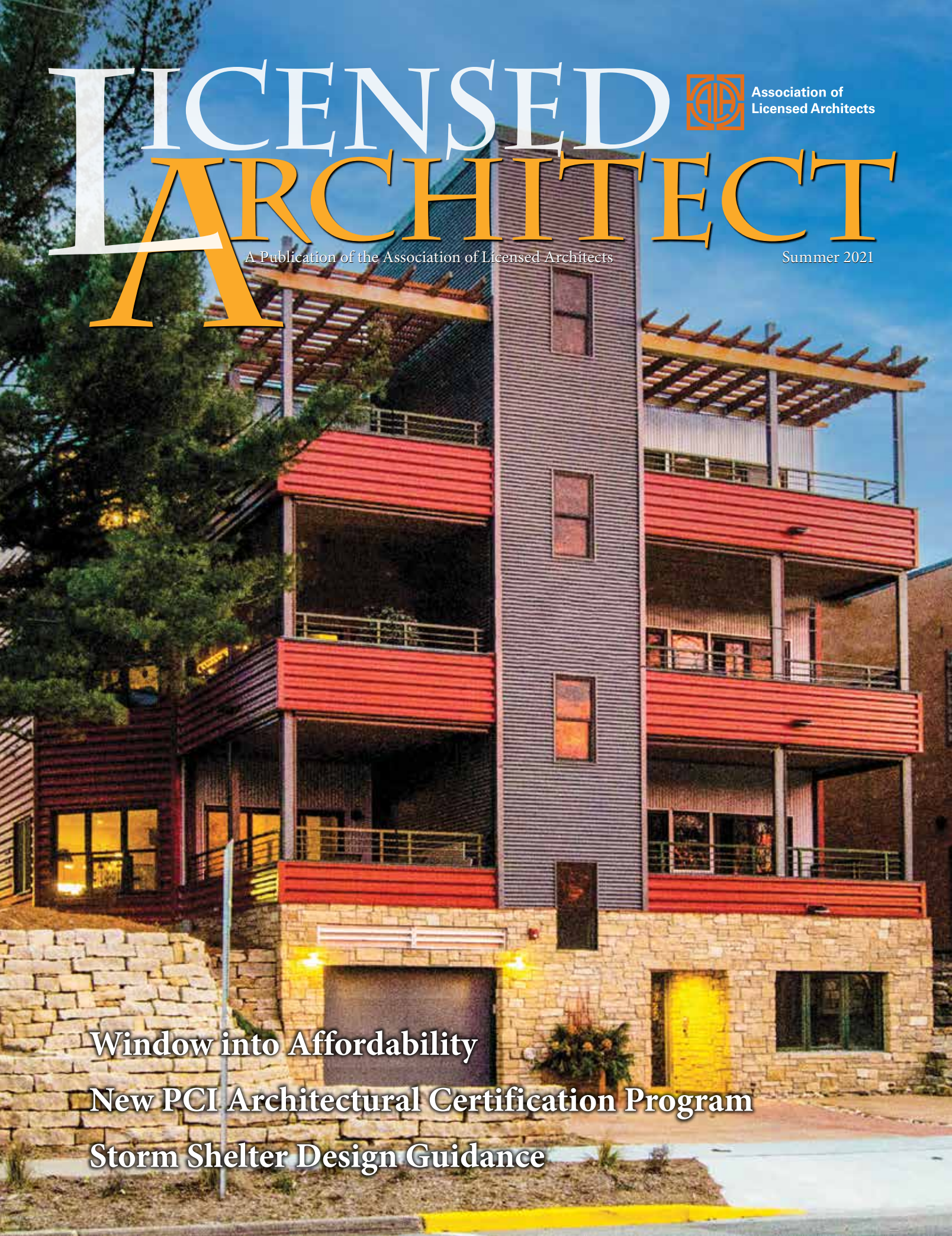
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Summer 2021



Window into Affordability

New PCI Architectural Certification Program

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Cover photo:
Dennis Kroll,
Kroll & Associates Architecture LLC

PRESIDENT'S message



Time flies. We are already past the middle of 2021. I hope you have enjoyed the summer and are finding an opportunity to relax, travel a bit, embark on new adventures or just indulge in a good book.

Our first hybrid event, held on August 26, gave us an opportunity to offer an in-person experience as well as a live webinar. As the pandemic continues to challenge us, we are likely to continue the hybrid format into next year. The hybrid model provides access for all to attend so we believe this solution will benefit everyone.

The ALA's important annual event is happening soon. The 2021 ALA Architecture Conference, scheduled for October 20-22, will be held virtually again this year. The conference begins at 12:30 PM each afternoon and ends by 4:30 PM, so it offers you a convenient way to balance work and continuing education. You can earn up to 7 continuing education credits; most qualify for HSW.

This is our 23rd year producing the annual conference and while we are not in person, we strive to bring you quality education and the opportunity to connect with many suppliers through the virtual exhibit hall. We have an amazing keynote speaker: Marlon Blackwell, FAIA, Marlon Blackwell Architects. Blackwell, a practicing architect and professor at the Fay Jones School of Architecture at the University of Arkansas, has received more than 120 design awards, including state, regional, national and international awards. As one commenter noted on his 2012 American Arts and Letters Award in Architecture, "Blackwell's design is truthful architecture – simple, powerful and steadfast."

