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# GLAZING THE WAY

## Reimagining Campuses


**The Power of Single-component Grouts**

**Crowd Pleasers: Modular Textile Solutions**

**Maximizing Protection with Sprayfoam**

CSI
CONSTRUCTION SPECIFICATIONS INSTITUTE


THE construction specifier
VOL 78 | NO. 6 | JUNE 2025

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PHOTO COURTESY TECHNICAL GLASS PRODUCTS (TGP)

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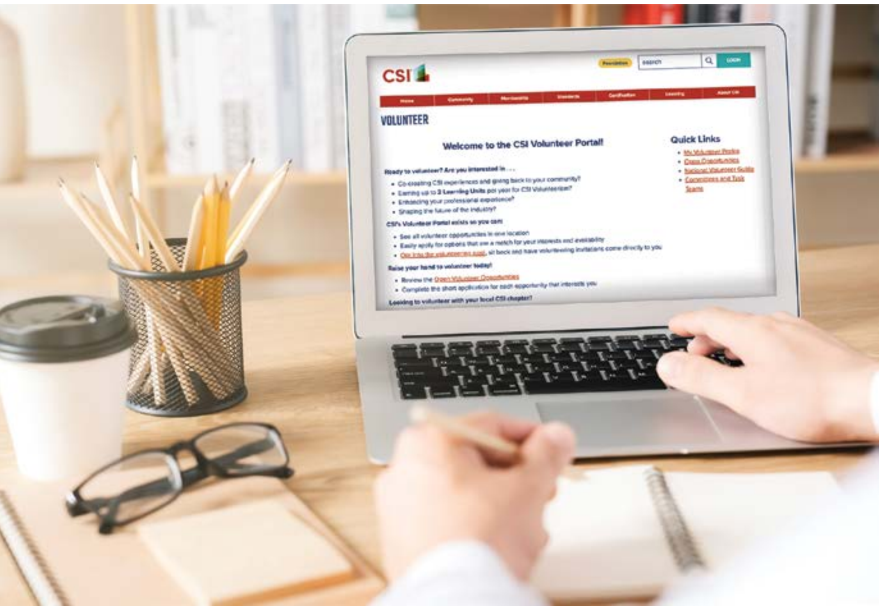
# Celebrating CSI Volunteers Making a Difference




**CSI volunteers have a remarkable role in helping our organization make an impact in the AECO industry.** Whether at the local, regional, or national level, volunteers are catalysts for ensuring we have meaningful networks and tools to deliver better projects.

Chaitanya Korra, CSI, CDT, senior design manager

There can be a lot of reasons someone chooses to become a CSI volunteer, so we asked a few to share why they give their time to CSI.

Chaitanya Korra serves as a CSI Education Committee member and editor of the Project Delivery Study Workbook. His commitment to volunteerism reflects the spirit of collaboration that defines CSI.

"Volunteering with CSI is important to me because it allows me to collaborate with industry experts to develop knowledge resources that contribute to the advancement of best practices in construction specifications and project delivery, and empower professionals across the construction sector. Seeing how my efforts directly enhance the professional growth of CSI members and improve project outcomes makes volunteering both fulfilling and impactful."

Matt Gregory, CSI, CCS, CDT, architect, planner, specifier

Matt Gregory's role as the CSI Puget Sound Chapter Membership Chair highlights the value of community building and member engagement in volunteerism. It reflects a commitment to fostering connection and ensuring members feel welcomed and involved—core elements that strengthen any professional community.

"Volunteering gives you the opportunity to learn how to do new things and acquaints you with people of similar interests. The end result is a feel-good sensation, knowing that you helped someone and were able to give back. Life is more than one's ambition and career; it is sharing one's talents or time with others for the benefit of the community."

Fernand Ricard, CSI, CCS, CDT, associate principal, specifier

Fernand Ricard helped analyze CSI certification exam questions to ensure relevancy and accuracy for future exam takers. His efforts demonstrate a strong commitment to delivering meaningful credentials and fostering the professional development of others within our community.

"The organization thrives when its members volunteer, and I enjoy contributing to the success of an organization that has supported me over many years. Earning my CCS was a meaningful milestone, and I wanted to help future examinees feel the same pride in their accomplishment. By supporting CSI's efforts to offer relevant, high-quality exams, I'm proud to contribute to the continued value of CSI certifications."

Joining the CSI volunteer pool can help you make the same sort of impact and find professional growth. Visit csiresources.org/communities/volunteer to get started.


NEXT GENERATION DOVETAIL DECK

# From Mix to Fix

## The Benefits of Single-component Grout

By Howard Jancy

PHOTOS COURTESY CUSTOM BUILDING PRODUCTS

**Single-component grouts, which do not require the addition of water or epoxy resins at the job site, have evolved significantly over the years.** The latest product formulations, now backed by industry-accepted standards, offer a host of benefits for both project owners and installation contractors.

A significant development for single-component grout is the introduction of dedicated ANSI standard designations: ANSI A118.19, *Organic Premixed Grouts for Installation of Ceramic Tile* and ANSI A108.22, *Installation of Premixed Grout in Tilework*. This standardization underscores the advancements in the product, ensuring quality and reliability in every application. The standards are applicable for tiles defined by ANSI A137.1, *Specifications for Ceramic Tile*; ANSI A137.2, *Specifications for Glass Tile*; and ANSI A137.3, *Specifications for Gauged Porcelain Tile and Gauged Porcelain Tile Panels/Slabs*.

Since the formulations of this type of grout vary between manufacturers and cement and epoxy grout formulations, developing the ANSI A118.19 material standard required new test methods. For example, testing methods for indentation resistance were deemed more relevant than compressive strength since grout joints have become much smaller and would rarely see a direct point load at 3 mm (0.11 in.) (Figure 1). The new standards followed extensive testing by the Materials & Methods Standards Association (MMSA) and review and acceptance by the American National Standards Institute (ANSI) (Figure 2).

### What is premixed grout?

ANSI A118.19 defines organic premixed grout "as a ready for use, factory prepared mixture of water, polymers, aggregates, pigments and other materials to produce water resistant, stain

figure 1

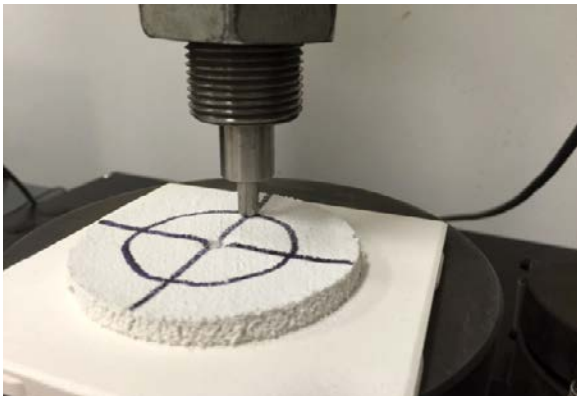


**FIGURE 1:** ANSI A118.19–Section 5.1, Indentation resistance. Two grout specimens are molded. One is tested after drying for 28 days at ≥70.3 kg/cm (≥1,000 psi). The second test is after 21 days of drying, immediately followed by seven days of immersion in water at ≥35.2 kg/cm² (≥500 psi). Allowable indentation is ≤1.14 mm (≤0.04 5in.).

**FIGURE 2:** ANSI A118.19–Section 3.0, Property requirements for organic premixed grouts.

TABLE COURTESY ANSI A108, A118, AND A136, STANDARD SPECIFICATIONS FOR THE INSTALLATION OF CERAMIC TILE

figure 2

**3.0 Property requirements for organic premixed grouts**

| Property | Test Method | Requirement | |
|---|---|---|---|
| Indentation Resistance | Section 5.1 | 28 days | ≥ 1,000 psi (6.9 MPa) |
| | | 21 day dry 7 day wet | ≥ 500 psi (3.4 MPa) |
| Abrasion Resistance | Section 5.2 | ≤ 500 mm³ | |
| Resistance to Mold Growth | ASTM G21 | 0 | |
| Water Cleanability | Section 5.4 | Free of visible haze, lumps or dry material | |
| Chemical Resistance | Section 5.5 | No deterioration and indentation resistance of ≥ 500 psi (3.4 MPa) | |

resistant, and uniformly colored materials." Delving into the product's definition helps one better understand what makes this type of grout a standout material.

*Premixed, ready-to-use, factory prepared*

All the grout's chemical components are accurately measured and blended during manufacturing. No additional water or resinous material is added prior to installation, ensuring color uniformity and long-term durability that could otherwise be compromised by the improper mixing of water or resins on the job.

*Polymers*

Polymers play a crucial role in grout composition by forming a strong adhesive bond between the organic filler and pigment components and the tiles' edges. This enhances crack and abrasion resistance and boosts water and stain resistance.

Another great advantage of the polymers in single-component premixed grouts is the elimination of efflorescence, as they do not use portland cement as a binder in their formulation.

*Water-resistant and stain-resistant*

Single-component grouts never require a sealer. The adhesive polymer fills very small voids between the organic filler and pigments, creating an impenetrable film on the grout's surface. Lacking open pores, the cured grout is easier to clean, and mold and bacterial growth within the grout are eliminated. Some single-component grouts even exceed epoxy grout's stain resistance to common stains (Figure 3, page 10).

Considering its many attributes, a single-component, premixed organic grout seems to eliminate the need for cementitious and epoxy grouts. The term "organic" is often associated with mastics, and single-component grouts share some general similarities with them. These grouts can offer several potential benefits: improved indoor air quality due to lower VOCs, a safer option for installers who are allergic to epoxy-figure 3

Water and stain resistance are verified by the water bead on the grout joint. A darkening of the grout beneath the water bead would have indicated an absorptive surface prone to staining. The no sealer requirement of organic premixed grouts makes regular maintenance easier.

PHOTOS COURTESY CUSTOM BUILDING PRODUCTS

based products, and easier maintenance since they are more resistant to staining. One grout product can now be used on all residential and commercial tile installations, but can a grout choice be this simple? Unfortunately, not.

While the simplicity of choosing a single-grout product is appealing, it is crucial to evaluate additional factors before reaching a decision. Factors such as the costs of material, installation, maintenance requirements, heat and chemical resistance, and the aesthetic and functional longevity of the grout play a significant role in determining the most suitable option for a project.

The grout's price should never be the sole determinant when selecting a product. By considering these aspects, one can make an informed decision that aligns with the project's budget and performance requirements and the project owner's vision.

## Standards

For a better understanding of tile setting methods and materials, ANSI A108, A118, and A136, *Standard Specifications for the Installation of Ceramic Tile* and the *TCNA Handbook for Ceramic, Glass and Stone Tile Installation* should be in everyone's technical library. There are several necessary ANSI standards for tile grouts.

The specification, ANSI A108.10, *Installation of Grout in Tilework*, describes the minimum requirements for grouting ceramic, porcelain, glass, and natural stone tile. It is currently under review for revision. Some of the pending revisions will better define the grouting requirements of large-format tiles, particularly large rectangular formats exhibiting warpages and installed with offset grout joints, as well as the different performance characteristics of each grout type.

