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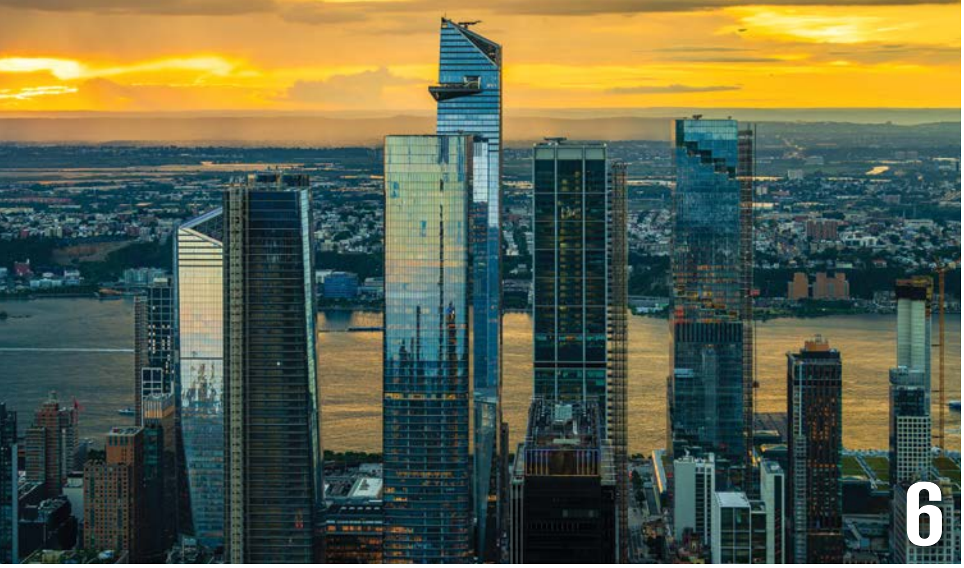

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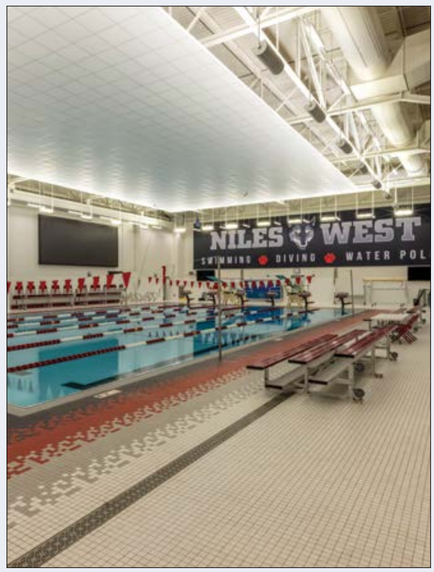

On the cover:

Niles West High School's renovated natatorium now shines with 32 high-performance LED luminaires designed for humid, corrosive environments. Replacing outdated metal halides, the indirect, glare-free lighting improves safety, spectator visibility, and maintenance access. The upgrade enhances both function and atmosphere, creating a vibrant, durable, and code-compliant aquatic facility.

PHOTO COURTESY KENALL MANUFACTURING

See article on page 39.

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THE construction specifier

volume 78
number 12
december 2025

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Rates	1 Year (12 issues):	2 Years (24 issues):	3 Years (36 issues):
U.S.	$59.00	$99.00	$139.00
Canada	$69.00	$109.00	$149.00
Foreign	$199.00		

For members of CSI, $16.50 of annual dues are allocated to the publication of *The Construction Specifier*.

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Tel: (800) 689-2900 (703) 684-0300, Fax: (703) 684-0465 (703) 236-4600

The Construction Specifier (ISSN 0010-6925) is published monthly by Kenilworth Media Inc. for CSI, 123 North Pitt Street, Suite 450 Alexandria, VA 22314. Periodical postage paid at Alexandria, Virginia, and at additional mailing offices. Printed in the USA.

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CSI Welcomes CSC's Nick Franjic as Honorary Member

At the 2025 CSI National Conference, CSI bestowed special recognition on Nick Franjic, executive director of Construction Specifications Canada (CSC), naming him an Honorary Member.

Honorary Membership is CSI's most prestigious distinction, awarded to individuals who have provided distinguished service to the construction industry in areas aligned with CSI.

CSI board chair William Sundquist, FCSI, says, "Nick's three decades of leadership have shaped collaborations across North America and elevated both CSC and CSI. Nick's vision and dedication have forged deep and lasting partnerships between our organization—partnerships that continue to benefit every member of the design and construction community. Nick's impact on our industry is both broad and profound."

Building enduring partnerships

Franjic has been a driving force behind the long-standing partnership between CSI and CSC, helping strengthen North America's design and construction community through lasting, collaborative relationships among volunteer and staff leaders.

"When William called to inform me of the CSI board's decision, I was speechless, and so grateful and overwhelmed," Franjic says. "And I have to say, I'm glad it wasn't a Zoom call. Those of you who know me are aware of how emotional I can be.

"After I hung up the phone, I sat for a few minutes and asked myself, 'Why me?'" says Franjic. "To be honored in this way by an association that I have had dealings with for over 30 years is not just the icing on the cake but the cake itself, too. I will forever cherish the friendships that have developed from day one to today."

A bond across borders

Members of both CSI and CSC widely supported the honor, recognizing Franjic's professional contributions as well as his consistent kindness and friendship.

"I gave it some thought, and what I'd like to pass on is the hospitality that he shows when my wife and I attend the CSC Conference," says Ronald L. Geren, FCSI, Distinguished Member, CCS, CCCA, CDT. "He is a big guy—you can't miss him—but with a bigger heart and a deep passion for CSC. He has helped to bridge the cross-border cooperation between our two associations, building a bond with a strength that few other associations have ever experienced."