In addition, we have booked several well-known favorites in their fields, including Steve Easley, Building Consultant; Kim Paarlberg, ICC; Jeff Boldt, IMEG and Stacey Brown Randall, Business Coach. We will be covering codes, exterior insulation, building moisture management and one of our most popular topics: generating consistent referrals for your business.

In the virtual Exhibit Hall you can explore the products and services of our exhibitors, which include manufacturers and service providers. Please support ALA and continuing education for our members by signing up today and participating in the show. Thank you for your investment in ALA and our profession!

We had a great response to this year's Design Awards program intent to participate with more than 100 entries. Judging takes place in November this year.

Please do not hesitate to contact us if you have any needs or concerns that we can address during these trying times. Stay safe and healthy and enjoy the rest of the summer.

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Window into Affordability



BY: KARYN BEEBE, P.E., LEED AP, WEST REGION FIELD SERVICES MANAGER, APA – THE ENGINEERED WOOD ASSOCIATION

Long Beach looks to an inclusive future with affordable housing development, Las Ventanas, while designers look to engineered wood as a cost-effective solution to a unique design challenge.

To help address the local homelessness crisis, Long Beach, California, enacted the "Everyone Home Long Beach" plan—an initiative that encouraged innovative, low-income housing solutions for the community. This plan sparked the bold vision for the development of a modern, affordable housing complex dubbed Las Ventanas, which means "the windows," a fitting name for a project that provides new windows of opportunity to low-income residents looking for housing options.

With a modest $28 million budget, it was vital for the designers and contractors to provide creative and strategic planning and construction of the affordable housing complex. Three local companies brought their unique expertise to tackle the project: AMCAL General Contractors, of Agoura Hills; CORE Structure Inc., with locations in Laguna Hills and the Bay Area; and William Hezmalhalch Architects (WHA), with offices in Orange County, Los Angeles and the Bay Area. These firms came equipped with decades-long histories of providing creative and cost-efficient multifamily construction solutions.



Courtesy William Hezmalhalch Architects



Courtesy APA - The Engineered Wood Association

Going for Bold

The striking bright red, four-story apartment complex was designed by WHA and CORE Structure Inc., though AMCAL was involved during the early design stage and provided regular feedback to the design team.

Las Ventanas received unanimous approval from the City of Long Beach Planning Commission in December of 2017. "It was vital that all the window openings remained true to the original design presented to the community, so determining shear wall locations and minimizing hold-downs was my primary coordination with CORE Structure," said Bernard Ines, Architect for WHA. "I remember reviewing the framing plans and was pleasantly surprised that no windows were jeopardized." The project broke ground in July 2019 and was completed in spring 2021.

Set on just over an acre off the Pacific Coast Highway in Long Beach, directly adjacent to the Metro A Line (Blue), the 148,000 total square-foot complex features 102 residential units with 3,962 square feet of retail space and a semi-subterranean podium parking garage. True to the name "Las Ventanas," the apartments offer naturally lit, open floor plans with patios or balconies. On-site amenities include a children's play area, outdoor seating with grilling space, locked bicycle storage, computer lab, community room, media center and more.

Las Ventanas integrates traditional wood framing with engineered wood products from APA members Norbord, Tolko, Boise Cascade, Pacific Woodtech and Rosboro. Oriented strand board (OSB) and plywood continuous sheathing on the walls, floors and roof served as an integral part of the structure's lateral force-resisting system. Glued-laminated beams (glulam) and laminated veneer lumber (LVL) were used as headers, and LVL was used widely as rim joists throughout the structure.

A Cost-Effective Solution

When a challenge arose with the plan, the designers found a cost-effective solution using engineered wood framing. Due to the sloped site, the top of the post-tensioned concrete podium was intentionally elevated at the retail spaces on the uphill side, so the floor on the third level includes areas of both concrete and wood construction. The wood shear walls above did not align with the concrete walls below, presenting a unique challenge. The design team's innovative solution to the alignment problem was specifying glulam and LVL floor beams to transfer the load from levels above and providing a seismic gap at the concrete/wood floor interface.

"The engineered wood beams allowed us to simplify the connection design while maintaining the ceiling height we needed," said Hooman Tavallali, Vice President of Production



LVL beams helped achieve an all-wood floor system within the allotted ceiling depth



Glulam beams and headers helped simplify connections

at CORE Structure. “Steel is also more expensive, so we were able to save them a lot of money.”

This decision kept the budget for Las Ventanas in bounds for reasons beyond material costs; choosing engineered wood over steel also improved construction efficiency. Using engineered wood products allowed the team to eliminate the need to hire additional laborers for the erection, fireproofing and inspection of steel.

“The elimination of steel beams was a big advantage with regard to both cost and construction time,” said Dan Balistreri, Superintendent of AMCAL General Contractors. “The engineered wood products were easily used by the framer and inspected with the rest of the framing. The need for an extra trade to erect steel beams and columns was eliminated, which resulted in a faster and smoother construction process.”



Heavily loaded areas also incorporated glulam beams

Panelized walls were delivered to the jobsite, which further optimized construction time.

A Window of Opportunity

Working within the budget, the design team saw that they could take advantage of the continuously sheathed exterior walls by designing the shear walls for force transfer around openings (FTAO). With FTAO, the design team was able to reduce the number of hold-downs and material costs while maximizing window openings—an apt goal for a building named “Las Ventanas”—adding to the bold and budget-friendly design.