ANSI A118, *Material Specifications*, lists four types or formulations of grout available for residential and commercial installations. Listed from the lowest to highest cost and overall performance:

- A118.6 Standard Cement Grouts—Portland cement binder plus redispersible dry powder polymer
- A118.7 High Performance Cement Grouts—Calcium-aluminate cement binder plus redispersible dry powder polymer content
- A118.19 Organic Premixed Grouts—Liquid latex polymer binder
- A118.3 Chemical Resistant—Epoxy resin binder

Inexpensive grouts are available, saving money at installation. Still, additional costs may accrue for the project owner once the tiled surface is in service, such as regular maintenance, repair, and even replacement. Let's briefly compare the pros and cons of each grout type. For a more detailed product comparison, it is important to read the manufacturers' technical data sheet for product performance, ANSI standard designations, limitations, and installation instructions.

*ANSI 118.6—Standard Cement Grouts for Tile Installation*

- Will effloresce (Figure 4)
- Lowest flexural and compressive strengths and stain resistance
- Requires a sealer and periodic reapplication to protect from staining
- Potential for moisture-related color variation: mixing, haze/residue cleaning, humidity
- Sanded grout is likely to scratch polished stone tiles: limestone, travertine, marble
- A redispersible dry polymer (RDP) added during product manufacturing eliminates errors associated with the job site addition of a liquid polymer. RDP also modifies the flow and spread of cement grouts, making them easier to apply.
- Least expensive grout formulation

*ANSI A118.7—Standard Specifications for High Performance Cement Grouts for Tile Installation*

- Rapid setting: elevated temperatures during mixing and installation are potentially problematic
- Less likely to effloresce

- Less likely to scratch polished stone, but a test area is recommended
- High early strength
- An RDP added during product manufacturing eliminates errors associated with the job site addition of a liquid polymer. RDP also modifies the flow and spread of cement grouts, making them easier to apply
- Improved stain resistance: higher polymer content compared to A118.6 grouts
- More color uniformity with different tile types, as well as with varying temperatures and humidity during installation and curing
- Rapid setting: less potential for sagging while curing in vertical joints during

*ANSI A118.19—Standard Specifications for Organic Pre-mixed Grouts for Installation of Ceramic Tile*

- Not for use in continuously submerged installations, steam rooms, or steam showers with temperatures above 71 C (160 F)
- Low temperatures or excessive moisture following installation will inhibit polymer reaction and drying, causing staining of porous natural stone and cement tiles
- Less likely to scratch polished stone, but a test area is recommended
- Crack resistant, but do not use in movement joints or at changes in plane
- Ready to use from the pail, easy to spread and clean (Figure 5, page 12)
- Will not effloresce
- Less product waste: opened pails can be resealed for later use
- No sealer required: water, stain, mold, and bacteria resistant

*ANSI A118.3—Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive*

- Highest material and installation cost
- Pot life and working time impacted by elevated temperatures
- Low ambient and slab temperatures delay curing and negatively affect workability
- Less UV stable
- May be allergenic to some installers
- Very specific mixing and installation requirements
- Less likely to scratch polished stone, but a test area is recommended

figure 4

The white deposit on the grout join is efflorescence. It is formed when moisture vapor brings dissolved mineral salts through the grout to the surface. Portland cement-based grouts (ANSI A118.6) are most prone to this occurrence.

- Enzymatic cleaner-resistant formulations available
- No sealer required: water, stain, mold, and bacteria resistant
- High heat, abrasion, and chemical resistance

## Importance of polymer technology in grouts

Polymers have been used in various construction products for many years. They have become a key component in natural stone and porcelain tile setting materials since advancements in polymer technology provide stronger and more durable installations, particularly in response to thermal cycling, continuous moisture exposure, heavy impact, and static and dynamic loads.

To understand how polymers function, consider the metal links of a chain. Each link may be strong, yet its actual benefit is derived only when connected with other links. As these links are joined, their collective strength and utility surpass those of the chain's individual components.

Polymers are compounds formed by linking a monomer into repetitive chains. This bonding process (polymerization) creates an improved microstructure that retains and enhances the original monomer's characteristics. When used as a binder in tile grouts, the improved characteristics are bond strength, adhesion, impact resistance, and moisture and chemical resistance.

figure 5

Open the pail and use it without premixing. Small jobs are no problem since a partially used bucket can be resealed and used again later. This provides great workability for floors and walls.

Cement grouts without a polymer only form a mechanical bond between the aggregate and pigments and the tiles' edges. When a polymer is used with cement grouts conforming to ANSI standards A118.6 and A118.7, the micropores typically present in the hardened cement paste and any microcracks are filled. The strengthened cement matrix contributes to the improved characteristics previously listed.

Polymers play a significant role in the formulation and performance of organic premixed grout conforming to ANSIA118.19, as the polymer is the only binder; no cement is used. As such, two of the negatives associated with cement-based construction products, the porosity of the cured material and adding too much or too little water during jobsite mixing, are eliminated. Porosity impacts water and stain resistance. Mis-mixing the water can affect workability, durability, and color uniformity.

No water or polymer is added at the job site. Once opened, the pail of grout can be used immediately without mixing. The polymer binds the mineral filler and pigments and provides an adhesive bond to the tiles' edges.

The polymer improves the rheologic properties, flow, and spread, making grout installation easier and quicker. Instead of angular sand, a rounded organic filler enhances the grout's flow and spread. The spherical organic filler acts like 'ball bearings' that provide less resistance to the contractor's grout float and ensure that narrow grout joints are filled completely without voids.

Even the next day after installation, grout haze cleanup is easier than cement grout, particularly epoxy grout. When properly resealed and stored, a partially used pail can be used again days, weeks, or months later. Color uniformity is assured from pail to pail since the grout's components are properly proportioned during manufacturing, and no additional liquid materials (*e.g.* water, polymer, epoxy) are required. Once the grout is completely cured, it is impervious to moisture and stains. It does not need a sealer, and periodic cleaning of the grout joints is quicker and easier since there are no pores to absorb and retain dirt (Figure 6).

figure 6

If grout haze is not promptly removed, it can become a permanent blemish on a tiled surface, particularly on honed, natural stone and cementitious tiles, which are characteristically micro-textured or porous.

### Tile grouting, then and now

The development of each grout type shown above has been influenced by industry and project-specific needs. A low-cost, simple sand and cement grout evolved to polymer-based cement formulas due to the need for color consistency and longer working time. With the popularity of stain-resistant porcelain tiles, high-performance grout with greater stain resistance was developed to achieve lower absorption and even better color consistency. Epoxy-based grouts were difficult to use, so formula improvements expanded their use to residential and light commercial projects. With the creation of enzyme-based degreasers, typically used in commercial kitchens, new epoxy formulas were developed to be more compatible with this "no rinse" cleaning method.

Single-component grouts were created to address industry concerns regarding mistakes (too little or too much water) when mixing cement grout, efflorescence, and the need for stain resistance without sealing. Another benefit of using polymers is better resistance to cracking. So, while single-component grouts are higher priced than cement grouts, they are much lower in material and installation costs than epoxy grouts and combine some of the benefits of both.

Welcome the contemporary age of grouting solutions by choosing a premixed grout—an efficient choice for installers and a satisfying option for project owners across various projects.

## additional information

### AUTHOR

**Howard Jancy,** CSI, CDT, is the commercial architectural services representative for CUSTOM Building Products. He has more than 30 years' experience with tile, stone and concrete flooring design, installation and remediation. His responsibilities include specification writing and review, technical services and continuing education. Jancy's article, "For the Want of a Horseshoe Nail: Identifying Causes of Tile Failure" received *The Construction Specifier*'s Article of the Year Award in 2017. Jancy's expertise includes CSI Division 03, 04, 07, 09 products and processes. He works with the contractor, distributor, designer, specifier and owner through all project phases. He understands the complexities and capabilities of a building product's attributes to meet the architect's requirements and the owner's vision.

### KEY TAKEAWAYS

Single-component, premixed grouts have advanced significantly, following ANSI standards such as A118.19 for organic premixed grouts. These grouts are ready-to-use, eliminating the need for onsite mixing, offering enhanced durability, stain and water resistance, and mold prevention. Key features include improved crack resistance and no efflorescence. While they are more expensive than cement grouts, they offer cost savings in maintenance and installation compared to epoxy grouts. Choosing the right grout requires considering cost, installation, and long-term performance, with polymers playing a crucial role in improving grout strength, adhesion, and moisture resistance.

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Cement grout
Premixed grout
Single-component grout

# Modular Textile Lightweight Construction

## The Future of Resilient and Sustainable Stadiums

By David Peragallo, assoc. AIA

PHOTOS COURTESY SERGE FERRARI GROUP

**As the world grapples with the increasingly extreme impacts of climate change, architects and builders continue to prioritize materials and building techniques that help manage the effects of wind, rain, flooding, and fires.** This is especially true for athletic stadiums and sporting venues, which require extensive funding and labor to design and construct, thus they must endure and serve the needs of owners and visitors. As stadiums evolve into multi-purpose, fan-centric destinations, the demand for innovative materials that enhance durability, weather resistance, and energy efficiency has never been greater. These cultural hubs for regional teams and community use must be built to resist harmful weather conditions for years to come.

Due to their magnitude and capability to host thousands of guests, today's stadiums in North America have become more than just destinations for sports fans. Considering the changing landscape of the entertainment industry, with technologies such as virtual reality and new venues such as the Sphere in Las Vegas, venue owners and managers have looked to repurpose their properties whenever possible. Hosting top-selling bands and artists and expanding the stadium's use for more than one team has increased their overall revenue and helped keep visitors in seats year-round with four-season sports programming and various entertainment.

One solution that experts in this industry have explored as a new option to address these concerns is the use of modular textile construction materials—lightweight but durable alternatives to traditional architectural frameworks. These lightweight solutions are typically installed over a metal or aluminum frame, where the mesh is tensioned and securely fixed to the profiles, ensuring long-term stability without re-tensioning. This type of composite membrane delivers very high mechanical resistance to sustain even the most extreme weather conditions. These materials are expertly engineered to withstand extreme weather conditions, from the intense UV exposure and high temperatures of the southern U.S. to the


heavy snow loads and harsh winters of the northern U.S. and Canada. The exceptional durability and resilience make them a reliable choice for even the most demanding climates.

The Yeni Sakarya Atatürk Stadium in Sakarya, Turkey, exemplifies modern stadium design, incorporating advanced materials to enhance both functionality and aesthetics.

### An efficient solution for long-term results

High-performance modular textile construction materials are developed with technology that ensure long-term durability against wind, rain, sand, and sun, resulting in a facade that can be installed anywhere from the desert to the rainforest.

High-performance textile membranes used in modular construction often consist of a polyester

Yeni Sakarya Atatürk Stadium features a mesh for textile facades and a high-performance membrane, enhancing the stadium's visual identity and ensuring long-term durability and comfort for spectators.

base fabric coated with polyvinyl chloride (PVC) or glass fiber fabrics coated with polytetrafluoroethylene (PTFE). These materials offer an ideal balance of strength, flexibility, and resistance to UV degradation. PTFE-coated fiberglass, in particular, is prized for its exceptional fire resistance, durability, and long service life. Meanwhile, advancements in PVC formulations now include phthalate-free plasticizers and fluorine-free coatings, reducing environmental impact. These chemical innovations not only support compliance with stringent fire safety codes but also enhance thermal comfort and contribute to lower lifecycle emissions.