"All of us are passionate about this industry. When you hit the board level, that seems to be especially true. But board members come and go," says CSC president Kelly Sawatzky RSW, CSP. "Nick has been with us for 30 years. He's not just a font of historical knowledge of the organization; he's a strand of yarn that knits people together."

Sawatzky adds, "Nick champions standardization and ensures collaboration between our organizations. He helps ensure that Canadian voices are heard, and I think these voices have given breadth and depth to the standards, so much so that they are being adopted all over the world. CSI can be so proud that this cooperation has resulted in such beneficial resources for all of us."

A lasting impact

Sundquist says, in addition to all Franjic's accomplishments, "Perhaps what stands out most about Nick is not just his list of accomplishments, it's his style of leadership. Those who have worked for him describe him as humble, steady, and deeply committed to the people behind the work."

Franjic acknowledged numerous CSI and CSC colleagues—including past and present board leaders and CSI CEO Mark Dorsey—for their roles in the associations' shared success.

"Throughout my time at CSC, I've been incredibly, incredibly fortunate to have the support of an executive council, board of directors, and many members both professionally and personally," says Franjic. "And I feel blessed to be able to say I have a CSI family as well.

"Thank you truly for this incredible honor," he says. "I will treasure it wherever my life takes me. Thank you."

Celebrating All of 2025 CSI Honors and Awards Recipients

At the recent CSI National Conference, CSI recognized dozens of chapters and individuals whose efforts continue to make the organization more relevant and impactful across the industry.

Each honor reflects the dedication, passion, and loyalty of those recognized.

Join us in congratulating all 2025 award and honor recipients! See the full list at csiresources.org/awardsrecipients.

Congratulations, CSI scholarship winners

The CSI Foundation supports aspiring AECO professionals from underrepresented communities through scholarships for CSI Certification and National Conference attendance.

2025 CSI National Conference scholarship recipients

- Oscar Chmiel
- Omar Lubis
- Nicholas Rubino

2025 CSI certification scholarship recipients

- Maher Bata
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40-year Study of Silicone Sealants

Silicone versus Alternative Chemistries

By Errol Bull, P.E., CSI

PHOTO © SHUTTERSTOCK/ COURTESY MOMENTIVE PERFORMANCE MATERIALS INC.

As structural glazing systems become more ambitious and complex, and demands for durability and sustainability continue to rise, the longevity of building materials has never been more critical.

Sealants play a crucial role in the long-term performance and weatherproofing of curtain walls and glazing systems. Choosing the right sealant can mean the difference between decades of low-maintenance performance and costly repairs and system failures.

In fact, it is long been known "the sealing material is typically the most critical element of the joint assembly affecting durability," as this excerpt from the 1966 edition of *Time Saver Standards* states (Figure 1).[2]

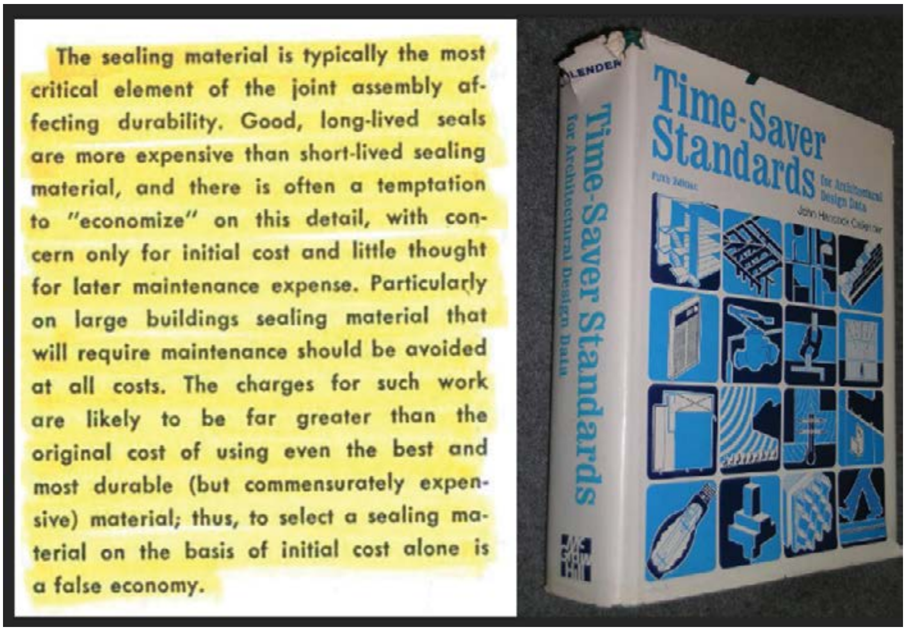
But which chemistry stands the test of time? This article presents the results of one of the longest-running glazing sealant studies—a 40-year outdoor weathering assessment comparing silicone, polyurethane, and acrylic-based sealants. Conducted at the Atlas Weathering Test Site in Florida, this real-world study provides compelling insights for architects, specifiers, building envelope engineers, and contractors seeking to make informed material selections that impact every aspect of the building envelope.

The feature highlights the performance of silicone chemistries, especially acetoxy and alkoxy types, by comparing key properties such as adhesive strength, cohesive strength, flexibility, toughness, resilience, hardness, surface appearance, and long-term durability under extreme heat, UV, and humidity conditions. It also provides comparative data to inform specification decisions.

The need for long-term data

Modern buildings are expected to last many decades, some for centuries. That is why it is important for modern materials to have long-term performance data under real-world conditions. While accelerated aging tests provide useful

Figure 1



The sealing material is typically the most critical element of the joint assembly affecting durability. Good, long-lived seals are more expensive than short-lived sealing material, and there is often a temptation to "economize" on this detail, with concern only for initial cost and little thought for later maintenance expense. Particularly on large buildings sealing material that will require maintenance should be avoided at all costs. The charges for such work are likely to be far greater than the original cost of using even the best and most durable (but commensurately expensive) material; thus, to select a sealing material on the basis of initial cost alone is a false economy.