“We tried to make it as affordable as possible,” said Tavallali. “We were able to reduce the number of hold-downs by 30–40 percent. We also used straps instead of the typical tie-down rods to transfer tension from floor to floor, which made labor and construction easier.”

Why FTAO?

Wood structural panel sheathed shear walls are the primary lateral-load-resisting elements in wood-frame construction. As wood-frame construction is continuously evolving, designers in many parts of the U.S. are optimizing design solutions that require the understanding of force transfer between elements in the lateral load-resisting system. Engineers are facing design challenges as it is becoming more common for buildings to incorporate larger and more numerous door and window openings. The increased openings present a challenge for designers because they reduce the area available for lateral resistance throughout the structure.

The force transfer around openings (FTAO) method of shear wall analysis meets this challenge by providing more design flexibility, because it allows for narrower wall segments to be used to meet required height-to-width ratios. Traditional segmented shear wall design ignores any sheathing used above or below a window opening.



The window geometry of the walls at the inner courtyard above the concrete podium allowed the use of FTAO at most exterior walls

When continuously sheathing a building, FTAO deflection equations account for the additional stiffness provided by wood structural panels below the openings, thereby reducing the calculated building drift. FTAO can also reduce the number of hold-downs required, reducing material costs.

Opening New Vistas

A clear vision and a strong plan saw the team through its challenges. "The project was pretty smooth," said Balistreri. "And it's on schedule as a result of extensive coordination prior to the start of construction."

Strategic design, creative construction techniques and cost-effective engineered wood products came together to create a space that opens up new vistas for low-income Long Beach residents and local businesses alike.



By adding horizontal strapping around the shear wall openings on the interior of Las Ventanas, the engineer was able to eliminate vertical strapping and hold-downs at either side of the openings while streamlining construction



FTAO Tools for Success

APA Technical Note: Design for Force Transfer Around Openings presents a rational analysis for applying FTAO to walls with asymmetric piers and walls with multiple openings. It is based upon APA modeling and testing and uses methodology that assists the design professional in solving for the required sheathing, nailing, hold-downs, straps and maximum deflection.

The FTAO calculator is an Excel-based tool for professional designers that uses FTAO methodology to calculate maximum hold-down force for uplift resistance, the required horizontal strap force for the tension straps above and below openings, the maximum shear force to determine sheathing attachment and the maximum deflection of the wall system. The calculator includes worksheets for shear walls with one, two and three openings and a design example.

Get the technical note and calculator and learn more about FTAO at:

www.apawood.org/ftao

Kroll & Associates Architecture, LLC

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Kroll & Associates is a small design firm located in Hudson, WI, just outside the Minneapolis-St. Paul metro area. We believe good design is an adventure as well as a patient search for good solutions. Founded in 1987, we are a network of architects, landscape and interior designers, and consultants dedicated to creating environments that are sustainable, support life, and lift the spirit.

We consider ourselves stewards of the environment, and in turn, strive to design environments that are supportive of the human spirit and our connections with nature. We are committed to environmentally sustainable design practices, including energy and water conservation, and the use of sustainable building materials, as well as to the conservation of existing buildings through renovation and adaptive re-use to avoid the cost of new construction. Our work is intentionally diverse, keeping our design perspective fresh. We strive to design facilities that are compatible with the context in which they are built and the traditions, aspirations, and dreams of the client.



720 First Street Lofts, Hudson WI

We designed and constructed a six-unit condominium on an infill lot on the edge of Downtown Hudson. Natural light and ventilation, no-water landscapes, and saving trees wherever possible were initial priorities. We designed for LEED certification and future net zero upgrades. Live-work and universal design were also considerations.







Ciranda HQ - 708 Second Street Offices, Hudson WI

We were asked to design an office facility to accommodate their growing organic food importing business on a narrow lot adjacent to their existing facilities at the edge of the downtown in Hudson. This would allow them a pedestrian-walking access to the downtown and the St. Croix River trails. Natural light & ventilation, sustainable no-water landscape, and low maintenance materials were the driving considerations.







Ciranda Yoga Garage & Grounds

By removing the existing garage and constructing a new one we added the required onsite parking and a space for a new corporate wellness program and their international teleconferencing needs. It is designed to fit into the surrounding historic residential neighborhood.



Dino's at the Fair

We opened up and remodeled the existing "crab shack" building at the MN State Fairgrounds to the adjacent lot and created an enclosed courtyard for outside seating, dancing and performances.



The Ridge at Snowmass, CO

Ski-in/ski-out condominiums designed with Benedict Associates, Inc.



RobbinsArchitecture

Robbins Architecture specializes in designing warm and livable modern homes. Founded by Celeste Robbins and located in Chicago's North Shore, the firm is recognized for homes that connect seamlessly to the outdoors bringing the timeless beauty of nature into the home. Whether it's tucked in the mountains, overlooking a lake, or towering above a city, our homes reflect each client's lifestyle and aspirations and the essence of how they want their space to feel and function.

We bring the confidence, openness, and agility to meet any design challenge, knowing a close collaboration with our clients makes the end result richer.





Photography: Steve Hall @ Hedrich Blessing

Mountain Modern, Colorado

Nestled within eighty-nine acres of Colorado ranch land and surrounded by the majestic Rocky Mountains, this home responds to its site with a sweeping, modern design. Expanses of glass wrap the home to introduce light and blur the separation between indoors and out. Inside, a series of sunlit spaces gracefully flow into one another, gradually breaking down the scale of the site. Carefully selected materials make the home warm and welcoming.