High-performance modular textile construction materials are frequently specified for cultural and historical landmarks, where they help preserve building exteriors against unpredictable and often harsh regional weather conditions. Over time, a structure's color will remain intact and will show minimal wear and tear from seasonal weather events, resulting in less overall maintenance and even fewer situations where replacement is required. This is especially important for stadiums where constant programming is scheduled, and shutting down the venue for repairs is often inconvenient. If repairs or replacements are needed, the structure remains intact while only the fabric is replaced. This enables a swift resolution for maintenance, color updates, or design changes. By preserving the main structure and allowing for seamless fabric replacement, these solutions offer significant cost savings for future modifications.

Modular textile construction materials have become crucial for safeguarding stadiums against extreme weather, which is becoming increasingly frequent and intense throughout the U.S. During the Los Angeles wildfires, NFL games had to be relocated or rescheduled to protect players and fans from exposure to smoke and ash. Implementing modular textile construction materials that meet national and international fire standards is more important than ever. Ensuring these stadiums, if damaged, can be easily and quickly repaired will save millions of dollars in repair costs and prevent additional losses in revenue during maintenance.

One of the key benefits of modular textile construction systems is their ability to integrate form and function. While it is essential to balance aesthetics and functional requirements, a visually striking stadium should also meet the practical needs of the space it covers. Thoughtfully designed modular textile construction will complement the architectural context of their surroundings, considering how end-users will interact with the structure. Due to the flexibility of these high-performance textiles, they are an ideal solution for a variety of venues as they can be designed, installed, and customized to reflect

the home team's branding and include design elements that tie into the local culture.

### Why modular textile construction?

Compared to traditional building materials such as steel and concrete, modular construction offers a more sustainable and reliable option that is, overall, less expensive to manufacture and install. When partnering with the right builder and installer, working with modular textile construction materials can significantly reduce timelines and costs. Concrete, metal, and aluminum are particularly detrimental to the environment due to the amount of $CO_2$ released during their creation. Modular textile construction materials can be sourced and produced using less overall energy and are lighter to transport and install, making them safer and easier to work with.

One of the most significant benefits of modular textile construction materials relates to the installation process. Once delivered, they are easy to maneuver and can be adjusted, offering more flexibility in design, future alterations, or dismantling for reuse or recycling. With the right partners, stadium architects and builders can be sure that their modular textile construction system will fit their needs and can be reworked as those needs change over time.

### Boosting energy savings and daylight autonomy

As a result of exceptional heat and light regulation, stadiums that implement these high-performance architectural membranes experience higher energy savings than those built with traditional construction materials.

A 2018 study concluded that compared to only one glass facade and an opaque roof, an additional translucent and thermally insulated membrane roof increased the continuous daylight autonomy from 15 to 38 percent.[1] This resulted in a 30 percent reduction in the electricity needed for artificial lighting in the roof-covered area of the sports field used in this study. These results created a benchmark for planners, investors, and future buildings of this type as they showed the direct impact these materials have on the energy usage of these textile structures.

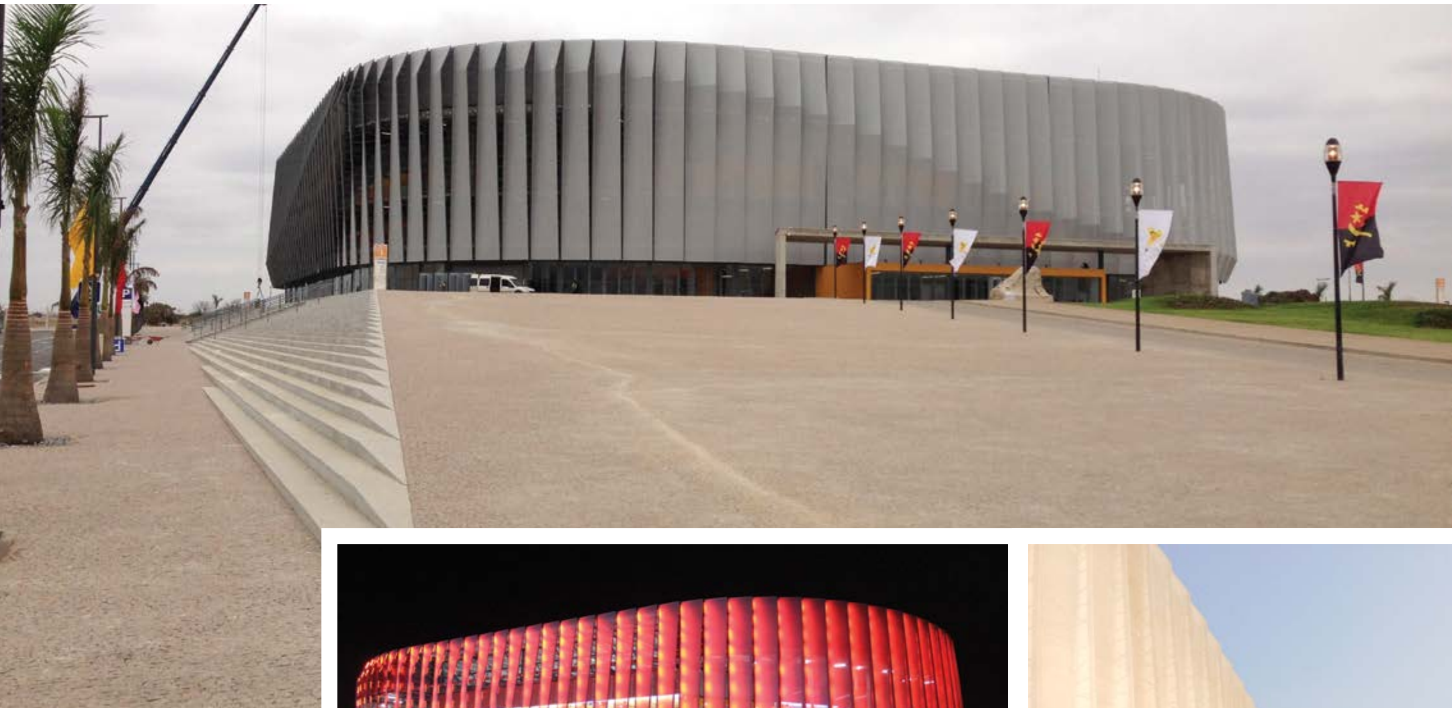
### Enhancing temperature control in outdoor arenas

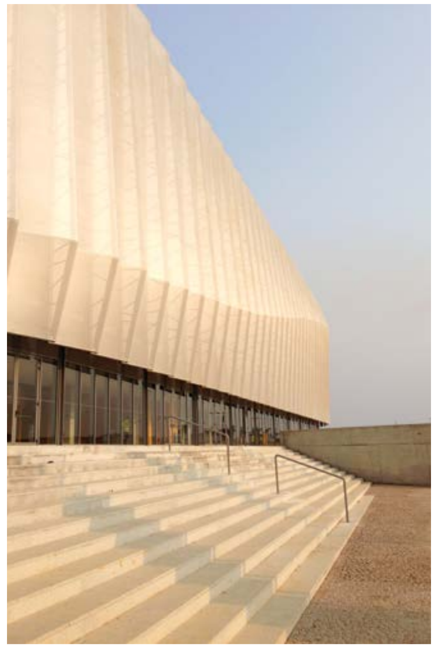
Thermal and light regulation is also a priority for outdoor arenas, especially in warmer climates where events occur during heat, humidity, and sun. To protect players and spectators, modular textile construction materials can take shape as durable, structural, and lightweight textile roofs. With the correct balance of light needed to illuminate sporting events and concerts that will protect players or attendees, these structures offer the best possible protection from the sun, wind, and cold during winter. The breathability

The Brazilian Paralympic Training Centre (Centro Paralímpico Brasileiro) in São Paulo is a premier facility dedicated to developing Paralympic sports in Latin America. The architectural design of the center incorporates a high-performance composite mesh.

of the membranes also offers optimal ventilation, with air being able to pass through to regulate the temperature of outdoor arenas in an energy-efficient manner.

Traditional building materials, such as steel, conduct heat and can raise the overall temperature within the structure, resulting in more energy use and an unpleasant experience for visitors. Tensile architecture promotes better airflow, keeping temperatures within the stadium lower and more comfortable, especially in hot climates. These passive cooling systems reduce the need for mechanical ventilation or air conditioning, creating a more





The Luanda Multisports Pavilion in Angola showcases contemporary sports architecture with an innovative, environmentally responsive facade featuring a high-performance mesh.

pleasant environment for fans without overwhelming energy use.

## Stadiums as landmarks with custom elements

Modular textile construction solutions help ensure venues remain visually striking and structurally resilient while prioritizing an improved spectator experience and enhanced environmental performance.

Stadiums are also viewed as landmarks that reflect the history and people of the region. The range of design capabilities that modular textile construction provides allows operators and owners to dress these venues in colors, patterns, and shapes that evoke and tie into local themes. These customized and unique options offer more ways to adhere to brand standards and be creative than a traditional roof or awning.

## Enhancing visuals with less structure

In addition to modular, tensile architecture—a form of construction that uses tensioned membranes, cables, and lightweight structures to create large-span, flexible, and often visually striking architectural designs—also offers protection at stadiums. When used in tandem, these innovative solutions help enhance the spectator experience by providing ample shade and UV protection while improving the acoustics and sightlines throughout the venue.

They also use fewer supports and allow for larger spans of roof coverage without columns or beams, which provides spectators with unobstructed views of the field or stage, ensuring that more seats in the stadium offer premium visibility. With fewer visual barriers, spectators have a clearer line of sight to the action, improving the overall experience.

The Nîmes Sports Hall in France uses a 2,500-m$^2$ (26, 909-sf) mesh designed for textile facades.

## Conclusion

High-performance modular textile construction materials are developed with technology that ensures long-term durability against wind, rain, sand, and sun, and can be installed anywhere, regardless of weather conditions. These textiles are increasingly sought after for today's stadiums as they are an innovative and sustainable alternative to traditional building materials with their flexible, durable, and sustainable characteristics. They can be used for various applications and provide significant benefits in terms of energy efficiency, providing exceptional thermal regulation and light control that contribute to reducing energy consumption and lower operational costs. These materials' long-term durability ensures venues can withstand extreme weather conditions, offering protection and longevity for iconic structures worldwide. As demand for energy-efficient and sustainable solutions continues to grow, modular textile construction will play an increasingly important role in shaping the future of modern stadium design.

### NOTES

[1] Refer to www.mdpi.com/2075-5309/8/9/118

## additional information

### AUTHOR

**David Peragallo,** assoc. AIA, senior specification manager North America, Serge Ferrari Group, has created, organized, and led the implementation of projects for high-performance architectural textiles throughout his career. Before joining Serge Ferrari Group in 2021, he served as specification and regional sales manager for Verseidag-Indutex GmbH, a German-based supplier of architectural textiles.

### KEY TAKEAWAYS

Modular textile construction offers durable, lightweight, and weather-resistant solutions for modern stadiums. These materials enhance energy efficiency, reduce maintenance, and support flexible, sustainable design. Ideal for extreme climates and multi-use venues, they improve spectator comfort, aesthetics, and functionality while lowering costs and environmental impact over a stadium's lifespan.