An excerpt from the 1966 issue of *Time Saver Standards*.

TABLES COURTESY MOMENTIVE PERFORMANCE MATERIALS INC.

insight, nothing replaces real-world testing of the effects of outdoor exposure over extended periods.

That is why GE Silicones (now Momentive Performance Materials) launched one of the world's most ambitious sealant weathering studies in 1983, applying a variety of sealant chemistries to test panels and leaving them exposed to Florida's tropical climate.

The 9-ha (22-acre) Atlas Weathering Test Site (the first approved testing facility for the Cool Roof Rating Council) offered an ideal environment for the study. With high humidity, intense UV radiation, and regular tropical storms, the Florida climate is one of the most challenging natural environments for testing the durability of glazing sealants.

Table 1

ID #	Polymer type, descriptors	Manuf	Filler type	Color
1	Silicone, 1PT, +/-25%, Ac	A	100% Fumed Silica	White
2	Silicone, 1PT, +/-50%, Al	A	Calcium Carbonate / Fumed Silica	Gray
3	Silicone, 1PT, +/-50%, Al	A	Fumed Silica	Trans/Clear
4	Silicone, 1PT, +/-50%, Al	A	Calcium Carbonate / Fumed Silica	Gray
5	Silicone, 1PT, +/-50%, Al	B	Calcium Carbonate / Fumed Silica	Gray
6	Silicone, 1PT, +100/-50%, Am	B	Calcium Carbonate / Fumed Silica	Limestone
7	Silicone, 1PT, +/-25%, Ac	B	100% Fumed Silica	Black
8	Silicone, 1PT, +/-25%, Ac	C	100% Fumed Silica	Black
9	Silicone, 1PT, +/-25%, Ac	D	100% Fumed Silica	Black
10	Polyurethane, 2PT, +/-50%	D	Fumed Silica	Black
11	Acrylic Terpolymer, 1PT, XX	D	Calcium Carbonate	Black
12	Polyurethane, 1PT, +/-25%	E	Calcium Carbonate / Fumed Silica	Limestone
13	Polyurethane, 1PT, +/-25%	F	Calcium Carbonate	Gray

Description of sealant products.

Key findings: A summary

After 40 years of outdoor exposure, the results are unanimous: silicone sealants consistently outperformed polyurethane and acrylic in durability, elastic recovery, and surface integrity, demonstrating long-term performance. Although the test focused on sealants, these same chemistries are used across curtain wall and glazing applications.

Study parameters

The panels used in the study featured square pieces of glass and painted aluminum substrates, mounted on outdoor racks facing south at a 45-degree angle. Thirteen sealants from six different manufacturers were applied and were evaluated at 22-, 30-, and 41-year intervals for:

- Adhesion—The sealant's ability to bond securely with substrates over time
- Cohesion—The sealant's ability to maintain internal integrity without splitting
- Flexibility—The material's ability to bend and stretch without cracking
- Resilience—Measured by recovery to the original shape after being bent 180 degrees and released
- Hardness and toughness—Indicators of strength and resistance to environmental stress
- Surface appearance—Visual assessment of discoloration, cracking, and degradation

REINFORCING THE FUTURE: HOW NSC'S INNOVATIVE CONNECTIONS ARE REDEFINING PRECAST PARKING STRUCTURES

By Northford Structural Connections (NSC)

Northford Structural Connections (NSC), a leading developer and manufacturer of advanced connection systems, has stepped forward with innovative solutions designed to eliminate these chronic issues. Their flagship products—the Double-Tee Flexible Connection (DTFC) and the Double-Tee Connection (DTC)—represent the next generation of resilient, field-ready technology for both retrofit and new construction.

In the world of precast concrete construction, structural connections are the unsung heroes that determine a parking structure's long-term performance. Over time, the industry has seen a recurring challenge—shear connection failures in single- and double-tee flanges that compromise safety, durability, and seismic stability.

UNDERSTANDING THE CHALLENGE: WHY FLANGE CONNECTIONS FAIL

Precast-tee flange connections often fail for three fundamental reasons:

- Corrosion of embedded or exposed reinforcement
- Restrained tension during temperature changes, especially in colder months
- Fatigue loading from daily vehicular traffic

The results are familiar to engineers and owners alike—joint movement, bouncing at the seams, and water infiltration. These visible symptoms often mask a deeper problem: once the flange connection fails, the cantilevered precast elements become unsupported, compromising the deck diaphragm's seismic integrity and overall safety of the structure.

WHY TRADITIONAL REPAIRS FALL SHORT

For decades, repair approaches have focused on addressing the symptoms, not the cause. Spall repairs attempt to bond new concrete to a stressed substrate—a losing battle from the start. Likewise, weld repairs at fatigue fractures simply restart the clock without resolving the underlying issue of cyclic stress and tension restraint.

The result? Short-lived fixes that delay, rather than prevent, structural deterioration.

THE NSC APPROACH: ENGINEERING FOR MOVEMENT AND LONGEVITY

Recognizing that rigid connections were part of the problem, NSC's engineers sought a new path—a connection that could move when the structure moved.

The result was the Double-Tee Flexible Connection (DTFC), an underside-mounted, stainless steel system designed specifically for retrofit applications. Its flexible geometry allows controlled movement across the joint, relieving tensile stress while maintaining shear integrity.

The DTFC's corrosion-resistant stainless steel design and fatigue-resistant construction ensure that it performs reliably under the demanding conditions of parking decks, all while allowing installation without garage closures or traffic disruption—a critical advantage for owners and

A PARALLEL SOLUTION FOR NEW CONSTRUCTION

Building on the success of the DTFC, NSC developed the Double-Tee Connection (DTC)—a modern evolution of the traditional slug weld used in precast fabrication. The DTC's refined geometry enhances fatigue resistance, reduces stress at the weld interface, and significantly improves out-of-plane bending performance.