Ravine House, Glencoe, IL

Set atop a deep ravine along Lake Michigan, this modern home embraces the beauty and drama of the landscape. An intermittent pattern of carefully composed windows within a limestone-paneled wall creates both a sense of privacy against the street and sculptural patterning for the façade. In the living spaces, views of the ravine and trees create expansive connections to nature through every season.





PHOTOGRAPHY: STEVE HALL @ HEDRICH BLESSING





PHOTOGRAPHY: STEVE HALL @ HEDRICH BLESSING

Woodland Modern, Glencoe, IL

Placed within tree-layered ravine, this home is situated between a densely wooded slope and an open, sun-filled terrace. Expansive walls of windows invite each of the contrasting views into the home for a connection to nature that brings delight, regardless of the season. The large stair hall aligns with a linear reflecting pool. This powerful architectural gesture brings the graceful view of lily blossoms and koi fish into the daily routine within the home, framing and celebrating nature as timeless art.

New PCI Architectural Certification Program Kicks Off in 2021

BY: MONICA SCHULTES

Changes to the PCI Architectural Certification Program will better align specifier expectations with plant production capabilities.

Plant Certification Program has been the gold standard for decades and has been used by specifiers to ensure adherence to high levels of design, tolerance, and manufacturing. However, to address the unique aspects resulting from advances in architectural precast concrete, it became necessary to enhance the program.

With architects taking exterior finishes and shapes to unprecedented levels, their expectations have risen, along with the aesthetic and performance characteristics that have become commonplace. Improvements in technology, advanced mixture designs, and formwork generated by automated machinery have all raised the bar. PCI certification needed to distinguish between the intricate craftsmanship typical of high-end architectural projects from those that require a simpler solution.

Phase Out

The former A1 architectural category as well as the associated BA and CA categories have been redefined into four new certification classifications. Architectural precast concrete components will be governed by Categories AA, AB, AC, and AD, which are differentiated by panel complexity and production tolerances. Architectural trim units will continue to fall under Category AT.

One of the main concerns expressed by some regarding the old A1 category was that it was too broad and encompassed wide variations in products. The purpose of the new categories is to distill the specific capabilities that a plant demonstrates during an audit and better align those with specifier expectations on a project-to-project basis.

Before these changes, there had been no teeth in the program and it was too generic—there was dissatisfaction with the giant barrel of more than 120 A1-certified producers designated as "architectural." "Now, specifiers will have more assurance that they will be getting the level of architectural precast concrete product required on a specific project," says Scott Robinson, Midwest sales and marketing manager for Gate Precast Company.

One-size-fits-all is not conducive to the ever-increasing demand for precast.

It starts with the finished product and works back to means and methods. The biggest change is based on the complexity of shape and tolerances; how a producer gets there is up to them, whether they use a computer numerical control machine or carpenters to make the forms.

Catalyst for Change

While the basic premise for PCI certification has been adequate for decades, it lacked nuance and detail. "As the chair of the new Architectural Certification Committee, I have been involved from the beginning, when we collaborated with prominent architects from across the country to begin shaping this new program," recalls Robinson. After hearing the concerns of high-level architects, the lengthy collaborative process of revamping the program began. The result of those efforts can be seen in this new certification.

"We have created enhanced levels of precast concrete products to meet the aesthetic, installation, and performance demands of today's more complex, BIM [building information modeling]-generated exterior envelope requirements," says Robinson.

"Differentiating between producer aesthetic capabilities is important to architects," says Randy Wilson, director of architectural precast systems at PCI. "We utilized PCI's process of working through committees and task groups to adapt the plant certification program to meet every project's needs.



ERIN DERBY PHOTOGRAPHY

The Nordstrom project in New York City won the 2019 Sidney Freedman Craftsmanship Award and is an example of the AA certification category

One-size-fits-all is not conducive to the ever-increasing demand for precast."

The Matrix

The new architectural categories are laid out in a matrix that clearly defines the category distinctions. These new designations ensure a high-quality product within each specified category that conforms to the complexity

The designation applies to level of complexity, not level of quality.

of the project. "The ultimate goal is to better align the expectations of the customer with the proven capabilities of the plant," says Robinson.

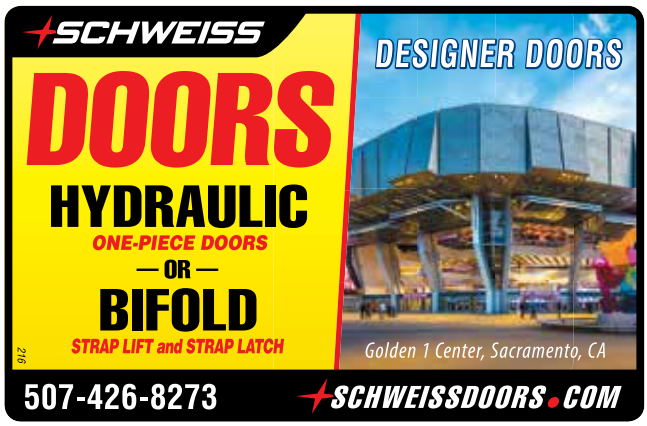
The matrix helps differentiate the precast concrete products and defines the levels of complexity. Certification in a category includes all classifications with less complex products. "The new status is very rigorous and accurately assesses the capabilities of these precast plants. The table of requirements for each classification should communicate very clearly to the specifiers the capabilities we have verified for each plant," says Mike Kesselmayer, managing director of quality programs at PCI.

