunnels, and elevated walkways. "Common entrances" include all entrances except those restricted or used exclusively as service entrances.

Additional requirements apply to transit facilities and entrances for inmates and detainees in judicial, detention, and correctional facilities.

Regarding size, weight, and function, at least one door serving each accessible room or space must meet the prescribed entrance accessibility requirements. Figure 1 illustrates those requirements. Additionally, accessibility focuses on the weight in pounds (lb) to pull the door open at 2 kg (5 lb); this is the reason for using the custom-balanced door and the ease of opening these larger custom doors.

In addition, one active leaf of double-leaf doors is required to meet the criteria for clear width and maneuvering clearance. For designers, clear openings of doorways with swinging doors must be measured between the face of the door and the stop when open at 90 degrees. No projection into the clear width is permitted below 813 mm (32 in.), allowing those in wheelchairs to navigate doorways comfortably. This is especially critical in vestibule areas or ramps with limited maneuvering space.

Accessible guidelines are important for a host of other reasons:

- Inclusivity matters—Accessible compliance ensures entrances cater to the diverse needs of individuals regardless of their physical abilities. It goes beyond legality, promoting inclusivity and belonging in public spaces. Designers can specify balanced doors that are custom-made and designed to varying sizes and material types to meet accessible standards.
- Legal imperative—Failure to comply with accessible standards in areas that have been adopted into the building code not only results in legal repercussions but also hinders the goal of creating universally accessible environments. In fact, according to an article published by ADA Solutions, "an initial violation could set your business back as much as $75,000. Subsequent violations could be up to $150,000."[2]
- Enhanced user experience—Accessible entrances contribute to an enhanced user experience for everyone. A well-designed entrance considers all individuals' diverse needs, and it should be no more difficult to access for wheelchair users or those with mobility impairments than anyone else.

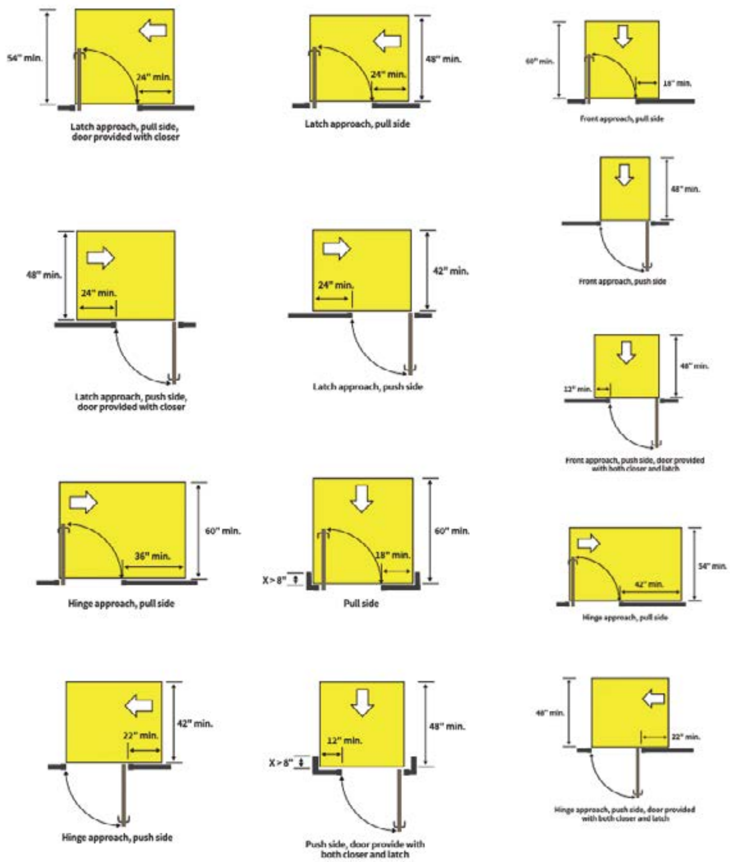
Leading manufacturers are offering custom-balanced doors designed as a complete system to meet the requirements of the accessible standards. By using balanced hardware, mounting locations, and integrated smart technology, including auto-operators and sensors, the doors ensure *ADA* compliance and integrate architecturally into a custom-designed entrance system that can last a lifetime with the proper maintenance.

Although not a standard integration yet, additional smart technology that can be integrated into balanced doors includes smart glass. In the future, the industry could see smart glass being used for specific applications or industries, relied on for its ability to change opacity and transparency for privacy and/or light control.

Welcoming all

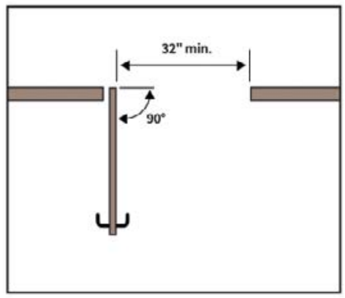
Designing universal entrances for accessible compliance is a multifaceted endeavor that must consider inclusivity and user experience, which should be a promise for all facilities accessible

Figure 1



Clear Width

Clear openings of doorways with swinging doors shall be measured between the face of the door and the stop, with the door open 90 degrees. No projection into the clear width is permitted below 863.6 mm (34 in.).