Designed for new precast production, the DTC not only simplifies fabrication but also extends the service life of the structure, representing a proactive rather than reactive approach to connection design.

INNOVATION THROUGH COLLABORATION

Both the DTFC and DTC were developed in collaboration with industry experts, laboratories, and field professionals who understood the practical realities of parking structure performance. This partnership-driven approach allowed NSC to bridge the gap between theoretical engineering and real-world construction demands, creating products that are both technically advanced and field-friendly.

CONTINUING EDUCATION: BUILDING AWARENESS THROUGH AIA-CES

NSC is committed to collaborating with engineers, architects, and contractors on the evolving science of connection performance. Through its AIA Continuing Education (CES) program, NSC offers accredited webinars and presentations that explore fatigue behavior, connection mechanics, and modern retrofit strategies—empowering design professionals to make informed, durable choices.

A LASTING IMPACT

From restoring aging garages to constructing the next generation of precast decks, NSC's mission is clear: build stronger, smarter, and longer-lasting connections.

> To learn more about the DTFC and DTC systems, access technical data sheets, or schedule an AIA-CES presentation, visit nscclips.com or contact admin@nscclips.com.

Table 2

ID #	Polymer type, descriptors	Overall	Dirt-pick-up	Surface irregularity	Discoloration
1	Silicone, 1PT, +/-25%, Ac	Excellent	Significant	None	None
2	Silicone, 1PT, +/-50%, Al	Good	Significant	Moderate	None
3	Silicone, 1PT, +/-50%, Al	Excellent	Significant	None	Significant
4	Silicone, 1PT, +/-50%, Al	Excellent	Significant	None	None
5	Silicone, 1PT, +/-50%, Al	Excellent	Significant	None	None
6	Silicone, 1PT, +/-100/-50%, Am	Good	Significant	Moderate	Significant
7	Silicone, 1PT, +/-25%, Ac	Good	Significant	Moderate	Significant
8	Silicone, 1PT, +/-25%, Ac	Excellent	Significant	None	None
9	Silicone, 1PT, +/-25%, Ac	Excellent	Significant	None	Moderate
10	Polyurethane, 2PT, +/-50%	Poor	Light	Significant	N/A
11	Acrylic Terpolymer, 1PT, XX	Poor	Light	Significant	None
12	Polyurethane, 1PT, +/-25%	Poor	Light	Significant	Significant
13	Polyurethane, 1PT, +/-25%	Poor	Significant	Moderate	None

Surface appearance and conditions.

Table 3

ID #	Polymer type, descriptors	Flexibility	Resilience	Toughness
1	Silicone, 1PT, +/-25%, Ac	Excellent	Excellent	Excellent
2	Silicone, 1PT, +/-50%, Al	Poor	Poor	Poor
3	Silicone, 1PT, +/-50%, Al	Excellent	Excellent	Good
4	Silicone, 1PT, +/-50%, Al	Poor	Poor	Excellent
5	Silicone, 1PT, +/-50%, Al	Good	Good	Poor
6	Silicone, 1PT, +100/-50%, Am	Excellent	Excellent	Poor
7	Silicone, 1PT, +/-25%, Ac	Excellent	Excellent	Excellent
8	Silicone, 1PT, +/-25%, Ac	Excellent	Excellent	Excellent
9	Silicone, 1PT, +/-25%, Ac	Excellent	Excellent	Excellent
10	Polyurethane, 2PT, +/-50%	Good	Poor	Poor
11	Acrylic Terpolymer, 1PT, XX	Poor	Poor	Excellent
12	Polyurethane, 1PT, +/-25%	Poor	Poor	Excellent
13	Polyurethane, 1PT, +/-25%	Poor	Poor	Excellent

General overall condition.

Description of sealants

All sealants used in this study were commercially available in 1983 and intended for use in construction applications. The products were sourced from six different manufacturers. As of the time this paper was prepared, nine of the original 13 sealants remained available on the market. Table 1 (page 7) below offers a brief overview of the products included in the study.

Note:

- 1PT = single-component product
- 2PT = multi-component product
- ±25, ±50, +100/50 percent = the manufacturer's published movement capability
- Ac = acetoxy chemistry; sealant releases acetic acid during cure
- Al = alcohol chemistry; sealant releases an alcohol during cure
- Am = acetoamide chemistry; sealant releases N-ethylacetamide during cure
- XX = unknown/not published

Evaluation methods

Surface appearance and condition—The aged sealants were visually inspected for overall appearance and surface damage, such as cracking, bubbling, discoloration, dirt pickup, and other irregularities. These observations were recorded during the inspection. To help assess the sealant surfaces more clearly, light cleaning was done using a household detergent and a sponge to scrub the sealant beads and nearby glass or metal panels. The test assemblies were cleaned and photographed both before and after sealant cleaning and removal, allowing for the best visual evaluation of the sealant surfaces.

Table 2 provides a qualitative assessment of the physical appearance and condition of the sealants. The following ratings were assigned and are tabulated:

- For overall surface appearance and condition—Samples were visually and qualitatively assessed as excellent, good, or poor.
- For dirt-pickup—Samples were visually and qualitatively assessed as: light, moderate, or significant.
- For surface irregularity—Samples were visually and qualitatively assessed as: none, moderate, or significant.
- For discoloration or color change—Samples were visually and qualitatively assessed as: none, moderate, or significant.

General overall condition

The 40-year study also evaluated the sealants for flexibility, resilience, and toughness. Samples were tested using various methods, including stretching, bending, twisting, and gouging. Each sample was rated as excellent, good, or poor, with results shown in Table 3. The following definitions were used as a guide for scoring:

- Flexible—Capable of being easily bent, without breaking or cracking
- Resilience—The ability to return to the original form, position, etc., after being bent or stretched
- Toughness—Not easily gouged or defaced

Adhesion

Sections of each sealant were cut from the glass and aluminum panel test assemblies, and adhesion was evaluated at that time. This was achieved through a hand-pull and visual inspection of the joint bond line to determine the mode of failure (cohesive or adhesive). Adhesion results are shown in Table 4.