By using five levels of architectural capabilities, a designer or owner will better understand the complexity of products available from a plant and how they meet the needs of their project. Introducing Categories AA through AD is in line with today's reliance on certification as a requirement for awarding contracts; it only makes sense for this new definition to further the use and understanding of precast concrete in all its forms.

To underscore the commitment to this new program, even though a producer might have been certified for 40 years, every precast concrete plant must go through the certification process to determine the new categories. "This change and additional cost is painful to producers. However, it is overdue and will demonstrate tremendous value for the marketplace. It is the right thing to do," says Wilson.

Complexity versus Quality

While the former A1 group has been divided into four categories, there is not one level that is superior to the others. "The designation applies to level of complexity, not level of quality," explains Robinson. "AA is the highest level



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InsideOut Studios, Rick Peters / Wells Concrete

The University of Minnesota Pioneer Hall Renovation exemplifies the AB category

of complexity and the double "alpha" designation is meant to avoid confusion in the marketplace."

The menu of color and finishes, types of cement, batching requirements, and embedded materials outline all of the requirements that a producer must meet to be certified at that level. A precast concrete producer must show proficiency in all those areas; they cannot just pick and choose a la carte.

Category certification is effective for two years. During that period, plants must demonstrate their continued capability to produce those products. Plant audits after initial certification in a category include a review of ongoing production to demonstrate capabilities to produce key features identified for each category.

Mock-up Artists

Mock-up panels are a critical part of initial certification in the new program. Two of the three required mock-ups can be created in advance of the auditor's arrival. One panel must be cast during the audit and the produced panels must match the drawings for the relevant category.

The mock-ups are a significant departure from the original program. "The specificity of the program is also different, all related to achieving the quality goals. This will be the premier program in this arena and designers will appreciate the information about all the processes from casting to installation," says Kesselmayer.

Audits

It will be business as usual for many architectural precast concrete producers. "We [Gate Precast] have always made products in all five categories," says Robinson. For those structural precasters who would occasionally produce "archi-structural" panels for a project, it may limit which projects they can pursue if they are not recertified. "WHAT we are making is not changing, but knowing WHO has the experience and capability to manufacture these pieces is the big difference," adds Robinson. "This program is really holding the precast concrete producers to be more accountable for what they are promising about their products," says Wilson.

In the new program, multiplant producers are treated as separate entities: every plant has to prove its own capabilities. There will be no sharing of mock-up panel forms between plants that are owned by one company, nor can they be stored and used for subsequent recertification.

Spec Building

Once designers learn more about the program and embrace the changes, the biggest hurdle will be differentiating and identifying under which category their specific project falls.

The precast concrete industry now faces the hurdle of communicating the cause and effect of this new program. They will need to help designers differentiate various levels of complexity. "My concern is that architects will blindly specify AA for everything as a default. That is why we are emphasizing the idea of complexity versus quality," explains Robinson. "High quality is expected across the board."

Kesselmayer is also concerned architects may specify a higher category than what they need due to misconceptions about complexity versus quality. It is important to understand the categories and where their project best fits. "That will come with time and experience," he says.

Board of Appeals

An Architectural Certification Review Board (ACRB) has been established to support the program. If there are questions about an audit or compliance has not been achieved for the requested category, PCI staff will provide the information to the ACRB for its review. The ACRB will review all certification recommendations for recertification.



Stiler and Henry Photography

Springhill Elementary School in Greenbrier, Ark, is an example of the AD certification category

The ACRB includes an architect experienced with architectural precast concrete, a representative from a qualified architectural producer, a site evaluator, an auditing organization representative, and the PCI director of architectural precast systems.

The ACRB can make a recommendation for certification in a category or a plant re-audit, a project reevaluation, or both. A site evaluation may be required if the architect/general contractor/construction manager surveys are deficient or for a recommendation for plant certification in an alternative category.

Given the wide range of production capabilities, means, and methods, an appeals process is available to handle discrepancies judiciously. PCI's standard appeals process was supplemented to fully address the types of issues that could arise with the new certification categories.

Many precast concrete producers have already passed the inspections and been approved. Others have been sidelined with COVID-19 restrictions or have been delayed. Most are well aware of their capabilities and understand the intricacies of casting the mock-ups in front of the auditors.