### MASTERFORMAT NO.

13 34 00—Fabric Structures
13 34 19—Pre-engineered Fabric Structures

### UNIFORMAT NO.

B2010—Exterior Walls
B3010—Roof Coverings

### KEYWORDS

Division 13
Modular textile construction
Prefabrication
Tensile architecture

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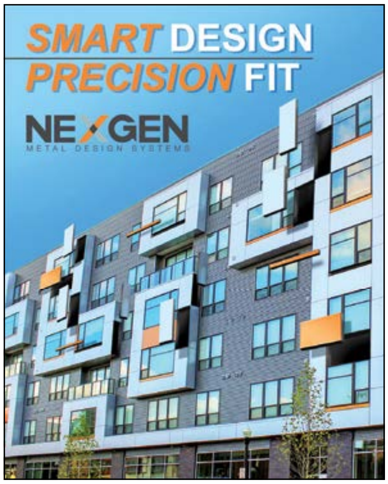


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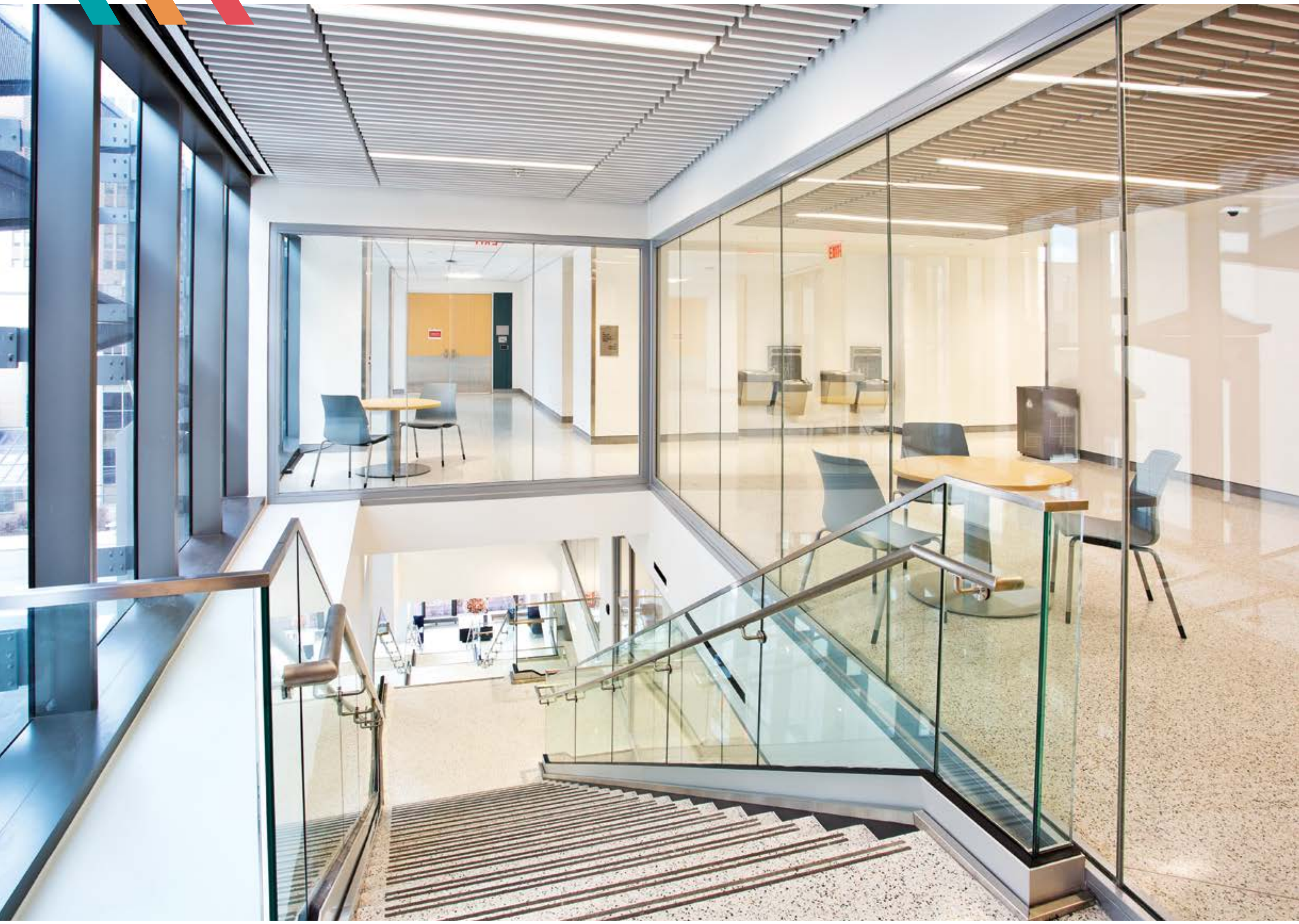


# Transparent Fire-rated Design

## Where Safety Meets Student Experience in Campuses

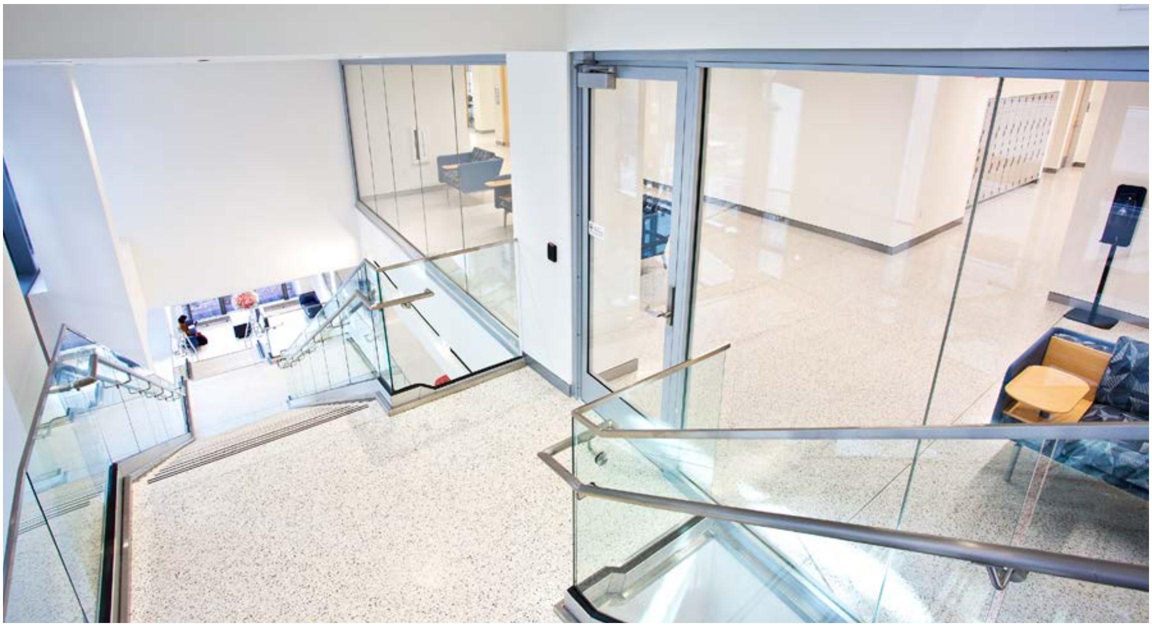
By Jonathan Edly

PHOTOS COURTESY TECHNICAL GLASS PRODUCTS (TGP)

**When designing educational spaces, project teams must meet code-driven requirements such as accessibility and fire safety.** They may also be inclined to create built environments that promote student and faculty wellness. In fact, at the end of 2023, two educational design experts from Gensler discussed trends shaping the design and construction of college campuses.[1] These experts identified that many colleges and universities are reimagining how their physical locations can function to benefit students and educators. Architectural design solutions for renovations to existing buildings can range from providing optimal access to daylight to fostering a sense of belonging and engagement.

Historically, the challenge to maximizing daylight, engagement, and other occupant-centered design strategies has been limited by fire-rated materials, which have been limited to opaque materials or minimal lites of transparent, fire-rated glass. However, developments in fire-resistive glass, which guards against fire, smoke, and radiant heat, have allowed designers the ability to increase transparency, daylighting, and visual connection while remaining code-compliant.

The redesign of the University of Pittsburgh's Alan Magee Scaife Hall demonstrates that fire-rated glazing assemblies not only support fire-rated designs but also can contribute to community engagement, particularly in stairwells



Minimal colorless spaces in these butt-glazed, fire-rated assemblies provide a cohesive design aesthetic with the stairwell's glass railings.

and other means of egress systems, which are critical to fire and life-safety goals. Looking at the details around Alan Magee Scaife Hall's rebuild can serve as an example of how careful planning and collaboration can help retrofits achieve fire- and life-safety code requirements without sacrificing forward-thinking design goals.

## Reimagining the design to meet student needs

The University of Pittsburgh opened the doors to a seven-story west wing addition to Alan Magee Scaife Hall in the spring of 2023. The medical students may first notice that the lecture halls, labs, and classrooms have been updated to offer the most cutting-edge learning environments. However, the addition aims to improve the building beyond the classroom space. The redesign also includes team-based learning, small group rooms, and an entire floor dedicated to medical students. This floor is meant for students to congregate, study, and build community. As such, it was important for the design to incorporate a high degree of transparency between spaces. Transparency not only supports easier wayfinding but also encourages student collaboration and interaction.

Alan Magee Scaife Hall's renovation also features a glass curtain wall facade that extends two stories before the building's original limestone exterior walls. This curtain wall floods the cafe and lounges inside with ample daylight. Above the exterior curtain wall, floor-to-ceiling window systems extend the rest of the height to aid in daylighting strategies. All these design elements work together to create a welcoming interior environment.

According to MCF Architecture, the design firm behind the addition, the building serves the university's 150 medical students as both an academic building and a social hub. The social aspect of the renovation is not an afterthought. Designing campus buildings to facilitate community, foster a sense of belonging, and curb feelings of loneliness can significantly improve attrition rates and combat depression,[2] which has been cited as impacting 44 percent of students according to a national survey conducted by the Healthy Minds Study.[3]

Access to daylight, intuitive navigation, and a sense of openness are key design elements of the project. MCF Architecture, therefore, designed the renovations to facilitate connections within the academic community through extensive use of transparent glazing. These glass assemblies contribute to an open and inviting floorplan. However, the building's monumental staircase presented a challenge. According to MCF Architecture, the stairwell activates the space, creating a social hub by contributing "bright, modern spaces intended for student interaction." According to local building and fire codes, it must also defend against fire and other threats to life safety.

## Meeting building code requirements

In the past, in order to meet code requirements, specifiers may have been limited to opaque materials and relatively small lites of glass—constraints that were apparent in Alan Magee

Butt-glazed, fire-rated assemblies support daylighting goals by improving light penetration from exterior curtain walls.

Scaife Hall's original floor plan, which used opaque fire-rated walls. While effective for meeting fire rating requirements, these materials obstruct views, work against navigability, and limit access to daylight.