Overhead view of swing clearance requirements.

Illustrations courtesy Ellison Bronze

by the public. Manufacturers can be a key resource for architects, designers, and owners when educating and helping create accessible-compliant entrances.

Ultimately, the synergy between design, functionality, and accessibility of balanced doors is helping to create entrances that are both high-performing and aesthetically pleasing. Their continued specification by architects and designers will contribute to creating truly inclusive public spaces.

Notes

[1] See the notes online at constructionspecifier.com/custom-balanced-doors

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ADDITIONAL **INFORMATION**

Author

Tracy Hultin is president and CEO of Ellison Bronze. Hultin joined the Falconer-based custom balanced door manufacturer in 2009 as national sales manager, then vice president of sales and marketing, and was elevated to president and CEO in 2021. With more than 25 years of professional experience working for custom door manufacturers, Hultin possesses a deep understanding of Ellison Bronze, its customers, and the architecture and design industry as it relates specifically to commercial doors and entrance systems.

Key Takeaways

Custom-balanced doors, a nearly century-old invention, blend advanced technology with inclusive, easily accessible design. Engineered for accessibility and sustainability, they are now integrated into modern buildings alongside smart technologies such as touchless activation, card reader electric strikes, and power operation systems to improve user experience and security.

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Universal design

AI Fuels Data Center Demand Can Precast Concrete Keep Up?

By Tim Cullen and Tom Bagsarian

Photos courtesy Encon United

MUCH ATTENTION HAS TURNED TO DATA CENTER CONSTRUCTION, NOT ONLY IN THE UNITED STATES, BUT THROUGHOUT THE WORLD, AS TECHNOLOGY COMPANIES STRIVE TO FIND FACILITIES TO HOUSE THE INFRASTRUCTURE NEEDED AS ARTIFICIAL INTELLIGENCE (AI) BECOMES MORE PREVALENT. PRECAST CONCRETE IS A DESIRABLE MATERIAL FOR THESE BUILDINGS FOR A VARIETY OF REASONS, WHETHER USED FOR WALLS, FLOORS, AND ROOF PANELS IN A TOTAL PRECAST STRUCTURE OR AS AN ENCLOSURE SYSTEM. REGARDLESS OF THE APPLICATION, PRECAST OFFERS THE SAME OFF-SITE CONSTRUCTION BENEFITS.

While data centers are currently being constructed at a fast pace, they are not a new building type. The most basic computer data storage facilities date back to World War II. The computer boom of the 1980s resulted in the need for more storage facilities and the term "data center" first came into use. Then came the dot-com bubble of the late 1990s, followed by the introduction of mobile devices in the 2010s.

However, for the data center market, these developments pale compared to the advent of artificial intelligence (AI), which requires more storage than many ever imagined. Goldman Sach found that one ChatGPT query needs 10 times as much electricity as a Google search.

The question now is how to build these facilities to meet the surging demand for data centers AI has created. A McKinsey & Company report forecasts 10 percent annual data center growth until 2030; some believe this is conservative. A representative for Microsoft said at the National Institute of Building Sciences (NIBS) Building Innovation Conference in May 2024 that his company alone operates 150 data centers worldwide.

"Things are not slowing down," says Roksana (Roxy) Taghizadeh, associate principal with AG&E, a structural engineering firm based in Dallas, Tex., and the engineer of record for 50 to 80 data centers a year. "There is huge demand for us to churn these out as quickly as possible to meet expedited construction schedules."

Precast concrete is an ideal material for the construction of buildings that will meet the aggressive schedules important for data center owners.

"Since precast concrete components are manufactured offsite, they can be procured and fabricated prior to the site being disturbed, and the precast can be scheduled to be erected at a specific time once the foundations are in place," says Corey Greika, vice president/general manager of Coreslab Structures in Indianapolis.

"Once precast concrete erection begins, it is an extremely fast process, especially when you consider that insulated precast concrete wall panels have all the elements of a finished wall system (finished surface, air, and vapor barrier) built in. This predictability and speed are critical to the success of the project from the owners' perspective."

Many precast concrete producers have also installed new production lines to increase their capacity and speed to manufacture data center components.

"Precast concrete producers can also use multiple manufacturing facilities to help meet schedules," Greika adds. "Most data center owners procure their precast concrete well in advance, which helps keep a project on schedule and avoids construction delays."

Michael Lyons, vice president and mission-critical practice leaker at architecture firm HKS, stresses data center clients should collaborate early with precast concrete producers.

"Early collaboration allows us to integrate precast concrete solutions seamlessly during the design phase, enabling the fabrication of precast concrete panels concurrently with site preparation," Lyons says. He explains that precast concrete means fewer trades will be at the jobsite, streamlining construction and minimizing delays.