Site Survey and Evaluation

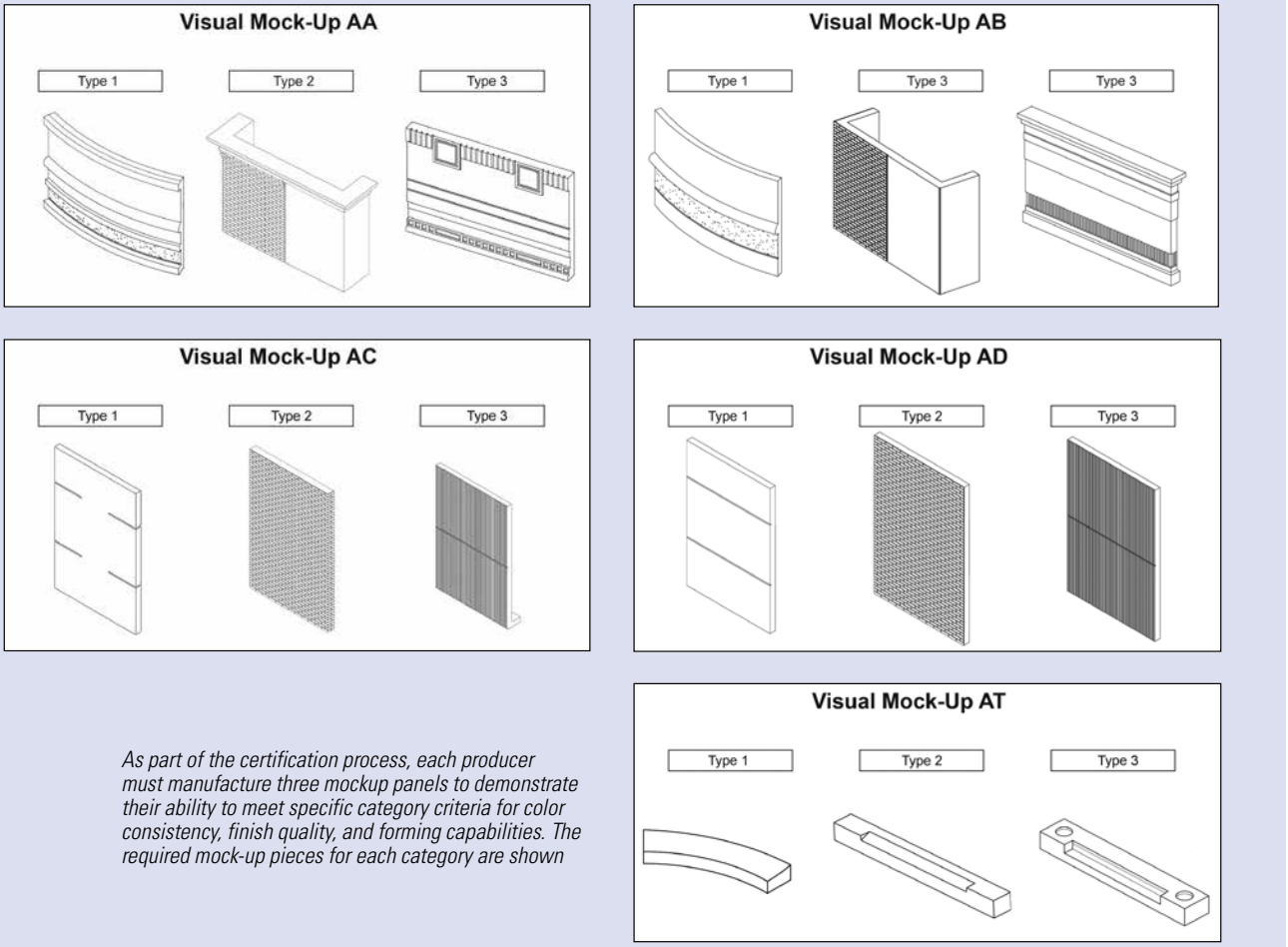
Post-occupancy evaluations will be required for all plants that have done AA projects and those beginning in the summer of 2022. A post-construction survey will be distributed to project team members, including the contractor and architect of record, for AB- and AA-specified projects.

PCI anticipates that architects will take the survey seriously, given the input and control over project categories and the heightened level of scrutiny in the certification process. "I will be encouraging designers on my projects to complete the survey and provide feedback," says Robinson. The surveys give the customer an opportunity to evaluate the producer for a specific project; they are job-specific and not generic. "The surveys are critical to the whole program," says Wilson.

The site evaluation is a very timely and applicable part of the process. "This is a new aspect where we will be looking at the quality of the completed project," says Kesselmayer. Based on the feedback from project surveys, at least one AA project per year will be graded on-site by a site evaluator, including any patching work that must fall within the requirements of PCI MNL 117, *Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products*.

The feedback will help PCI better educate the design community on the best way to maximize the use of precast concrete. It will also emphasize the importance of collaborating early in the design process and enable producers to add more value to each project.





As part of the certification process, each producer must manufacture three mockup panels to demonstrate their ability to meet specific category criteria for color consistency, finish quality, and forming capabilities. The required mock-up pieces for each category are shown

Deadline 2021

After October 1, 2021, the A1, CA, and BA certification categories will cease to exist and specifiers should select a new architectural certification category that meets their project requirements. Any project being awarded after that time should use the new categories. The new categories are defined by the project's level of complexity and aesthetic features and not any other criteria. "The standard A1 spec doesn't have a place in the market anymore," says Wilson. Those old specs will have to be rewritten or a request for information submitted to select a new category.

While the current plan is to roll this out in mid-summer, the pandemic has thrown a wrench in the plans to conduct audits across North America. It is important that we are able to complete on-site audits of each plant, but travel restrictions associated with the pandemic have necessitated virtual/remote audits in some parts of the country. "Given the importance of the mock-ups, these assessments have to be done in person and not virtually," says Kesselmayer.

After the initial process of reorganizing precasters into their matching category, they will need to demonstrate their continued capabilities with the auditors' review of ongoing production over the course of a two-year period. If these continued capabilities cannot be demonstrated this way, then the construction of mock-ups or reassignment of categories will be necessary. The same process of consulting the precast concrete producer early in the design process will be more important as designers select the proper categories for their projects.