To optimize the finished space for daylight, intuitive wayfinding and openness, it was essential that the stairwell incorporate extensive glazing. This preserves unobstructed sightlines through the stairwell to each floor. It also maximizes the amount of daylight harvested from the external glass curtain wall. To meet code requirements without sacrificing design intent, the project teams turned to butt-glazed fire-rated glass and full-lite fire-rated door assemblies. Both systems incorporated fire-resistive rated glass held by narrow-profile steel frames. It is important to note that for most fire-rated designs, the entire assembly, which includes glass, frames, gaskets, and, for doors, hardware, will need to have a fire rating. Each component in the assembly must meet the minimum requirements listed in local building codes.

Since the designs for Alan Magee Scaife Hall featured large spans of glass, the fire-rated doors and glazing systems needed to be fire-resistive rated to meet design goals and building code requirements. Whereas fire-protective ratings describe the extent to which a wall, window, or door can protect against fire and smoke, fire-resistive ratings include data on how these assemblies can defend against fire, smoke, and radiant heat to preserve exit routes in the case of a fire.

As a critical component of a means of egress system, the full-lite, fire-rated doors specified for this project are fire-resistant rated for 60 minutes to meet temperature rise and positive pressure requirements for fire door systems. Further, because they hold transparent glazing within narrow-profile steel frames, they maintain open sightlines into each building floor. The fire-rated doors offer an ideal solution for Alan Magee Scaife Hall's particular challenges—a solution that the fire-rated, butt-glazed assemblies enhance.

## Minimal framing to maximize daylight access and improve wayfinding

Alan Magee Scaife Hall's central staircase is filled with natural daylight, thanks to the exterior glass curtain wall and window systems that span its seven stories. To ensure the spaces around the stairwell could also harvest the light from these exterior systems, the designers enclosed it with multiple elevations of fire-rated, butt-glazed assemblies. These assemblies join lites of glass with narrow, 5 mm (0.20 in.) vertical butt joints. Replacing traditional vertical mullions, these joints allow uninterrupted horizontal spans of


Full-lite, fire-rated glass doors protect occupants and support design intent.

glass. The glass is held within a narrow-profile, fire-rated steel perimeter frame. As a result, these glazing assemblies offer the largest glazing areas and provide a close visual match to the adjacent non-rated exterior glazing systems.

In addition to supporting daylight access, the fire-rated, butt-glazed assemblies support a more navigable interior. Moving into the building, each floor of Alan Magee Scaife Hall has a different color theme for the walls and accents. Since these glazing systems provide unobstructed sightlines from the stairwell into each level, they work with this color coding to help students find their way through the building. The fire-rated, butt-glazed assemblies also support the social aspects of the rebuild. Since students can see their peers on each level, they can more readily meet and build community.

Like the full-lite fire-rated doors, it was also critical that the butt-glazed assemblies meet code requirements for fire and life safety. Not only did the stairwell need to be surrounded by fire-rated materials to maintain a safe path of egress in the event of a fire, but it also needed to support compartmentalization strategies. If the stairwell were open, the continued, open area would provide no defense against the spread of smoke and fire. Compartmentalization efforts help stop fire and smoke from filling an entire building to protect occupants and mitigate damage.

To meet the code requirements for this aspect of the built environment, both the glass and the frames of the butt-glazed assemblies are fire-resistant rated for up to 60 minutes to block fire, smoke, and radiant heat for up to an hour. This helps contain fire and defend paths of egress so occupants can safely evacuate. They do this without the profile size discrepancies common in traditional hollow metal framing systems.

## Offering a cohesive design aesthetic

It can be difficult to create a cohesive look between different parts of a stairwell. For Alan Magee Scaife Hall, the stairwell brought together several features and materials within a confined space—the butt-glazed, fire-rated glass assemblies, the handrails, and the exterior glass curtain wall. The fire-rated assemblies' narrow-profile steel frames provide a close visual match to the neighboring exterior curtain wall.

This quality is paramount as multiple systems with varying performance requirements are in proximity, which can lead to discrepancies in framing profile sizes. Improving visual compatibility between fire-rated and non-rated systems can provide a more unified and intentional aesthetic to a space. The precision roll-forming techniques used for the framing systems within Alan Magee Scaife Hall result in narrower fire-rated frames that help design

Unique corner details within this retrofit were handled successfully with a collaborative planning and installation process.

teams achieve code requirements without sacrificing their intent.

Further, the fire-rated, butt-glazed assemblies offer a close visual match to the handrail systems. Both systems use butt-glazed panels. The handrail system uses these panels to anchor its continuous handrail. The perimeter frame of the fire-rated assemblies is finished to create a sense of cohesion with the handrail. Creating symmetry between this element and the landings to each floor, the fire-rated glazing systems support compartmentalization efforts while maintaining a cohesive aesthetic.

## Solving installation challenges before they show up

Both the fire-rated butt-glazed assemblies and full-lite, fire-rated door systems were able to meet code requirements without compromising intuitive wayfinding, visual connection, and access to daylight. As a result, they were able to support the functionality and aesthetic intentions of the space, helping the project teams achieve a safe and occupant-centered interior.

However, for these systems to look and perform as intended, it was crucial that the glazing subcontractors and related trades install them to an exacting level of detail in order to provide complete fire-rated enclosures for the stairways. The building's stairwell includes several custom corner conditions that could have proved challenging without collaboration throughout the design and installation phases. These aspects of the application needed multiple materials and systems to work together to achieve the right dimensions and material conditions.

The glazing system manufacturer collaborated with the project design team to fabricate custom corners that met the floor plan, which was critical to both the look and performance of these fire-rated glazing assemblies. The manufacturer also provided the glazier with thorough documentation on how to install these systems and worked closely with multiple project stakeholders

Fire-rated glazing preserves open sightlines and access to daylight around a central staircase.

to ensure the material was phased in a way that supported an efficient and safe installation.

The ability for building professionals to work in detail with a glazing manufacturer allows the successful design and installation of larger, more complex scopes. This includes navigating challenges in the design phase. It also involves supporting installation with high-quality crating and well-planned shipping schedules. While staying within schedules helps reduce delays in new construction, it is often critical in renovation projects since storage areas are not as readily available.

### Working as a team pushes the envelope in stairwell design

Today, Alan Magee Scaife Hall functions as a learning and social hub. Students can come and go while seeing their peers studying or relaxing on each of the seven floors. The fire-rated, butt-glazed assemblies that encase the central staircase support the design goals of improved visual connection and intuitive navigation. As a result, the rebuild was able to optimize the hall's interior to meet current demands for occupant comfort more effectively.

Not only do they contribute to a more occupant-centered design by improving navigability, but they also support medical students in building community—all while maintaining fire- and life-safety code requirements with fire-rated framing and glass. While the assemblies themselves allow code-compliance that does not compromise design intent, the collaboration between designers, glaziers, and the manufacturer ensured these fire-rated assemblies were fabricated to meet the specific details of the project as well as shipped and installed in a way to support a safe and efficient build.

#### NOTES

[1] Review "Trends To Watch: Shaping the future of Higher education" by Gensler, gensler.com/blog/trends-shaping-future-of-higher-education

[2] See "How smart campus design can curb college dropout crisis" on *San Francisco Chronicle* by Brian Krenke at sfchronicle.com/opinion/openforum/article/How-smart-campus-design-can-curb-college-dropout-14833376.php

[3] Refer to "College Students' Anxiety, Depression Higher Than Ever, but So Are Efforts to Receive Care" by Justin Heinze, School of Public Health University of Michigan, at sph.umich.edu/news/2023posts/college-students-anxiety-depression-higher-than-ever-but-so-are-efforts-to-receive-care.html

## additional information


#### AUTHOR

**Jonathan Edly** represents Technical Glass Products (TGP) in the Midwest and Mid-Atlantic regions. TGP supplies fire-rated glass, framing systems, and specialty architectural glazing products. Edly has worked with commercial glaziers and metal fabricators for more than 15 years throughout the U.S.


#### KEY TAKEAWAYS

The 2023 redesign of the University of Pittsburgh's Alan Magee Scaife Hall emphasizes student-centered design by enhancing daylight, wayfinding, and community spaces. It balances aesthetics with fire and life safety codes using fire-rated, butt-glazed glass assemblies. Collaborative planning ensured these innovations supported both design goals and code compliance.


#### MASTERFORMAT NO.

08 88 56—Fire-resistant Glazing

#### UNIFORMAT NO.

B2010—Exterior Walls
C1010—Partitions

#### KEYWORDS

Division 08
Fire-rated glass
Butt-glazed glass

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# Closed-cell Polyurethane

## Insulate, Seal, Protect

By Jean-François Lupien

PHOTOS COURTESY HUNTSMAN BUILDING SOLUTIONS AND GROUPE VALCO

**In any construction project, the integrity of a building's foundation is paramount.** Ensuring the longevity and structural soundness of a foundation requires effective waterproofing. If the water infiltrates, it can cause severe damage, including cracks, mold growth, and erosion of building materials. Fortunately, innovations in waterproofing technology—such as polyurethane sprayfoam and polyurea coatings—are revolutionizing the industry and transforming foundation waterproofing, focusing on the technical, economic, and environmental benefits. These advanced materials provide superior protection, enhance energy efficiency, and contribute to the sustainability of commercial buildings.

### Effective waterproofing for commercial foundations

Waterproofing is essential for the long-term durability and stability of any building. Foundations, especially in large structures, are subject to various stresses from environmental factors such as temperature changes and moisture to the sheer weight of the building itself. Without proper waterproofing, water can infiltrate the foundation, leading to cracks, corrosion, and even complete structural failure in severe cases.

Traditional waterproofing methods, such as tacked membranes and bitumen coatings, have been used for decades. These are the common insulating/waterproofing materials for foundations in floodplains. However, these systems have limitations, including potential seams and weak points where water can penetrate. In contrast, polyurethane sprayfoam and polyurea coatings, while potentially carrying a higher initial cost, deliver superior seamless, flexible, and durable protection, making them cost-effective over the long term.

The trades involved are typically the same as those handling traditional waterproofing—foundation waterproofing contractors—although specialized training is often necessary to ensure the correct application of sprayfoam and polyurea coatings in accordance with manufacturer specifications.

Polyurethane sprayfoam and polyurea coatings are ideal for commercial waterproofing because they can handle large areas, withstand higher stresses, and resist environmental factors such as moisture and temperature changes. Their flexibility allows customization to meet specific challenges, such as vibrations or chemical exposure. Additionally, these high-performance

solutions help commercial buildings meet strict regulatory standards.

### For a dry and durable exterior foundation

A stable and watertight building envelope is difficult to achieve when weather such as rain, snow, and ice affect the foundation. Issues such as cracks, water infiltration, and wood rot undermine the best building structure. The ideal time to insulate and waterproof a foundation is during the external excavation of an existing foundation or before backfilling a new one, ensuring a seamless seal between the footing and the wall.

Using sprayfoam insulation with a protective coating offers numerous benefits, simplifying the waterproofing process and enhancing overall efficiency. The foam expands to fill every crack, gap, or hole in the foundation, creating a continuous, seamless barrier that eliminates weak points common in traditional waterproofing methods such as membranes, which require seams or adhesives.

This comprehensive coverage strengthens the system's integrity, effectively preventing water infiltration. In addition, sprayfoam is more adaptable to various application conditions, being less sensitive to temperature fluctuations than traditional materials. This flexibility allows for installation across a broader environmental conditions, minimizing weather-related delays. Moreover, sprayfoam insulates and seals simultaneously, reducing multiple steps into one trade workflow. This streamlines the process, cutting installation time, labor costs, and ultimately accelerating project completion, while providing superior long-term waterproofing and insulation performance.