Over the last decade, average rack power densities have nearly quintupled to 10 kW, and self-weight has doubled to about 1,814 kg (4,000 lb). In five years, the average power densities are expected to quintuple again to about 50 kW per rack, with weights potentially doubling.

EnCon Design, LLC, a division of EnCon United Company, has seen suspended loads exponentially doubling and roof live loads tripling from 2010 to 2024. While the exact source of these increased loads is not always directly disclosed, many precast concrete producers committed to this market segment have invested in deep-stem double-tees to accommodate these loads. Nearly standardized, this section is 4-m (12-ft) wide and 12-m (40-ft) deep.

Precast concrete is highly versatile, making it well-suited for various construction applications. Its ability to support long,

May precast concrete producers have invested in deep-stem double-tees to accommodate higher loads necessary for data center construction.

clear spans is valuable for organizing various rack layouts with minimal disruption. As floor-to-floor heights rise to approximately 9 m (30 ft) to accommodate additional electrical and low-voltage connections, precast concrete proves to be an excellent choice.

Total precast solution

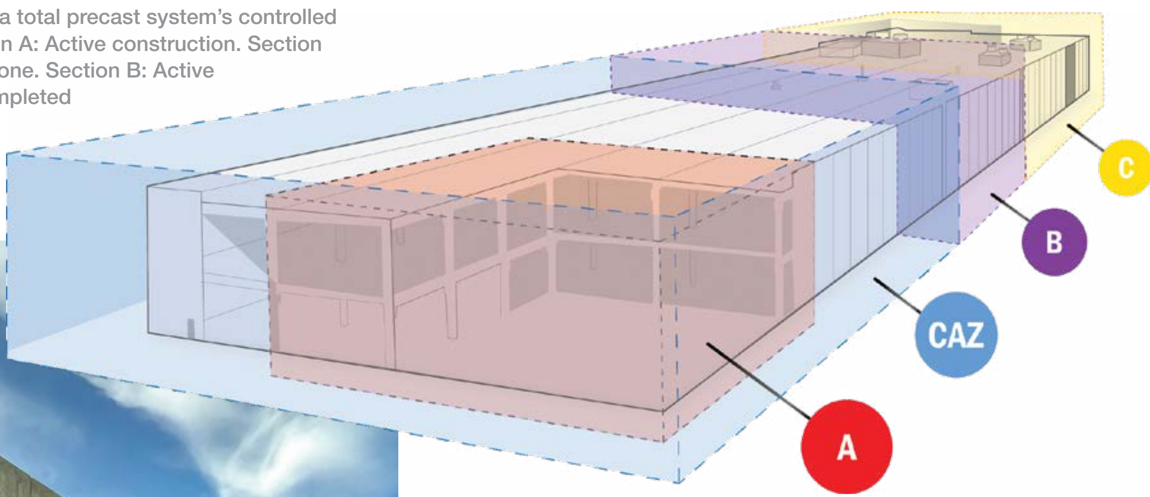
Jason Lien, executive vice president at EnCon United Company, notes data center designs are moving from sprawling single-story warehouses toward compact multistory buildings. This is likely due to efforts to conserve resources such as fiber optical cable and/or issues with latency between AI servers. At these increased heights, total precast concrete structures become even more attractive in terms of cost savings and impact on delivery. A total precast structure uses precast, prestressed concrete for the core and shell above grade. It may or may not have topping for the floor/roof. Precast concrete's inherent vibration absorption, quick shell enclosure, dedicated safe work regions, and total precast structure condense the functional ROI schedule while maintaining structural integrity.

Precast concrete's inherent two- or three-hour fire rating, temperature regulation through concrete mass and insulated wall panel construction, and strength, may result in a reduction in overall materials used—such as the number of columns required or volume of composite topping for the floors and roof. These reductions lower embodied carbon and require fewer labor hours onsite, lowering insurance requirements.

Precast, prestressed concrete finishes have schedule, cost, and design advantages. Using precast means moving the finish from the field to the plant, which saves time and requires less labor at the job site. Precast's integrated finishes require less long-term maintenance, resulting in lower long-term cost in dollars and carbon. Precast can match a broad range of architectural styles, shapes, sizes, and colors. Formliners and molds give precast practically unlimited and extraordinary design potential.

Numerous precast concrete suppliers exist, resulting in steady pricing and predictable delivery. While site challenges can result in uneven product quality using materials, precast concrete manufacturing happens with the same molds, crew, and location.

Precast/Prestressed Concrete Institute (PCI) certification and producers' quality assurance and quality control ensure precision



Illustrating the benefits of a total precast system's controlled access zone (CAZ). Section A: Active construction. Section CAZ: Controlled Access Zone. Section B: Active MEP work. Section C: Completed construction ready for crane to load occupant's equipment through a leave-out panel.