Flexibility

Sections of each sealant were cut from the glass and aluminum panel test assemblies. To qualitatively assess flexibility and/or elasticity, the samples were manually bent 180 degrees, photographed, and their flexibility was noted. The results of this 180-degree bend test are shown in Table 4 and rated as excellent, good, or poor, defined as follows:

- Excellent—Sealant able to withstand an 180-degree bend without breaking or cracking
- Good—Sealant able to withstand an 180-degree bend, but with some cracking
- Poor—Sealant unable to withstand an 180-degree bend without breaking

Elastic recovery

After each sealant was manually bent 180 degrees, it was immediately released, and its elastic recovery was observed and photographed. Elastic recovery is defined as the percentage of return to its original shape within five minutes of being released from the 180-degree bend. The results are shown in Table 4. Sealants that broke during the bend test could not be evaluated for elastic recovery and are marked as N/A in Table 4.

Hardness

As before, sections of each sealant were cut from the glass and aluminum panel test assemblies. These samples were taken to the lab and tested for Type A hardness using a sealant hardness tester made by Fowler, Canton, MA. For each sample, at least three immediate readings were taken and recorded. Table 5 shows the average hardness values.

Overall durability ranking

A specific ranking method was used in the 40-year test to help measure the overall durability of the sealants. Only performance factors that affect weathering durability were considered; visual appearance and surface-level conditions were not included. The key properties needed for long-term outdoor use in building construction include flexibility, resilience (elastic recovery), toughness, resistance to hardness changes, and the ability to maintain long-term adhesive bonding (as shown on painted aluminum in this study). Table 6 (page 12) presents the overall durability performance rankings of the evaluated sealants.

For ranking, the following rating system is used for Table 6:

- For flexibility (ref Table 4) → Excellent = 3, Good = 2, Poor = 1
- For resilience (ref Table 3) → Excellent = 3, Good = 2, Poor = 1
- For toughness (ref Table 3) → Excellent = 3, Good = 2, Poor = 1
- For percent change in hardness (ref Table 5) → 0–33 = 3, 34–66 = 2, > 66 = 1

Table 4

ID #	Polymer type, descriptors	Adhesion check		Flexibility	Elastic recovery
		Glass	Aluminum		
1	Silicone, 1PT, +/-25%, Ac	Adhesive	Cohesive	Excellent	Yes, 100%
2	Silicone, 1PT, +/-50%, Al	Cohesive	Cohesive	Poor	N/A
3	Silicone, 1PT, +/-50%, Al	N/A	Cohesive	Excellent	Yes, 100%
4	Silicone, 1PT, +/-50%, Al	Cohesive	N/A	Poor	N/A
5	Silicone, 1PT, +/-50%, Al	50% Cohesive	Cohesive	Poor	N/A
6	Silicone, 1PT, +100/-50%, Am	Cohesive	Cohesive	Excellent	Yes, 90%
7	Silicone, 1PT, +/-25%, Ac	N/A	Cohesive	Excellent	Yes, 100%
8	Silicone, 1PT, +/-25%, Ac	N/A	Cohesive	Excellent	Yes, 100%
9	Silicone, 1PT, +/-25%, Ac	Adhesive	Cohesive	Excellent	Yes, 100%
10	Polyurethane, 2PT, +/-50%	N/A	N/A	N/A	N/A
11	Acrylic Terpolymer, 1PT, XX	Adhesive	Cohesive	Poor	N/A
12	Polyurethane, 1PT, +/-25%	N/A	Adhesive	Good	N/A
13	Polyurethane, 1PT, +/-25%	N/A	Adhesive	Poor	N/A

Adhesion, flexibility, and elastic recovery.

Table 5

ID #	Polymer type, descriptors	Initial published hardness	40-year hardness readings	% Change
1	Silicone, 1PT, +/-25%, Ac	35	38	9%
2	Silicone, 1PT, +/-50%, Al	22	75	242%
3	Silicone, 1PT, +/-50%, Al	22	33	50%
4	Silicone, 1PT, +/-50%, Al	22	67	205%
5	Silicone, 1PT, +/-50%, Al	30	66	120%
6	Silicone, 1PT, +100/-50%, Am	15	12	-20%
7	Silicone, 1PT, +/-25%, Ac	25	31	25%
8	Silicone, 1PT, +/-25%, Ac	30	31	3%
9	Silicone, 1PT, +/-25%, Ac	24	30	25%
10	Polyurethane, 2PT, +/-50%	20-40	11	-62%
11	Acrylic Terpolymer, 1PT, XX	40-50	94	110%
12	Polyurethane, 1PT, +/-25%	35-45	87	118%
13	Polyurethane, 1PT, +/-25%	38	79	108%

Hardness.

Table 6

ID #	Polymer type, descriptors	Flexibility	Resilience	Toughness	Change in hardness	Adhesive bond durability	Rating totals
1	Silicone, 1PT, +/-25%, Ac	3	3	3	3	3	Σ = 15
2	Silicone, 1PT, +/-50%, Al	1	1	1	1	3	Σ = 7
3	Silicone, 1PT, +/-50%, Al	3	3	2	2	3	Σ = 13
4	Silicone, 1PT, +/-50%, Al	1	1	3	1	3	Σ = 9
5	Silicone, 1PT, +/-50%, Al	1	2	1	1	3	Σ = 8
6	Silicone, 1PT, +100/-50%, Am	3	3	1	2	3	Σ = 12
7	Silicone, 1PT, +/-25%, Ac	3	3	3	3	3	Σ = 15
8	Silicone, 1PT, +/-25%, Ac	3	3	3	3	3	Σ = 15
9	Silicone, 1PT, +/-25%, Ac	3	3	3	3	3	Σ = 15
10	Polyurethane, 2PT, +/-50%	2	1	1	1	1	Σ = 6
11	Acrylic Terpolymer, 1PT, XX	1	1	3	1	3	Σ = 9
12	Polyurethane, 1PT, +/-25%	2	1	3	1	1	Σ = 8
13	Polyurethane, 1PT, +/-25%	1	1	3	1	1	Σ = 7

Overall durability ranking.