### Surface preparation and application considerations

In addition to weather conditions, the condition of the concrete is critical. New foundations require sufficient curing time, typically at least 28 days, to ensure optimal strength before waterproofing.

This minimizes the risk of cracks and moisture infiltration. For existing foundations, the surface must be clean, dry, and free of loose debris for proper adhesion of the waterproofing materials. Following these guidelines ensures a durable, long-lasting seal and protection for the foundation.

Contractor spraying the waterproofing coating over closed-cell sprayfoam.

### Commissioning and testing considerations

In specific design applications, closed-cell sprayfoam insulation with an R-value of six per inch can meet and surpass energy code requirements while safeguarding the foundation. This insulation is applied from the exterior, forming a continuous, bonded, seamless barrier without needing surface prep, sealing seams, filling gaps, or gluing boards. In specific design applications, protection boards are necessary per building codes when using closed-cell sprayfoam insulation to safeguard it from external forces or environmental damage.

For example, a closed-cell polyurethane sprayfoam expands 30 times its original volume in just five seconds, thoroughly sealing the entire foundation. Typically, this sprayfoam is evaluated below grade, and findings show it maintains its integrity and is not prone to water absorption over time. It is resistant to flood damage.[1,2]

The closed-cell structure of sprayfoam is inherently water-resistant, preventing moisture infiltration and absorption, making it ideal for below-grade waterproofing. Evaluations show it maintains integrity even in prolonged water exposure or flood conditions. Its expanding nature ensures full coverage of foundation contours, eliminating weak points common with traditional methods such as tacked membranes.

While sprayfoam resists moisture well, polyurea coatings are required for first-rate durability. Polyurea provides superior resistance to water, chemicals, and abrasion, making it essential for foundations exposed to harsh conditions, continuous water pressure, or heavy foot traffic.

Grid of steel rebar over the waterproof coating and closed-cell sprayfoam insulation to enhance durability and resistance to environmental factors.

The combination of sprayfoam for sealing and polyurea for waterproofing and added protection offers the best defense against long-term water damage, especially in flood-prone areas.

For new construction, the foundation is accessible from the exterior and can be insulated on its cold side, below grade, or before backfilling; this is the preferred approach for insulating below-grade foundations. Insulating the foundation from the exterior enhances energy efficiency, eliminates thermal bridges, stabilizes interior temperatures, and reduces the likelihood of condensation. In existing buildings, excavation may be necessary for waterproofing due to inadequate initial design or poor construction. A closed-cell polyurethane can be applied across the foundation surface, including over the footing, to direct water toward drainage systems. Depending on the foundation type, applying polyurethane directly onto concrete, block, or stone foundations is advisable. Some sprayfoam options are classified as damp-proof materials. Still, when waterproofing is critical, additional layers such as polyurea coatings, bituminous coatings, or drainage membranes may be installed directly on the foam where high water levels or accumulation risks exist.

Post-installation testing is sometimes required, particularly if the foundation waterproofing is tied to the building envelope commissioning (BECx) process. In such cases, visual inspections, adhesion testing, and/or electronic leak detection (ELD) might be used to verify the integrity of the waterproofing system. Commissioning activities typically focus on confirming proper installation, coverage, adhesion, and absence of voids in critical areas.

## Maintaining the above-grade aesthetic during excavation

What should be considered for the above-ground portion of the foundation? There are several viable solutions, but one efficient method involves installing a galvanized Z-bar structure along the above-ground sections. This setup allows for the continuity of the exterior finish that extends both below and above ground. Installation of this structure is essential before any polyurethane product is applied. After insulating, it is advisable to mount a lightweight cement board onto the Z-bars. Following backfilling, a finishing layer can be applied to the cement board to achieve the desired aesthetic.

## Polyurethane sprayfoam

Polyurethane sprayfoam is a dual-purpose material that delivers both high-performance insulation and an effective air and moisture barrier, which is particularly valuable in commercial foundation applications. The closed-cell formulation expands rapidly upon application, filling irregular voids, joints, and surface gaps to create a continuous bond across the foundation surface. For example, closed-cell polyurethane sprayfoam can expand up to 30 times its liquid volume within five seconds, ensuring thorough coverage even on complex geometries.

With an R-value of approximately six per inch, it meets or exceeds most commercial energy code requirements. Its rigid structure contributes

significantly to thermal performance while minimizing thermal bridging. Its R-value adds dimensional stability and supports long-term durability, particularly when used below grade.

Sprayfoam is less sensitive to temperature and substrate conditions during application than traditional materials. It adheres well to substrates such as concrete, wood, metal, and masonry, forming a reliable base for subsequent protective layers—especially polyurea coatings. These coatings bond directly to the sprayfoam surface without requiring primers or adhesives, creating a monolithic system that resists water infiltration, freeze-thaw cycles, and mechanical stress.

## Polyurea coatings

Polyurea coatings are critical for commercial foundation waterproofing due to their fast-curing, flexible, and highly durable nature. Combined with polyurethane sprayfoam, they create a fully bonded, monolithic barrier that resists water intrusion, mechanical wear, and chemical exposure—even under harsh site conditions.

To ensure proper adhesion and long-term performance, surface prep is essential. Concrete must be clean, dry, and have a moisture content below four percent, with a pH between seven and 10. Application should be performed only when substrate temperatures exceed 5 C (41 F), ambient temperatures range from 15 to 35 C (59 to 95 F), and relative humidity (RH) is below 85 percent. The substrate also needs to be at least 3 C (5.4 F) above the dew point to avoid condensation.

Polyurea is applied using high-pressure spray equipment and cures within minutes, allowing rapid progress on commercial builds. Once cured, it forms an elastic, seamless membrane that expands and contracts with the foundation and maintains its integrity during freeze-thaw cycles, water exposure, or prolonged stress.

## Case study

To illustrate the effectiveness of polyurethane sprayfoam and polyurea coatings, consider this project on a commercial construction site. A leading insulation and waterproofing company was tasked with addressing the foundation waterproofing needs of a commercial building.

During the assessment and planning stage, they meticulously evaluated the steps needed to perform the work with the highest quality and on time. The project, conducted in cold weather conditions, involved a building with a blindside wall constructed directly adjacent to an existing structure or retention system. With the project being downtown and the limited space, it was challenging to waterproof the foundation to be poured. Traditional excavation methods were impractical due to the building's proximity to other structures, sidewalks, and towers.

Using traditional materials, the new foundations would need to be poured and excavated on its exterior, and then the insulation and waterproofing would be applied on the exterior of the new foundation. All this was not entirely possible. To overcome this challenge, the project team decided to insulate the retaining wall instead, apply the sprayfoam first, the waterproofing on top, and then pour the concrete, inverting the process. The team used a crane to gain a clear vantage point, enabling them to apply the waterproofing system effectively. From this elevated position, they applied a 76-mm (3-in.) layer of high-performance sprayfoam, followed by a polyurea coating to the surface of the adjacent structure or retention system. Once the membrane was installed, the concrete foundation was poured directly on top, reaching a depth of 9 m (30 ft). This approach allowed for precise application of the waterproofing membrane and ensured project completion within the confined space. In contrast to traditional methods requiring extensive excavation, polyurethane sprayfoam eliminates the need for significant digging, reducing costs and installation time.

Combining polyurethane sprayfoam and polyurea coating proved the optimal solution for

The foundation waterproofing project during polyurea coating application over closed-cell sprayfoam.

durable, long-lasting waterproofing. This system involves a two-component assembly, with a polyurea membrane applied directly over the hydroflouroolefin (HFO) sprayfoam. This waterproofing solution meets AC29 standards for below-grade applications. It complies with the *International Building Code* (*IBC*) as confirmed by a UL report.

The results of the project demonstrated several key benefits. The combination of polyurethane foam and polyurea coating improved the foundation's structural integrity by creating a monolithic barrier that prevented water infiltration and protected against structural movement and freeze-thaw cycles. Additionally, the high R-value of sprayfoam enhanced the building's thermal efficiency, reducing heating and cooling costs while improving occupant comfort. The project was completed efficiently, even with space limitations, resulting in significant cost savings compared to traditional methods, with reduced site preparation, maintenance and energy costs, providing a rapid return on investment (ROI). The polyurea coating's flexibility and elongation allowed it to adapt to the foundation's movement, preventing cracks and leaks even in extreme temperatures, while its resistance to chemicals and mechanical wear further contributed to the foundation's long-term durability.

## Economic and environmental benefits

In combination, polyurethane sprayfoam insulation and polyurea coatings offer significant economic and environmental benefits. Some of the key advantages include:

- Long-term cost savings—Although the initial investment in polyurethane and polyurea systems may be higher than traditional materials, they offer significant advantages, including quicker installation times and substantial long-term energy savings, making them a cost-effective solution over time.
- Energy efficiency—Polyurethane sprayfoam provides excellent insulation, which helps regulate the building's temperature and reduces energy consumption. This lowers heating and cooling costs, making the building more energy efficient.
- Eco-friendly formulations—Many polyurethanes and polyurea products are crafted with environmentally responsible ingredients, such as low levels of volatile organic compounds (VOCs) and sustainable blowing agents. For instance, some formulations feature an Ozone Depleting Potential (ODP) of 0.0, meaning they do not harm the ozone layer, and a Global Warming Potential (GWP) of less than one, indicating minimal impact on global warming compared to $CO_2$. These formulations promote healthier indoor air quality (IAQ) by reducing VOC emissions and limiting exposure to harmful chemicals. At the same time, their low ODP and GWP contribute to more sustainable construction practices, as supported by their Environmental Product Declaration (EPD). This combination helps create safer indoor environments and lessens the overall environmental footprint.
- Sustainability—Polyurethane sprayfoam insulation helps reduce the building's overall carbon footprint by improving its energy efficiency. The long-lasting protection these

materials ensures the building remains in good condition for decades, minimizing the need for reconstruction or extensive repairs.
- Waste reduction—The seamless application of sprayfoam and polyurea coatings reduces material waste compared to traditional waterproofing methods, aligning with sustainability goals.

## Best practices for application and maintenance

Following best practices for application and maintenance is essential to fully capitalize on the advantages of polyurethane sprayfoam and polyurea coatings.

During application, it is critical to properly prepare the surface by ensuring the foundation is clean, dry, and free of contaminants, as this promotes optimal adhesion. It is also important to follow the manufacturer's recommendations for the appropriate thickness of the polyurethane foam and polyurea coatings. Applying too thin a layer may reduce waterproofing effectiveness, while an overly thick layer can lead to material waste.

Additionally, applying these materials under suitable environmental conditions is crucial. Extreme temperatures or high humidity can affect curing times and adhesion, so scheduling the application during optimal weather conditions ensures the best results.

## The future of commercial foundation waterproofing

Polyurethane sprayfoam and polyurea coatings represent the future of commercial foundation waterproofing. As demonstrated by the case study, the combination of sprayfoam and polyurea coatings enhances the structural integrity of a foundation alongside further benefits.