As architectural styles evolve, so does precast concrete and the industry itself. PCI certification will continue to be recognized as the essential quality assurance program with its dual aspects of plant and field auditing. Those important elements have only become more stringent and quantified.

It is time to recognize that today's intricate and artistic creations brought forth with the latest design and production technologies are different from those of 50 years ago. With the industry touting the infinite potential for composition and creation of architectural precast concrete, the new certification differentiates complex work that includes custom colors, textures, and finishes from plain, serviceable panels.

CE Test Questions

PCI Architectural Certification

1. The Current PCI A1 Architectural category has been refined into four new categories; what are the designations of the four new categories in PCI's Architectural certification program?
   a. 1,2,3, and 4
   b. A1, A2, A3, and A4
   c. AA, AB, AC, and AD
   d. All of the above

2. If you were designing a warehouse, the most likely certification category would be:
   a. AA
   b. AB
   c. AC
   d. AD

3. If you were designing a museum with curved panels and 3-D molds, the most likely certification category would be:
   a. AA
   b. AB
   c. AC
   d. AD

4. The Precast/Prestressed Concrete Institute is:
   a. The Technical Institute for precast concrete industry
   b. A precast marketing consortium
   c. A technical school for concrete producers
   d. Only an association

5. One of the main concerns expressed by some regarding the old A1 category was:
   a. The old A1 category was that it was too broad and encompassed wide variations in products.
   b. The old A1 category was that it was too specific and limited product classification.
   c. The old A1 category was not generic enough to represent architectural precast designs
   d. The old A1 category was that it gave specifiers too much information to classify architectural designs.

6. The new architectural categories are laid out in a matrix that clearly defines the category distinctions. These new designations ensure:
   a. A high-quality product within each specified category that conforms to the complexity of the project.
   b. Specifiers will have more assurance that they will be getting the level of architectural precast concrete product required on a specific project
   c. Enhanced levels of precast concrete products to meet the aesthetic, installation, and performance demands
   d. All of the above

7. By using five levels of architectural capabilities:
   a. A designer or owner will better understand the complexity of products available from a plant and how they meet the needs of their project
   b. PCI is in line with today's reliance on certification as a requirement for awarding contracts
   c. Helps further the use and understanding of precast concrete in all its forms.
   d. All of the above

8. Who is responsible for auditing PCI-certified plants?
   a. Architect of record or engineer of record
   b. An independent third-party auditor, with engineers specifically trained in precast concrete production process
   c. Local building code official
   d. Internal plant manager

9. To ensure you are specifying the proper category, you should:
   a. Use the provided matrix and make your best educated guess
   b. Consult with PCI and your local precast concrete producer early in the design process
   c. Use a master spec and trust the bidders will let you know the proper category during the bidding phase
   d. Base your specification off of past projects that have similar details

10. The new PCI Architectural certification begins on:
    a. October 1, 2021
    b. January 1, 2022
    c. January 1, 2023
    d. January 1, 2024

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Storm Shelter Design Guidance for K-12 Schools

BY: MATTHEW H. JOHNSON, ANDREA M. LA GRECA, AND CONNOR J. BRUNS, SIMPSON GUMPERTZ & HEGER

The National Oceanic and Atmospheric Administration (NOAA) reports an average of 1,000 tornadoes per year in the United States, mostly in the Great Plains, which is far more than anywhere else on the planet. These weather events bring high winds and rains and are difficult to predict, leading many institutions to construct storm shelters and other safe rooms to protect their inhabitants.

In recent years, the International Building Code (IBC) has mandated that all new construction for K-12 schools in most of the Midwest and South Central United States include a community storm shelter. It is important for community officials and project team members to understand these requirements and follow best practices for designing these critical structures.

Understanding The Code: ICC 500

Historically, there was limited design and construction guidance for structures to withstand the high winds associated with tornadoes. In response, the International Code Council (ICC) and the National Storm Shelter Association (NSSA) published "ICC/NSSA 500 – Standard for the Design and Construction of Storm Shelters" in 2008, which was updated in 2014 and is scheduled with changes again in 2020. At first a voluntary or local requirement, ICC 500 is now referenced in the 2015 IBC, solidifying the mandate for storm shelters in K-12 schools where wind speeds for tornadoes top
250 mph.

ICC 500 is a comprehensive document that addresses structural, architectural, mechanical, egress, accessibility, and siting aspects for designing storm shelters. Understanding these requirements can influence design, operational, and construction cost expectations associated with these storm shelter projects.

Determining Storm Shelter Location

Storm shelters may be either separate, detached buildings, or rooms and areas within the building. The selection should consider travel distance and accessibility for students and faculty,occupant type, and the potential need for multiple shelters.

Desirable locations include gymnasiums, music rooms, or similar gathering areas for large groups. However, these spaces typically have tall walls and long-span roofs, which require a robust structure to resist tornado wind loads. Alternative locations for a more economic structure include multiple classrooms or locker rooms.

Structural Criteria

The most drastic variations from conventional school structural design are the design wind pressures and missile impact test requirements for the storm shelter envelope components, including foundations, walls, roof, doors, windows, louvers, and other penetrations.

For storm shelters, design wind pressures are primarily a function of the design wind speed, and the extent and size of openings in the building envelope. A common misinterpretation of ICC 500 is to consider the storm shelter "enclosed" when developing these wind pressures. ICC 500 requires the largest door or window on a wall to be considered an opening, which usually classifies the building as "partially enclosed" and results in elevated internal wind pressures. Overall, the elevated design wind speed and internal wind pressure result in design wind pressures that are five to six times that of a typical school building.