Property	Acetoxy silicone	Alkoxy silicone	Polyurethane	Acrylic
Adhesion retention	Excellent	Very good	Poor	Poor
Elastic recovery	Excellent (100 percent)	Excellent (100 percent)	Moderate	Low
Surface appearance	Very good	Good	Fair	Poor
Flexibility (initial)	Moderate	Excellent	Moderate	Low
Flexibility (40 years)	High	Moderate	Low	Very low
Substrate compatibility	Limited	Broad	Moderate	Moderate

Performance comparison of silicone versus alternative chemistries over 40 years.

- Ability to bond for 40 years (based on results of painted aluminum test assemblies) (ref Table 4) ⟶ Adhesive

Failure = 1, Partial adhesion = 2, Cohesive failure = 3

Key findings: Silicone versus polyurethane and acrylic

After 40 years of continuous outdoor exposure, the results clearly demonstrate that silicone-based sealants outperformed polyurethane and acrylic in nearly every performance category.

- Durability—In all cases but one, silicone sealants demonstrated greater resistance to environmental aging and maintained adhesion and flexibility significantly longer.
- Elastic recovery—Silicone products displayed near-instantaneous 100 percent elastic recovery after stress, a critical factor in withstanding building movement.
- Surface condition—Silicone sealants retained a cleaner, more intact surface appearance than alternative chemistries, which exhibited more cracking and discoloration.

This level of performance makes a strong case for the benefits of silicone sealants for weatherproofing applications where longevity and structural integrity are paramount.

Acetoxy versus alkoxy: A chemistry comparison

Silicone sealants can be divided into several types, with acetoxy and alkoxy representing two of the most widely used chemistries. Each offers distinct performance profiles:

- Acetoxy silicones—These release acetic acid during curing, which limits their use on some substrates due to potential corrosion. However, they demonstrated the best long-term performance at the Florida test site, exhibiting minimal surface degradation.
- Alkoxy silicones—These release methanol during curing, a neutral, non-corrosive byproduct, that makes them suitable for a broader range of substrates, including metals such as zinc and nickel. Alkoxy silicones were found to be twice as flexible as acetoxy silicones for up to 30 years. Although their long-term durability slightly declined compared to acetoxy silicones afterwards, they still significantly outperformed polyurethane and acrylic alternatives.

Adhesion versus cohesion: Understanding failure mechanisms

One key finding from the study is the importance of understanding how sealants fail. In structural glazing and curtain wall applications, adhesion failure, where the sealant separates from the substrate, can result in catastrophic water intrusion or panel failure. Conversely, cohesive failure, where the failure occurs within the sealant itself, indicates that the bond to the substrate is still intact.

Silicone sealants consistently exhibited stronger adhesive properties than cohesive ones, reducing the risk of debonding and ensuring greater structural security.

Sustainability and cost implications

The study confirms silicone sealants value over time, with reduced maintenance, repair, and replacement costs translating into significant lifecycle savings. Moreover, silicone sealants can contribute to sustainability goals by reducing material waste and extending the lifecycles of building envelopes.

Neutral-cure alkoxy silicones also offer low volatile organic compounds (VOCs) and performance properties that help to improve indoor air quality and support sustainability certifications (such as LEED).

Future-proofing specifications

As curtain wall and glazing systems evolve to incorporate larger glass panels with higher wind load resistance and more sophisticated anchoring systems, the demands on sealants will continue to grow. Silicone's proven long-term elasticity, UV resistance, and environmental stability make it well-suited to support the evolving design goals of super and mega-tall structures worldwide.

For building envelope engineers and specifiers, incorporating performance data from this 40-year study offers a science-backed framework for choosing materials that reduce risk and enhance performance.

Conclusion: Silicone as the standard

This 40-year study presents a compelling case for specifying and using silicone sealants in various glass applications. The combination of flexibility, adhesion retention, surface stability, and chemical safety is unmatched by polyurethane or acrylic alternatives.

Architects, specifiers, and engineers seeking to build high-performance, low-maintenance structures are continuing to consider silicone-based chemistries as a strategic investment in the building's long-term success.

Test disclaimer

Performance results will vary depending on several process-related factors. Prospective customers should rely solely upon their own evaluative techniques to determine what processing parameters are attainable and optimal to their specific needs.

NOTES

[1] Review the study at siliconeforbuilding.com/blog/40-years-of-outdoor-weathering-a-real-world-40-year-landmark-study-of-silicone-vs-alternative-chemistries

[2] Callender, John Hancock. *Time-saver Standards: A Handbook of Architectural Design*. United States: McGraw-Hill, 1966.

additional **information**

AUTHOR

Errol Bull, P.E., CSI, is an application development leader at Momentive Performance Materials Inc. Member: CSI, IIBEC, ASTM C24, ISO TC59/SC8. With more than 25 years of global experience in construction sealants, adhesives, and coatings, Bull is an expert in structural glazing and sealant performance. He holds a bachelor of science in architectural engineering and a master of science in civil engineering.

KEY TAKEAWAYS

A 40-year real-world study shows silicone sealants outperform polyurethane and acrylic in durability, elasticity, and surface integrity. Acetoxy excels in long-term stability; alkoxy offers broader substrate compatibility. Silicone ensures lower maintenance, cost savings, and sustainable building performance.

MASTERFORMAT NO.

07 92 00— Joint Sealant
08 44 00—Glazing

UNIFORMAT NO.