Investing in polyurethane and polyurea systems is a smart choice for builders, architects, and engineers looking to future-proof their commercial projects. These materials offer superior protection, contribute to sustainability goals, and provide a return on investment that traditional waterproofing methods cannot match.

By adopting these cutting-edge solutions, construction professionals can ensure that commercial foundations remain strong, secure, and impervious to the elements for decades.

Liquid blowing agent technology and a waterproofing foundation coating.

**Notes**

[1] Refer to Technical Bulletin 2, Flood Damage - Resistant Materials Requirements, FEMA, August 2008.

[2] Read "Severe Weather and Closed-Cell Spray Foam: A Better Building Technology" on Honeywell.

## additional information

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**KEY TAKEAWAYS**

Closed-cell sprayfoam and polyurea coatings offer seamless, energy-efficient, and long-lasting waterproofing for commercial foundations. Together, they protect against moisture, cracks, and wear while reducing labor, improving insulation, and supporting sustainability goals—making them a smart, modern alternative to traditional waterproofing methods.

**MASTERFORMAT NO.**

07 14 16—Cold Fluid-applied Waterproofing
07 21 19—Foamed-in-place Insulation

**UNIFORMAT NO.**

A1010—Standard Foundations
B2010—Exterior Walls

**KEYWORDS**

Division 07
Closed-cell insulation
Polyurea coatings
Polyurethane sprayfoam
Waterproofing

# Hurricanes and Flooding

## Advancing Building Strategies for Resilience

By Vinu J. Abraham, P.E.
PHOTOS COURTESY INTERTEK

**While hurricanes are often associated with high-speed winds, flooding is frequently the deadliest and most destructive consequence of these storms.** Flooding is the leading cause of destruction in natural disasters across the U.S., impacting both coastal and inland regions. Riverine flooding, which occurs when rivers or streams overflow their banks due to excessive rainfall, flash floods, and urban flooding caused by heavy rainfall contribute to widespread damage nationwide. The devastating hurricanes of the 2024 season, along with severe flooding events in the Midwest and Northeast regions, have highlighted the widespread need for improved flood preparedness.

### The increasing threat of flooding nationwide

Coastal regions along the Atlantic and Gulf coasts face significant flood risks from storm surges, where hurricane winds push seawater onshore, causing severe inundation. However, flood threats extend far beyond coastal areas.

Since 2000, global warming has increased the number of people living in flood-prone regions by an estimated 20 to 24 percent,[1] expanding the reach of this danger. According to the National Oceanic and Atmospheric Administration (NOAA), flooding accounted for more than $200 billion in damages between 2010 and 2019, impacting approximately 90 percent of all natural disasters in the U.S.[2]

Even minor floods can be financially devastating. Beyond structural damage, flooding also poses serious health hazards, including mold growth, waterborne diseases, and indoor air quality (IAQ) issues. Prolonged exposure to flood-damaged environments can lead to respiratory illnesses, allergic reactions, and other long-term health concerns. The Federal Emergency Management Agency (FEMA) estimates that just 25.4 mm (1 in.) of water can cause up to $25,000 in damage to a home, affecting flooring, walls, appliances, and personal belongings. For commercial properties, the financial impact can be even greater due to larger spaces, specialized equipment, and costly business interruptions.

Several factors contribute to the growing flood risk. Rising global temperatures are driving heavier

A beachfront home in Manasota Key, Fla., lies in ruins after Hurricane Milton's devastating impact. The storm's powerful winds and storm surge overwhelmed the building's defenses, leading to roof collapse and shattered windows. This destruction highlights the vulnerability of coastal structures to hurricanes and the importance of resilient building practices in these regions.

Interior flooding from 25.4 mm (1 in.) of water illustrates FEMA's estimate that even minor flooding can cause up to $25,000 in damage. Shallow water can compromise flooring, walls, and appliances, and lead to long-term health risks such as mold wand poor indoor air quality.

rainfall and more intense storms. At the same time, urbanization and deforestation worsen flooding by increasing surface runoff, reducing vegetation that stabilizes soil, and replacing it with increased impervious surfaces such as pavement and rooftops. Population growth is placing more people in high-risk flood zones. A 2023 report by the First Street Foundation found that 39 million properties across the U.S. are at high risk from flooding, wildfires, or hurricane winds, with 12 million of these properties facing significant flood risk outside of FEMA-designated flood zones.[3] Recent major flooding events, such as the 2024 floods in the Mississippi River Basin and the devastating flash floods in Kentucky and Tennessee, highlight the widespread and escalating nature of this threat.

The need for flood-resistant designs and materials is no longer confined to coastal regions; it has become a nationwide concern. As a result, rigorous flood testing of building materials and infrastructure is essential for flood-resilient buildings and supporting post-disaster recovery efforts.

## The importance of flood testing

Comprehensive flood testing strengthens infrastructure and protects communities from rising flood risks. Evaluating materials and construction techniques informs material selection, improves building methods, creates better designs, and ensures regulatory compliance. This process leads to safer and more durable structures, in addition to better flood mitigation design and implementation.

Flood testing measures how well materials and systems resist water intrusion, hydrostatic pressure, and prolonged flood exposure. Key aspects of flood testing include:

- Structural integrity assessments—Engineers analyze walls, foundations, and building envelopes to determine their ability to withstand flood-related forces such as hydrostatic and hydrodynamic pressures, soil erosion, and debris impact. These assessments support the development of reinforced foundations, flood-resistant walls, and structural retrofitting solutions to improve resilience.
- Water intrusion testing—Simulating conditions such as prolonged submersion and wind-driven rain helps measure the waterproofing efficiency and efficacy of construction materials and assemblies. This process identifies weaknesses in seals, drainage systems, and barriers to prevent water penetration and long-term moisture damage. Addressing water intrusion is important for structural integrity and preventing mold growth and indoor air contamination, which can pose severe health risks to building occupants.
- Material performance validation—The durability of flood-resistant materials, such as membranes, sealants, coatings, and barriers, is assessed through both laboratory and field testing. Key performance metrics include water resistance, permeability, tensile strength, and long-term exposure to flood conditions.
- Compliance with regulatory standards—Ensuring adherence to industry standards, including FEMA's National Flood Insurance Program (NFIP), ASCE 24-24, *Flood Resistant Design and Construction*, and ICC building codes. Compliance testing confirms materials

This aerial image shows extensive flooding in an inland community in North Carolina, where rivers and streams have overflowed their banks following prolonged rainfall. Such inland flooding highlights the need for comprehensive flood resilience planning that extends beyond coastal zones.

A main road in downtown Gulfport, Fla., begins to succumb to rising waters being pushed ashore from Tampa Bay and the Gulf of Mexico during Hurricane Helene. Storm surge is one of the most destructive aspects of hurricanes and reinforces the need for site-specific flood modeling and resilient infrastructure in coastal regions.

and structures meet critical safety and performance benchmarks in flood-prone areas.

- System performance optimization—The performance of flood protection systems, including floodgates, barriers, sump pumps, and drainage solutions, is evaluated to verify they meet required design and code-based performance standards. Engineers also assess opportunities for design improvements to support long-term reliability and effectiveness.
- Full-scale testing—Physical mock-ups, such as floodgates, barrier sections, and wall assemblies, are tested under controlled conditions that simulate rising water levels, wave impacts, and prolonged submersion. These evaluations provide direct data on how systems and materials perform under extreme flood conditions and help identify areas for improvement in design, durability, and installation methods.
- Simulation modeling—Digital modeling is used to evaluate large-scale or site-specific scenarios that cannot be physically replicated, such as floodplain behavior, watershed runoff, or the capacity of drainage infrastructure during extreme rainfall events. These models help engineers predict system response, assess risks, and make informed design decisions based on projected performance under various flood conditions.

## Building envelope's role in resilient construction

One of the most vulnerable aspects of any structure during a flood is the building envelope, which includes windows, doors, roofs, and walls. Envelope compromises can lead to catastrophic failure, especially with the capabilities of wind-driven rain and storm surges to severely damage a building's interior and structural integrity. As the first line of defense, a well-designed building envelope is the best opportunity to reduce flood damage and protect both structural and non-structural components.

Several engineering principles and material advancements contribute to creating flood-resilient building envelopes:

- Elevated construction—Raising the structure above projected flood levels reduces the risk of floodwaters reaching critical building systems. Techniques to comply with FEMA and ASCE flood-resistant design guidelines include constructing homes on stilts, raised foundations, or elevated slabs.
- Flood-resistant materials—Walls and floors constructed with durable, non-porous, and water-resistant materials, such as concrete, flood-resistant drywall, and closed-cell insulation, prevent water absorption, reducing mold growth and long-term structural damage.
- Sealed openings—Windows, doors, and other penetrations must be fitted with watertight gaskets, floodproof barriers, and specialized

sealants to prevent water infiltration. Products that meet ASTM flood-resistant standards provide an extra layer of protection.

- Drainage and water diversion—Effective drainage systems, such as flood vents, sump pumps, and landscape grading, help redirect water away from the building, reducing hydrostatic pressure and minimizing water accumulation around the foundation.
- Reinforced structural elements—Strengthening walls, foundations, and key load-bearing components with flood-resistant concrete, steel reinforcements, and advanced coatings can help structures withstand hydrostatic and hydrodynamic forces from floodwaters.
- Impact-resistant openings—Installing high-performance impact-resistant windows and doors that comply with ASTM E1886 and E1996 provides critical protection against windborne debris and storm-driven water intrusion. While these systems are already required by code in coastal regions such as Florida, there may be additional opportunities to implement similar solutions in inland areas where severe weather events are becoming more frequent.
- Roof rainwater management—Proper roof design, including adequate slope, gutter capacity, and downspout sizing, helps manage heavy rainfall and direct water away from the structure. These measures reduce the risk of water accumulation, prevent overflow at roof edges, and protect building interiors and exterior assemblies during severe storm events. Using roofing materials that comply with FM Global and Miami-Dade TAS 110 testing reduces the risk of leaks and helps protect interior components from moisture damage.
- Protective coatings and barriers—Specialized waterproof coatings, hydrophobic sealants, and ANSI/FM 2510 flood protection systems help repel moisture, preventing long-term structural degradation.
- Site design strategies—Elevating structures, incorporating features such as bioswales (vegetated channels that slow and filter runoff), rain gardens, and permeable surfaces, and preserving natural floodplains are effective ways to reduce flood risk through site planning.

These strategies help manage stormwater at the source, reduce runoff, and improve the site's ability to absorb or redirect water during heavy rain events. Proper site design can protect buildings, infrastructure, and surrounding areas by reducing water accumulation and minimizing flood-related damage.

Such water intrusion can compromise structural integrity and contribute to mold growth, leading to indoor air contamination and increased health risks for occupants. These impacts emphasize the importance of sealed openings and rigorously tested barrier systems in flood-prone areas.

By combining strategic site planning with advanced materials and construction practices, engineers and architects can create buildings that are better prepared to withstand extreme weather events and reduce the risk of costly flood damage.

## Case study: The Louisiana Children's Museum

The Louisiana Children's Museum in New Orleans provides a compelling example of effective flood-resilient design. Having experienced 1.2 m (4 ft) of flooding during Hurricane Katrina, the site is now engineered to retain up to 0.9 m (3 ft) of floodwater during future storms, protecting surrounding neighborhoods. The museum is elevated 1.5 m (5 ft) above grade, meeting the city's building code requirements for hurricane-prone regions. Other flood-resistant features include native plantings to help absorb rain and flood water, a pier-based construction that allows water to flow beneath and recharge the lagoon, and open spaces that promote environmental education and flood mitigation.