PCI-certified precast concrete producers or erectors perform installation, ensuring that details and connections are installed according to specifications.

is beyond industry standards. Precast concrete producers are certified by PCI to manufacture and deliver specific products. The quality staff is certified to inspect products and hardware before concrete is placed in the form and certified to evaluate the product after the product is removed from the form. Concrete is sampled and tested at regular increments by a certified technician. The raw materials that flow into the plant are monitored and evaluated for compatibility and specification compliance with mill certification review. Historical information on casting and raw materials can be requested to ensure material sourcing and fabrication transparency.

A PCI-certified producer or subcontractor performs product installation. This assurance ensures details and connections are installed according to plans and specifications. Proper product handling and rigging ensure field staff safety and general product performance. Lastly, the team is working on an engineered installation plan developed based on staged loading and unloading, which is often found during construction.

When one considers all the many challenges facing the data center industry today, coupled with the ever-increasing demands precipitated by AI development, total precast structures stand out as a solution. Precast concrete building systems offer value and budget certainty, whether the accelerated schedule advantage yields faster ROIs, vibration control eliminates redundant interior framing, or the high thermal efficiency inherent within insulated precast walls.

Sustainability advantages

In addition to greater cost advantages and reliability, precast concrete provides data center owners and developers with lower embodied carbon, improved resiliency, and better safety. "Data center owners and developers are driving hard to reduce the embodied carbon in their data centers," says Allan Bedwell, chief sustainability officer at Clark Pacific, a precast concrete producer based in West Sacramento, Calif.

Precast concrete structures are ideal for adaptive reuse by providing longer spans with larger open spaces and fewer interior columns. This allows for easy building renovation as future occupancy needs change. Precast concrete construction also benefits from the pre-dominant use of bonded prestress strand reinforcement as compared to un-bonded which is typical in cast-in-place concrete structures. A bonded strand can often be cut, knowing it will still provide reinforcement benefits in other areas. Prestress concrete stemmed floor systems have the benefit of the bonded prestressing strand being concentrated in the lower two-thirds of the stems. This design allows for a lot of flexibility for future floor openings. Many precast concrete wall panel systems are designed and reinforced for future openings, even providing reveals to show where future cuts can be made.

Bedwell's company focuses on concrete mixes that use less cement and optimizes designs to minimize the quantity of concrete and steel in data centers and reduce embodied carbon. Clark Pacific will soon release its ASTM-verified environmental product disclosure (EPD) for a data center and third-party lifecycle analysis (LCA) that compares the total carbon emissions of a precast concrete data center to a steel data center.

The new three-story 65,032-m^2 (700,000-sf) total precast concrete data center in the Phoenix, Ariz., metropolitan area recently received the U.S. Resiliency Council's first Platinum Seismic Rating and Platinum Wind Rating.

"These platinum ratings indicate that the data center has the highest level of building performance and is expected to suffer negligible damage and repair cost, with a functional recovery time within a few days following a major seismic or wind event," says Bedwell.

"The benefit of utilizing precast concrete is its inherent strength and durability to withstand the loads from heavy equipment," says AG&E's Taghizadeh. "The hardened shell with its typically windowless exterior walls are ready-made to withstand all manner of weather and fire."

Data center designs are moving from sprawling single-story warehouses toward compact multistory buildings.

PCI forms data center task group

For decades, parking structures have been the focal structure type for the precast concrete industry. However, recent trends indicate a significant interest and expansion of data centers constructed using precast concrete.

Precast concrete structural and envelope systems meet the high-performance demands of data centers by providing cost-effective open spans, passive fire resistance, and durable, high-efficiency, low-maintenance building envelopes. This is very important to mission-critical facilities—which data centers often are. Precast concrete is a high-performance material that integrates easily with other systems and inherently provides the versatility, efficiency, and resiliency needed to meet the multi-hazard requirements and long-term demands of high-performance structures.

To support this growing market, the PCI Technical Activities Council has formed a Data Center task group with the support of the PCI Marketing Council. The task group's mission is to develop recommended practices for using precast concrete in data centers, organize the body of knowledge for total–precast concrete and precast concrete–clad data centers, and provide recommendations for integrating precast concrete with other trade requirements.

The Data Center task group is developing a new PCI document titled "Precast Concrete Data Centers: Recommended Practice for Design and Construction." This document will guide designers in addressing the unique challenges of data center design and demonstrate to developers and architects the benefits of using precast concrete for data center construction.

Precast concrete is the ideal construction material for data centers for many reasons. It is reliable and long-lasting, stands up to these buildings' increased loads, and does not have unpredictable pricing often associated with other building materials. Certification and quality assurance ensure the precision of the product, all to the benefit of building owners. **CS**

ADDITIONAL **INFORMATION**

Authors

Tim Cullen is the PCI director of technical activities. He has more than 17 years of experience in designing, detailing, constructing, maintaining, and renovating precast and prestressed concrete structures. Before joining PCI in 2022, he was vice president of Blue Ridge Design, a structural engineering firm, and previously a design engineer with High Concrete Group.