B2010—Exterior Wall Construction
B2020—Exterior Windows
B3060—Horizontal Openings

KEYWORDS

Division 07, 08
Silicone sealants

Manufacturers' Profiles*

DECEMBER 2025

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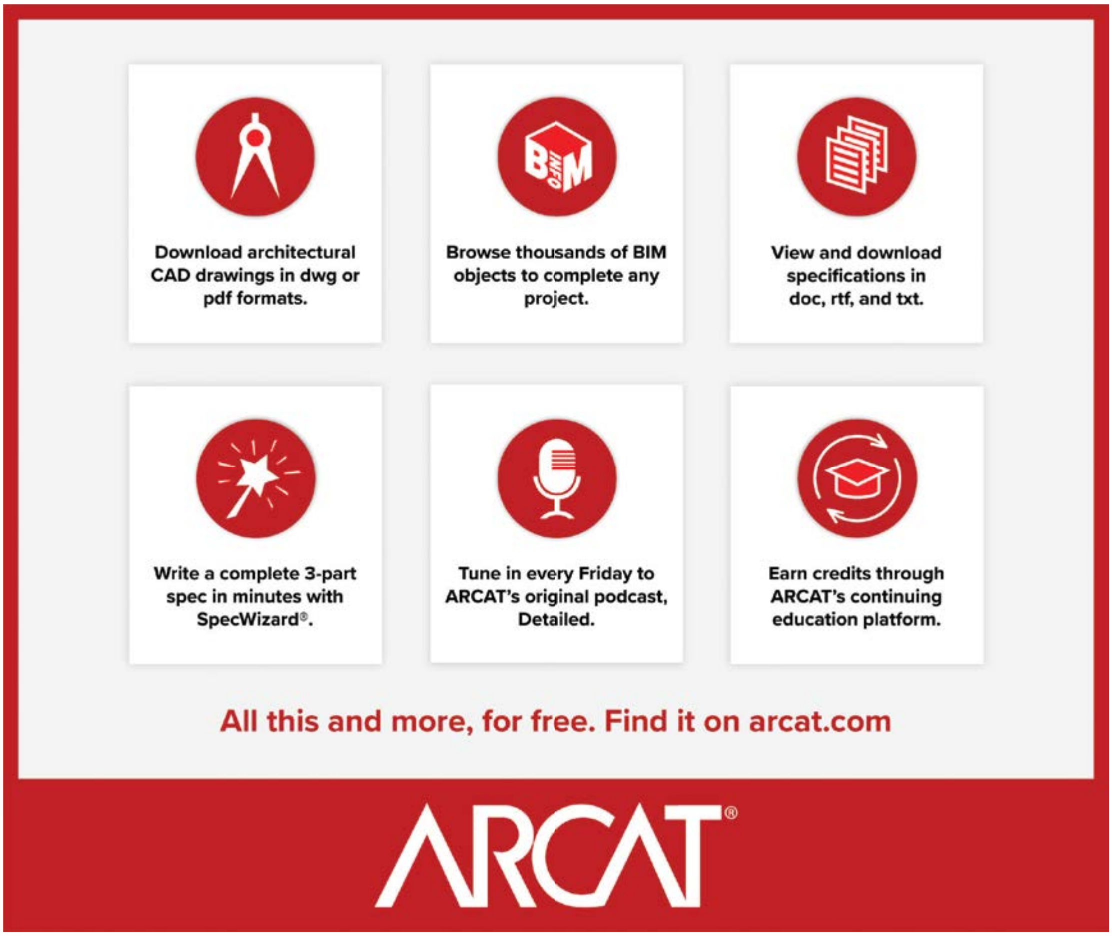

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Stepping Towards Silence

Flooring as a Key Acoustic Solution

By Justin Reidling

PHOTOS COURTESY ECORE

Occupant health and wellness are very important in buildings. Good acoustics help create spaces that support productivity, relaxation, and positive experiences. Whether in healthcare facilities, offices, hotels, multi-family residences, educational institutions or fitness centers, managing noise is essential to supporting both mental and physical well-being. One often overlooked element in the acoustic equation is flooring—a material choice that directly influences impact noise from footsteps, dropped objects, rolling carts, and even weight drops in gyms. The right flooring solution can play a transformative role in reducing noise levels and enhancing overall occupant satisfaction.

The challenge of noise across building types

Noise can be a disruptive factor in nearly every type of building. In healthcare settings, elevated and unexpected sounds can affect patient recovery by disrupting sleep, increasing the need for medication, and ultimately extending hospital stays. For staff such as nurses, excessive noise can lower speech intelligibility, impair decision-making, and contribute to fatigue.[1]

In commercial office environments, background noise from footsteps, conversations, and moving furniture can reduce concentration and productivity. Hotels and multi-family residences face challenges in maintaining restful spaces for occupants, especially when gyms, conference areas, or restaurants are located near sleeping areas.[2]

Educational settings require low noise levels for optimal learning, while fitness facilities must manage impact noise from heavy weights, cardio machines, and high-intensity workouts.

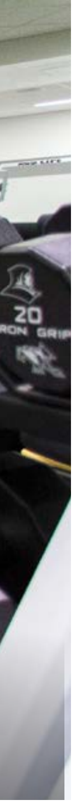
Managing impact energy to reduce noise

When an object—be it a shoe, a chair leg, or a dropped weight—lands on the floor, its kinetic energy is redirected in various ways. Part of this energy is returned to the object, causing it to bounce; some is converted into heat by the floor; and some is transmitted as noise into the surrounding room or adjacent spaces.