## The future of flood resilience

Integrating advanced flood-resistant technologies is becoming increasingly common in urban planning and infrastructure development. These technologies include permeable surfaces, smart drainage systems, and modular flood barriers. Many cities are already incorporating them into new projects to reduce flood vulnerability.

Ongoing research is driving the development of next-generation materials with improved water resistance, such as hydrophobic concrete and self-sealing flood barriers. Smart monitoring systems,

Strong winds and large waves hit the coast as a hurricane approaches. Wind pressure and flying debris can damage roofs, windows, and doors, making impact-resistant systems an important part of protecting the building envelope in storm-prone regions.

leveraging sensors and AI-driven analytics, are being developed to provide real-time flood risk assessments and optimize drainage management in flood-prone urban areas. As climate change intensifies flooding threats, continued research, innovation, and adaptive policies will be essential to strengthen the built environment.

## Conclusion

Extreme weather events, including floods and hurricanes, are increasing in frequency and intensity. Engineering solutions and site design principles that incorporate flood-resistant materials and systems, exceed code minimum regulatory compliance, and new technological advancements are essential for minimizing the economic and structural impact of flooding. Implementing flood testing and adaptive construction methods contributes to long-term infrastructure resilience. Ongoing research into advanced materials and AI-driven flood management systems promises to advance the effectiveness of flood mitigation strategies in both urban and coastal environments.

### NOTES

[1] Refer to climate.gov/news-features/blogs/beyond-data/2010-2019-landmark-decade-us-billion-dollar-weather-and-climate?utm

[2] Learn more at earthobservatory.nasa.gov/images/148866/research-shows-more-people-living-in-floodplains?utm

[3] Read more at assets.firststreet.org/uploads/2023/09/PR_Insurance-2.pdf

## additional **information**

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**Vinu J. Abraham**, P.E., is a licensed professional engineer with extensive expertise in addressing stringent windborne debris requirements. He is recognized for his leadership in developing protective glazing products that protect homes, businesses, and communities from severe windstorms. As vice-president of products for Intertek's Building and Construction division, he is responsible for the growth and management of building and construction operations throughout the United States and Canada. His prior experience includes serving as CEO at Hurricane Test Laboratory, Inc., where he spearheaded critical testing initiatives in Riviera Beach, Fla., including windborne debris impact testing, pressure testing, cyclic load testing, and water penetration testing. Abraham is a member of several professional associations, including the ASCE and the National Society of Professional Engineers.

### KEY TAKEAWAYS

Flooding remains one of the most widespread and destructive natural hazards in the U.S., affecting both coastal and inland areas. As extreme weather events increase and development expands into high-risk zones, communities must adopt proactive strategies to enhance resilience. Comprehensive flood testing of materials and systems ensures buildings can withstand water intrusion, hydrostatic pressure, and prolonged exposure. Essential components of flood-resilient design include reinforced structures, impact-resistant openings, and advanced waterproofing. Adherence to regulatory standards supports effective protection in both new and existing structures. Investments in infrastructure—such as improved drainage, barriers, and flood-proof materials—not only help reduce economic losses and safeguard public health but also support long-term sustainability and resilience in vulnerable areas.

### MASTERFORMAT NO.

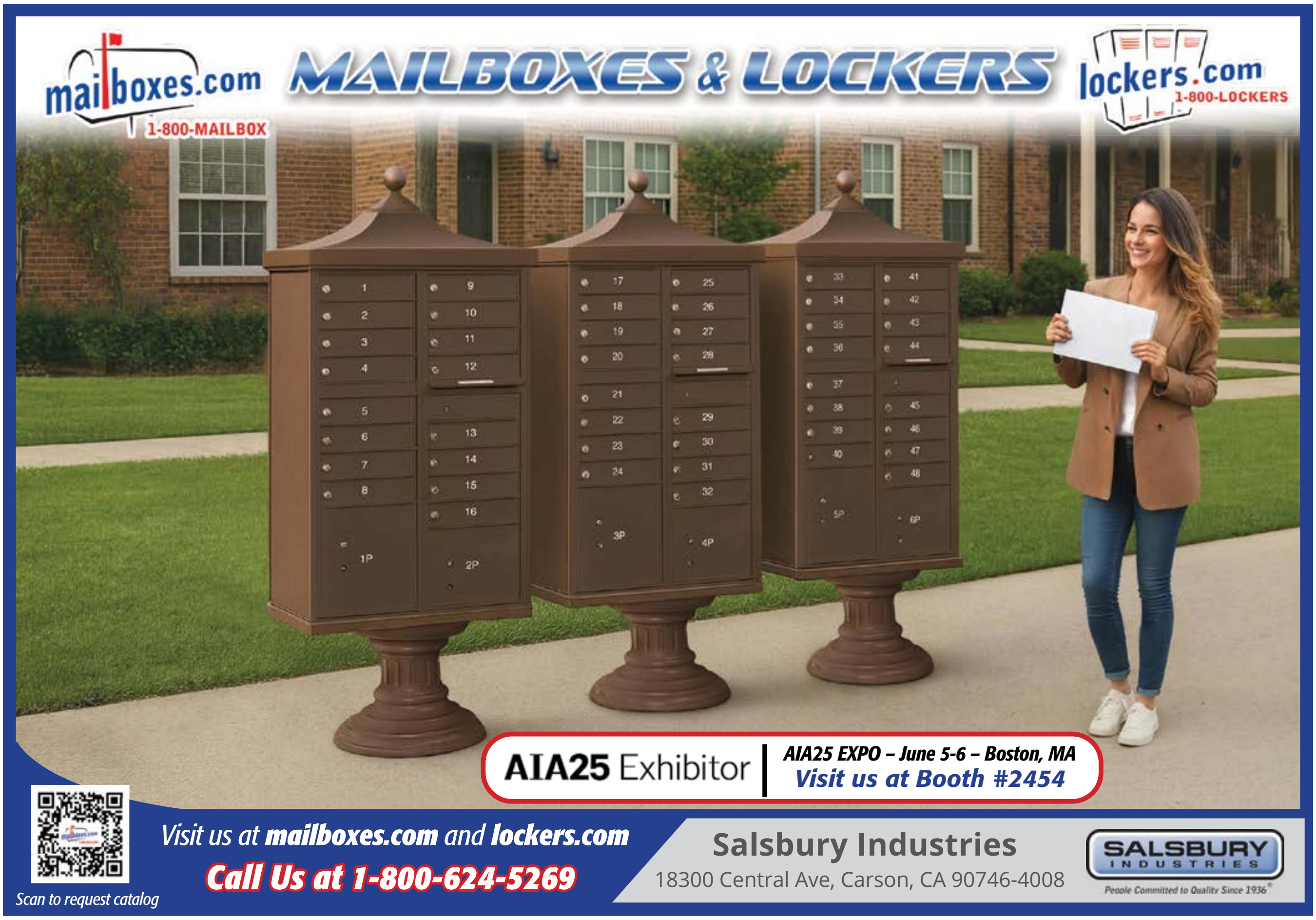
07 10 00—Dampproofing and Waterproofing
10 71 19—Flood Barriers

### UNIFORMAT NO.

A1010—Standard Foundations

### KEYWORDS

Division 07, 10
Building envelope
Flood-resistant design
Hurricane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failures

# Just a Trim Please

**Coordinating the interface details of building enclosure systems is a common challenge during design and construction to ensure continuity of dedicated control layers** (*e.g.* thermal, water-resistive air barriers [WRABs], etc.) between adjacent assemblies. This is particularly true where multiple trades are involved with the sequencing and installation of the various enclosure systems. In these cases, coordination of the transition trim components required to integrate the assemblies of different manufacturers properly is paramount.

While maintaining continuity of the dedicated control layers of the building enclosure is generally understood by the design profession, transitional components incorporated into the enclosure assembly are often overlooked during pre-installation coordination efforts. This is because these components are commonly viewed as an aesthetic element of a specific enclosure assembly that would not adversely affect the performance of an adjacent system or overall enclosure.

The challenge is that when trim elements are modified during pre-construction efforts to accommodate project-specific conditions better, the potential exists for the modifications to inadvertently deviate from the original design intent of the overall enclosure or tested assembly. Another difficulty is that trim elements may require enhanced coordination to ensure continuity of the surrounding control layers, depending on their relative position and detailing within the wall system. This may require a trim component to be installed separately from the surrounding system to facilitate proper integration. In these instances, trim components need to be designed and installed with the same rigor as the enclosure assemblies to ensure better intended performance. It is also important to note that while such components may appear functional in two-dimensional drawings, planar transitions, splice joints, terminations, etc., need to be fully understood, and appropriate details developed and reinforced during the shop drawing, mock-up, and installation phases of the building construction.

Some of the challenges mentioned above were encountered at a high-rise residential building where interface trim components of the metal panel cladding assembly were modified during construction in an attempt to simplify installation sequencing. In doing so, the trim component was extended into the rough opening of the adjacent aluminum-framed ribbon window system. This modification unintentionally interrupted the integration of the WRAB and aluminum-framed ribbon window system. As a result, the primary perimeter sealant for the window system was bonded to the leg of the metal trim within the rough opening rather than the WRAB, as originally designed. Due to installation sequencing, termination, and splice joint challenges, the trim utilized bed seals to ensure watertightness. Shortly after occupancy, widespread water leakage was reported along the windows. Investigative efforts determined that the bed seals were not continuous, which provided a direct pathway for water to bypass the control layer and enter the building.

figure 1

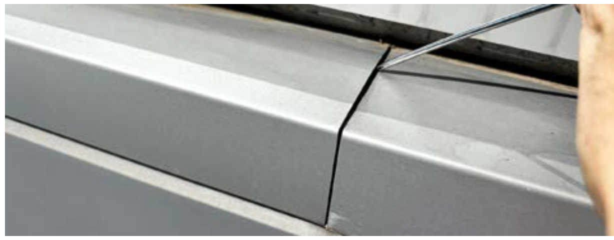

figure 2

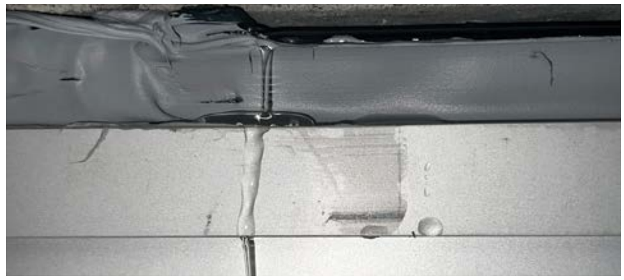

**FIGURE 1:** Close-up view of splice joint in metal sill trim that extends into the window rough opening, resulting in a discontinuity between the perimeter primary seal of the ribbon window system and the exterior wall assembly's water-resistive air barrier (WRAB).
PHOTOS COURTESY WISS, JANNEY, ELSTNER ASSOCIATES (WJE)

**FIGURE 2:** Resultant leakage (at head of window system) during diagnostic testing of splice joint in metal trim above.


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