Other considerations include:

- **Building connections**: Where the host building is connected to a storm shelter, the shelter must resist the "ultimate failure strength" of the connection in the event of the host building pulling away from the shelter. Preferably, storm shelters should be isolated structures intended to stand alone after a tornado and resulting failure of adjacent construction.

- **Wind uplift**: The roof structure is subject to substantial wind uplift pressures. This may require increasing roof framing sizes or strength, additional bracing for roof framing elements, or adding a weight over the roof framing to overcome wind uplift forces.

- **Debris hazards**: Structural design must consider other hazards such as wind-borne debris from other structures, towers, trees, vehicles, or temporary classrooms.





Wind speed guidance from the 2015 International Building Code commentary (left); tornado damage to Midwestern school building (right)

Non-Structural Criteria

ICC 500 also gives criteria for non-structural components of storm shelters, including occupancy, egress, access and accessibility, and fire safety. Where storm shelters are appendages to a host building, the shelter must be large enough to accommodate all occupants of the host building and shelter and be accessible from every part of the host building.

The shelter's essential features and critical support systems required by ICC 500 – such as ventilation, emergency lighting, and plumbing – must remain functional for a minimum of two hours following a tornado event. All systems not within the storm shelter envelope must be housed within independent structures that meet criteria for tornado wind loads and missile impact testing.

Summary And Best Practices

There are several recommended best practices that project teams can consider when designing storm shelters:

- Engage a storm shelter peer reviewer during design, and plan for additional review for deferred construction submittals.
- Isolate the storm shelter from the host building with an expansion joint.
- Design the shelter as a partially enclosed structure.
- Minimize mechanical, electrical, and plumbing penetrations through the shelter envelope.
- Locate support systems within the storm shelter's envelope or below grade.
- Confrm that all building envelope components meet ICC 500 impact testing criteria.

This topic brief is adapted from "*Winds of Change: Storm Shelter Design Guidance*," which appeared in the September 2019 issue of *School Planning & Management*.

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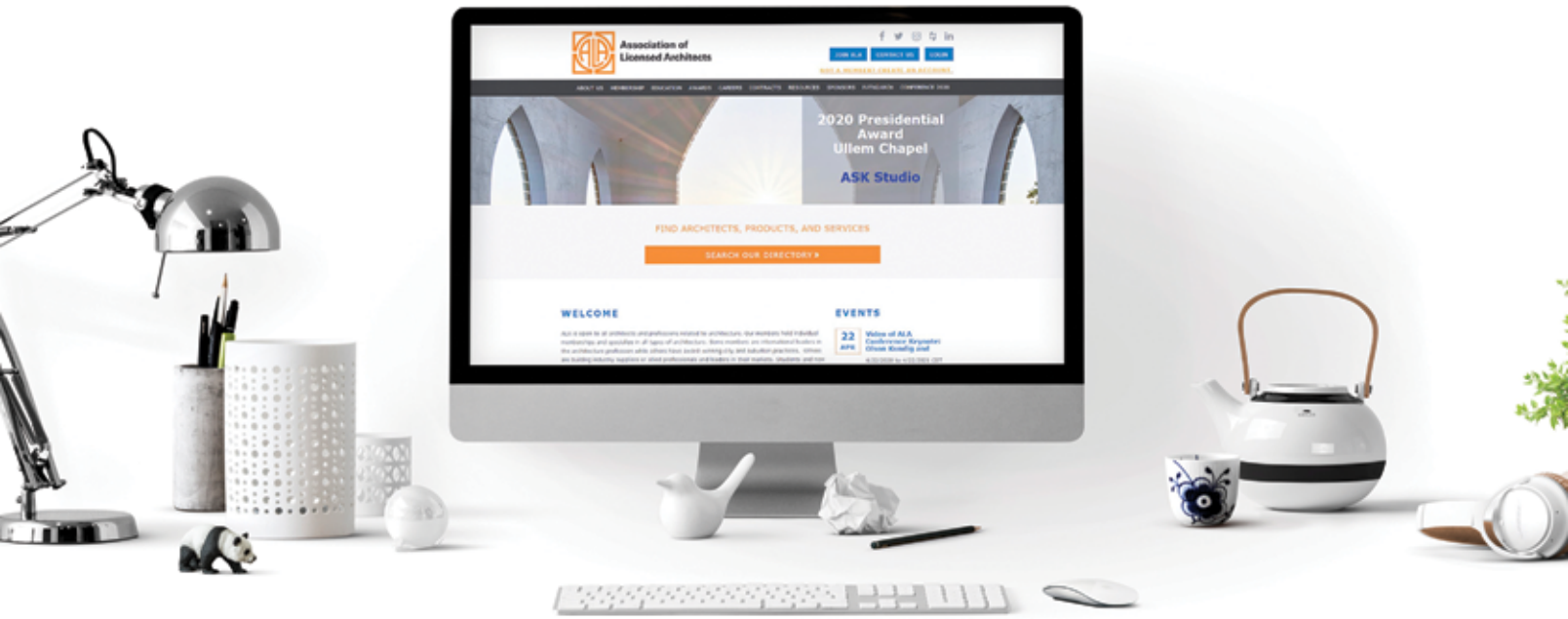
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