Tom Bagsarian, PCI editorial content manager. He has more than 25 years of experience writing about construction, and was managing editor of *Concrete Construction* and *The Concrete Producer* magazines. He has been with PCI for seven years.

Key Takeaways

As artificial intelligence (AI) fuels rapid growth in data center construction, precast concrete is emerging as a preferred building material due to its speed, durability, and sustainability. With off-site manufacturing, predictable quality, and accelerated installation, precast solutions help meet the surging demand while reducing project timelines and costs. Total precast structures provide fire resistance, vibration control, and high structural integrity, making them ideal for the evolving needs of AI-driven facilities. Additionally, precast concrete lowers embodied carbon, enhances resilience against seismic and wind events, and offers long-term adaptability, ensuring data centers remain efficient and future-proofed.

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Securing the Future

Electrification of Doors and Hardware

By Justin Hendricks, FDAI

Photos courtesy Intertek

WHEN CHECKING INTO ALMOST ANY HOTEL ROOM TODAY, GUESTS WILL UNLIKELY RECEIVE A TRADITIONAL KEY. INSTEAD, THEY WILL ENCOUNTER A SLEEK, SECURE, AND TECHNOLOGICALLY ADVANCED SOLUTION: ELECTRONIC ACCESS CONTROL (EAC). OVER THE PAST FEW DECADES, ELECTRIFIED HARDWARE AND DOORS HAVE REVOLUTIONIZED HOW BUILDINGS ARE SECURED AND ACCESSED, FROM HOTELS AND HOSPITALS TO OFFICE SPACES AND APARTMENT COMPLEXES.

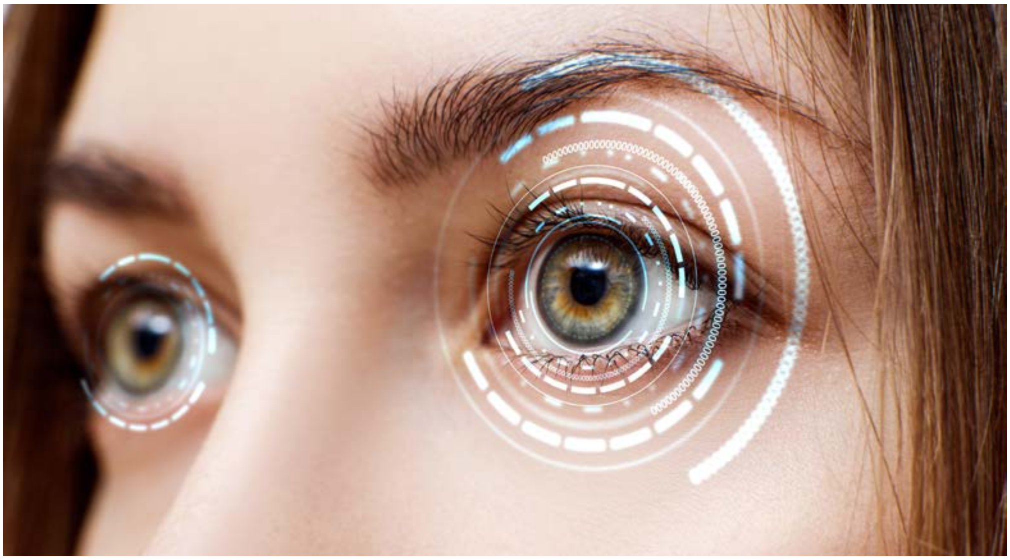
These systems combine convenience with cutting-edge security, reshaping how people interact with their surroundings. By bridging the gap between physical infrastructure and digital solutions, electrified hardware is driving the future of efficient and secure building management.

For architects, specifiers, and manufacturers, the widespread adoption of electrified door hardware presents both opportunities and challenges. The demand for secure and scalable solutions requires industry professionals to stay informed on emerging trends, fire protection standards, and product certification requirements. As safety and security needs evolve, manufacturers are creating solutions that meet stricter fire protection and access control requirements while prioritizing reliability and ease of use. Certifications and third-party testing play a key role in validating product performance, giving architects and specifiers confidence that these solutions align with industry standards and real-world demands.

Advancements in electrified hardware

The transition from traditional mechanical locks to electronic access control has been rapid and transformative. Early implementations, such as magnetic badges, simplified access while enhancing security. Over time, technological advancements have led to more innovative and interconnected systems, integrating multiple components such as card readers, electrified locks, and cloud-based management platforms.

Modern electrified hardware includes encryption protocols to protect sensitive data, tamper detection mechanisms to alert



An iris recognition system scans the user's eye to grant secure entry. Biometric methods use unique physical traits to provide high-level identity verification, reducing the chance of unauthorized access. Other forms of biometric authentication include fingerprints, facial recognition, voice recognition, and palm vein scanning.

managers to potential breaches, intrusion alarms for real-time notifications, and cloud integration for remote management and scalability.

Understanding electronic access control (EAC) systems

EAC systems have evolved into comprehensive solutions integrating hardware, software, and networking. Managing and monitoring access remotely is critical for businesses seeking more security and operational efficiency. EAC systems consist of the following components:

- Credential readers—Devices that scan and authenticate access credentials, such as cards, fobs, or biometrics.
- Control panels—The central hub that connects credential readers to electrified hardware.
- Software platforms—Cloud-based or on-premise solutions for configuring access permissions, monitoring activity, fire alarm integration, and generating reports.
- Hardware—Electric strikes, wiring, interconnected locks, magnetic hold open devices, fail-safe/secure protocols.

Integrating these elements has created opportunities for project teams to collaborate on seamless, secure building designs. As these systems evolve and advance, compatibility and integration with building management software have become the key factors for enhancing operational effectiveness.

Industry applications for electrified hardware

Hotels

Hotels have been leading the way in adopting EAC, using radio frequency identification (RFID) keycards, smartphone apps, and encrypted credentials to provide guests with secure and seamless room access. These systems allow real-time updates, making it easier for hotels to accommodate last-minute changes, late check-outs, or early arrivals without the hassle of reissuing physical keys.

A technician installs an electronic lock, aligning it for smooth operation. Electrified locks regulate access, integrate with credential-based systems, and reduce reliance on traditional keys, providing reliable security for buildings.

Beyond convenience, many hotels are now integrating EAC with mobile apps and loyalty programs, allowing guests to check in, unlock their rooms, and access amenities, all from their smartphones. This connection to rewards accounts adds a personalized touch, granting VIP guests exclusive access to premium areas and services.

Hotels are also exploring biometric authentication for high-security areas and VIP experiences, offering frictionless and secure access tailored to individual guests. These innovations go beyond improving security. They create a smoother, more enjoyable stay, giving guests the flexibility and control they expect while helping hotels provide a more personalized and efficient hospitality experience.

Hospitals

In healthcare, where security and accessibility are critical, electrified doors secure sensitive areas such as operating rooms and pharmacies, integrate with staff credentials for quick access, and provide audit trails to ensure compliance. For example,

A healthcare worker uses an access card to enter a restricted area, allowing access to patient care zones, medication storage, and sensitive records. Electrified access control (EAC) systems help hospitals and clinics regulate staff access, comply with privacy regulations, and manage movement during emergencies.

controlled access ensures that only authorized personnel can access medication storage or restricted patient areas, maintaining safety and regulatory compliance. Hospitals also benefit from automated locking systems during emergencies, which increases patient and staff safety while adhering to fire code requirements.

Office buildings
Office spaces benefit from customizable access permissions based on roles and schedules, remote access management for multi-location businesses, and integration with building management systems for enhanced energy efficiency. These features allow businesses to optimize security and streamline administrative tasks, such as onboarding and offboarding employees. Touchless entry systems are also gaining popularity in response to health and hygiene concerns, significantly enhancing user convenience.

Fire protection standards and egress requirements

Electrified hardware must effectively address security needs while prioritizing life safety. Fire protection standards, such as NFPA 101, *Life Safety Code*, and NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, provide guidelines to ensure electrified systems comply with egress requirements. These standards emphasize the importance of routine inspections to verify compliance with fire safety codes and ongoing maintenance programs to ensure operational reliability.

Regular fire door inspections are crucial to complying with these standards. These inspections verify the functionality of electrified hardware and confirm that doors maintain their fire-protection rating, ensuring they operate as intended during emergencies. When labels are damaged or missing, certified field labeling programs can inspect and, if applicable, restore compliance, helping to prevent products from being disqualified during audits. Building owners should prioritize partnerships with certified inspectors to promptly address any issues, ensuring continuous adherence to safety requirements.

Key considerations

- Fail-safe versus fail-secure locks—Fail-safe locks unlock during power failures to provide safe egress, while fail-secure locks remain locked to prioritize security. The appropriate type depends on the specific building application and fire safety requirements.
- Panic hardware—Electrified panic hardware is often required for egress doors in public and high-occupancy buildings, ensuring compliance with life safety standards while maintaining controlled access.
- Delayed egress locks—These locks allow controlled access with a delay for emergencies and have audible alarms and signage per NFPA guidelines. These systems balance security and safety, providing a critical solution for retail spaces and hospitals.

Certification and testing requirements

Entering the electrified hardware market requires strict adherence to certification and testing standards. For manufacturers, having their products meet the latest certifications is a legal obligation and a crucial factor in market entry. Certification to updated standards is often required to gain approval from the authority having jurisdiction (AHJ). Without it, products may face delays or rejection during inspection, jeopardizing project timelines and budgets.

Field inspection programs confirm doors and hardware adhere to fire safety codes, even after modifications or repairs. Product certification and field inspection labels provide authorities with proof that products meet NFPA 80 requirements, reducing the likelihood of rejections during annual inspections. Having the most up-to-date certifications and proper labeling on all opening protective components reduces clients' risk and liability, offering long-term peace of mind.

Everyone involved in bringing a project to life has an important role in understanding and applying the following certifications to make it a success:

- UL 294, access control systems—Evaluates performance under various conditions, including electrical interference and tampering. UL 294 certification ensures systems operate reliably under stress, a crucial factor for high-security environments.
- UL 10C, positive pressure fire tests—Certifies that doors and hardware withstand fire conditions, maintaining egress capabilities within the building during emergencies. Proper labeling of certified components simplifies compliance inspections and reduces liability risks.
- Federal Communications Commission (FCC) compliance—Verifies wireless components comply with electromagnetic compatibility standards. Compliance is vital for the safe integration of IoT-enabled devices, such as RFID readers and wireless locks.

A user unlocks a secured entry point using facial recognition, replacing traditional keys and keycards for a faster, more convenient, and more secure access solution.

- ANSI/BHMA standards—Define durability, strength, and finish criteria for door hardware. Examples include:
- ANSI/BHMA A156.3, *Exit Devices*
- ANSI/BHMA A156.25, *Electrified Locking Systems*
- Local and international codes—These include regional building codes and CE marking for the European Union, ensuring global applicability for manufacturers.

Reducing risk and liability

Proper certification and labeling are regulatory requirements and essential risk management tools as well. Compliant products minimize the likelihood of installation rejections by AHJs, legal liability during safety incidents, and operational disruptions. Specifiers, engineers, and architects play a crucial role by selecting certified products and partnering with manufacturers who prioritize compliance.

One significant advantage of compliance is the ability to avoid costly retrofits. Non-compliant installations can lead to delays, fines, and rework, which strain project budgets and timelines. Certified components provide peace of mind to all stakeholders by meeting legal and functional requirements right from the start. Clear documentation and labeling make it easier for facilities to pass routine inspections, reducing risks over time. This proactive approach builds confidence and strengthens industry partnerships among manufacturers, contractors, and clients.

Future trends in electrified hardware

As technology evolves, electrified doors and hardware are at the forefront of innovations that blend security, convenience, and sustainability. One of the most transformative trends is biometric access control, which uses fingerprints, facial recognition, or retinal scans to grant entry. These systems provide enhanced security by eliminating the risks associated with lost or stolen credentials, making them an ideal choice for high-security environments.

Mobile integration is another area of rapid growth. Smartphones are increasingly replacing physical credentials, allowing users to unlock doors and manage access through dedicated apps. This approach enhances user convenience and enables remote management capabilities, making it a scalable solution for businesses of all sizes. It also adds to the customer service experience and targets loyal customers. Additionally, mobile access improves the customer experience by offering seamless entry options and loyalty-based access privileges in hospitality, fitness, and corporate offices.

As the industry prioritizes sustainability, hardware design is shifting toward energy efficiency and eco-friendly materials. Low-energy systems and recyclable materials are aligning with green building initiatives, helping projects achieve LEED certifications and minimize their environmental footprint. Manufacturers now incorporate sustainable materials and energy-efficient components without compromising functionality or durability.

Battery technology advancements are further supporting the shift toward sustainable electrified hardware. Many wireless locks and access control devices are shifting to rechargeable lithium-ion batteries, which offer longer lifespans and lower environmental impact compared to traditional alkaline batteries. These improvements reduce maintenance needs and operating costs while improving system reliability. Additionally, battery backup solutions are becoming more advanced, allowing access control systems to remain operational even during power outages.

Artificial intelligence (AI) is also reshaping how different trades approach predictive maintenance and security, introducing smarter and more responsive solutions. AI-powered systems can monitor hardware performance, identify potential issues, and detect unusual activity, reducing downtime and preventing security breaches. Rather than relying solely on pre-programmed schedules, many modern systems integrate machine learning algorithms to analyze usage patterns and adjust settings dynamically based on real-time data. Some access control platforms incorporate anomaly detection and adaptive responses, enabling automatic security adjustments when detecting irregular activity.

While most manufacturers do not develop large language models (LLMs), they integrate AI-driven analytics through partnerships with cloud-based security platforms specializing in machine learning for predictive maintenance and access control. These systems continuously learn from data inputs, improving their ability to refine performance, strengthen security, and increase reliability. Further, seamless integration with smart building systems allows electrified hardware to work smoothly alongside other IoT devices, such as lighting, HVAC, and surveillance systems, creating unified and intelligent building management experiences.

Practical considerations for project teams

Successful integration of electrified hardware involves a coordinated effort across the entire project team, including specifiers, engineers, architects, and IT professionals. Each role plays a vital part in the project's success. Specifiers identify the best products and technologies to meet project-specific needs; engineers address technical requirements such as power supply and network integration; architects ensure the hardware aligns with the building's design and functionality; and IT professionals handle cybersecurity and system operations.

The process begins with conducting thorough site assessments to identify specific access control needs and potential challenges unique to the building's design and intended use. These assessments help determine the most suitable products and technologies for the project. Another critical step is verifying the compatibility of new electrified hardware with existing systems. This includes assessing legacy equipment, network infrastructure, and software platforms to ensure seamless integration. Coordination with EAC integrators and IT teams is essential to address network requirements, resolve compatibility issues, and establish robust cybersecurity measures for connected devices.

In addition, project teams must review certifications and test reports to confirm compliance with applicable industry standards and codes. Integrating AI-driven verification tools presents an opportunity to automate compliance checks, reducing manual errors and improving efficiency. This step guarantees the reliability and performance of the selected hardware under various conditions while meeting legal requirements. Engaging with manufacturers who provide comprehensive training and support can further streamline the installation and maintenance process. Such partnerships empower teams to manage the hardware effectively and reduce the risk of operational disruptions.

A person uses a biometric fingerprint scanner on an electronic access control (EAC) system to unlock the door, providing secure entry for authorized individuals.

By following these considerations, the project team can deliver solutions that are secure, compliant, and aligned with the client's long-term goals, contributing to the overall success of electrified hardware projects.

Conclusion

The electrification of doors and hardware has transformed the built environment, offering enhanced security, convenience, and compliance. For specifiers, engineers, and architects, a thorough understanding of the technical and regulatory aspects of these devices is necessary for delivering safe and efficient systems. By staying informed about trends, certifications, and standards, professionals can confidently navigate the complexities of electrified hardware and ensure their projects meet the highest levels of safety and functionality. With innovation driving the industry forward, electrified doors and hardware possibilities are exciting and limitless. **CS**

ADDITIONAL **INFORMATION**

Author

Justin Hendricks, FDAI, is a technical manager in Intertek's building and construction division. He brings extensive expertise in fire endurance testing and code compliance for building products, focusing on openings. His knowledge spans North American and European standards, ensuring comprehensive insight into global compliance requirements. Hendricks' areas of expertise include manufacturing facility auditing, quality control program development, third-party product certification programs, and product evaluations through engineering analysis. In addition, he has contributed significantly to business development initiatives, supporting clients in navigating complex certification processes. His dedication to advancing safety and compliance makes him a respected leader in the building and construction industry.

Key Takeaways

The electrification of doors and hardware is reshaping the built environment, offering innovative solutions for enhanced security, convenience, and compliance. This transformative technology integrates electronic access control (EAC) systems with modern building management, meeting the demands of hotels, hospitals, and office spaces. Emerging trends, such as biometric access control, mobile integration, and AI-powered predictive maintenance, signal a promising future for electrified hardware. By staying informed and adopting a collaborative approach, project teams can successfully implement electrified solutions that align with safety and long-term client goals.

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Structural Steel Corrosion: Evaluation and Repair

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Corroded structural steel framing is often encountered in existing buildings. This condition commonly occurs at locations where steel elements have been repeatedly exposed to moisture over time. Given the potential consequences associated with such conditions, it is necessary to understand the appropriate steps for the identification, assessment, and remediation of elements exhibiting various degrees of deterioration.

While most structural steel that is enclosed within a building is generally protected from sources of moisture that are likely to cause corrosion, some common conditions that frequently lead to problems include leakage through building enclosure systems, plumbing leaks, exposure to caustic chemicals, or undesirable construction practices such as placing steel elements in direct contact with concrete or masonry with exterior exposure. Steel framing in parking garages and sidewalk vaults is particularly susceptible to corrosion due to leakage through overhead concrete slabs and exposure to deicing salts used during winter. Deferred maintenance of protective coating systems for the steel can also accelerate corrosion.

Evaluation of corroded structural steel elements requires the expertise of a structural engineer familiar with assessing and repairing such conditions. Once identified, it is important to determine how much of the original member cross-section has been lost to corrosion and compare its remaining strength to the required loading demands (section loss of 10 to 15 percent generally raises structural concerns). Corrosion scale can expand to 10 times the volume of the original material and this can be deceiving as to the degree of section loss that has actually occurred. Since corrosion can result in increased thickness of the affected element, removal of the build-up of corrosion product is required to facilitate measuring the remaining steel thickness. Measurements can be made using traditional measuring tools when the element being measured has an exposed edge; however, where this cannot be accomplished due to access limitations, measurements can be taken utilizing non-destructive testing instruments such as an ultrasonic thickness gauge (an electronic device capable of measuring the thickness of a material from contact with an exposed surface).

Figure 1

Corroded beam in sidewalk vault.

Photos courtesy Wiss, Janney, Elstner Associates (WJE)

Figure 2

Corroded column base in parking garage.

If the section loss due to corrosion is determined to be structurally significant, reinforcement or replacement of a portion of or the entire member will typically be required. Reinforcement of structural steel members is commonly performed by welding or bolting additional plates or structural shapes to the deteriorated member. Design and implementation of the repairs require careful planning and sequencing, often utilizing temporary shoring to support the structure while repairs are made. Guidance for repair and strengthening structural steel members can be found in the International Existing Building Code and the American Institute of Steel Construction (AISC), Design Guide 15 Rehabilitation and Retrofit Guide. **CS**