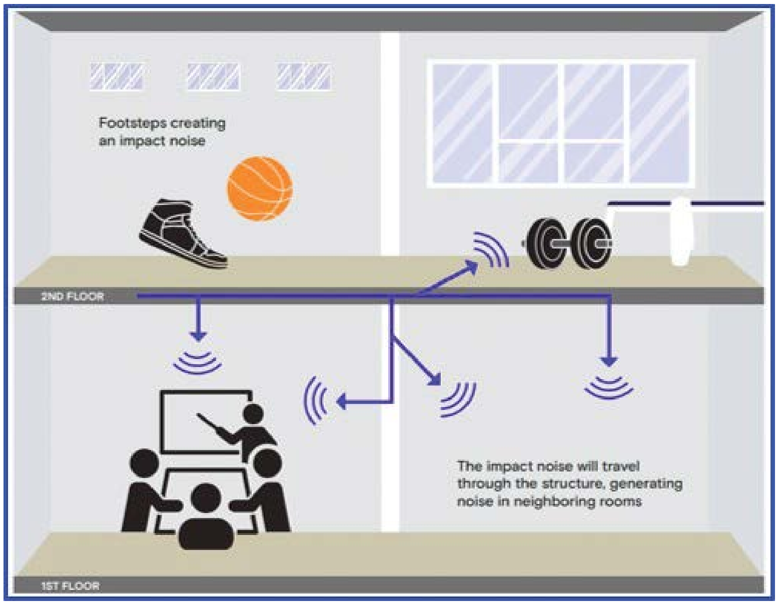
The amounts of heat and transmitted noise depend on the mass and damping characteristics of the floor-ceiling assembly, making the choice of building materials crucial. In simpler terms, the floor plays a significant role in managing how and where the energy is distributed.

In acoustical engineering, this transmission is often measured through metrics such as Impact Insulation Class (IIC) and High-frequency Impact Insulation Class (HIIC). IIC quantifies how well a floor-ceiling system attenuates low-frequency impact sounds, such as footsteps or dropped objects, while HIIC is more sensitive to sharper sounds, like the click of high heels. Both ratings are influenced by factors such as surface hardness, underlayment composition, and structural mass. For example, denser materials may reduce low-frequency "thuds" but allow higher-pitched sounds to pass through, whereas resilient underlayments can absorb and dissipate energy across a broader spectrum.

Carpet was once a popular choice for flooring in many types of buildings because it is comfortable and helps reduce noise. However, today's design trends prefer hard-surface floors for better light and temperature control, appearance, durability, and easier maintenance.



Unfortunately, these hard surfaces can make noise problems worse, especially in mixed-use and multistory buildings, where sound can travel between floors and from one tenant to another. Designers can improve noise control by carefully choosing and combining different flooring materials, creating spaces that meet the needs of healthcare, education, residential, and commercial settings.



Impact noise from footsteps, dropped objects, or gym equipment on upper floors can travel through a building's structure, disrupting occupants in neighboring spaces.

Flooring as a key acoustical solution

Performance flooring can greatly lessen sound from footfall, dropped objects, dragging furniture, and rolling carts. The effect can be orders of magnitude in terms of perceived noise. In hospitals, quieter flooring materials can reduce rolling and impact noise levels enough to encourage lower speaking volumes—a reverse of the 'cocktail party effect,' where everyone raises their voice to be heard. In fitness settings, specialized rubber flooring absorbs and isolates impact noise from dropped weights or fast-paced workouts, protecting noise-sensitive areas like offices, hotel rooms, or classrooms located nearby.

Evidence-based design and acoustical performance

Evidence-based design (EBD) is more than a philosophy—it is a disciplined approach that draws on scientific research and data to influence the built environment in ways that positively affect human health, behavior, and experience. EBD considers numerous factors, including visibility, circulation paths, ergonomics, and acoustics. It is especially relevant in facilities like hospitals, schools, and workplaces, where design decisions have measurable outcomes.

Loud or uncontrolled noise can cause stress in the environment, hinder sleep and healing, and decrease concentration or productivity. The ability to proactively address acoustical issues rather than retrofit solutions after problems arise is a hallmark of thoughtful, occupant-centered design.

Studies comparing hard-surface materials, such as vinyl composition tile (VCT) and luxury vinyl tile (LVT), with acoustically engineered flooring systems have shown significant differences in both decibel levels and IIC ratings, which measure how well a floor assembly reduces impact sound transmission.[4]

In multi-family housing, building codes require a minimum Impact Insulation Class (IIC) rating of 50 to reduce impact sound transmission between residential units. This minimum contributes to a baseline of acoustic comfort and privacy. Similar guidelines exist across other sectors, including hospitality, education, and healthcare.

Well-designed flooring aligns with EBD principles to meet and exceed minimum requirements. For example, a 3-mm (0.12 in.) LVT on a 152-mm (6-in.) concrete slab structural floor A typical floor might achieve an Impact Isolation Class (IIC) of 40 or less. In contrast, a Luxury Vinyl Tile (LVT) with rubber underlayment might reach an IIC of 50 or more. Additionally, a vinyl plank with a built-in rubber pad could achieve an IIC of 54.

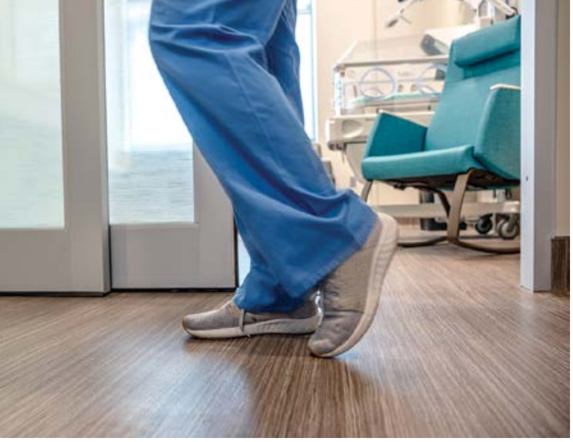
Ultimately, EBD encourages architects, designers, and facility planners to assess the long-term impact of their decisions. Flooring that contributes to reduced noise transmission is a strategic investment in the health, satisfaction, and productivity of every person who walks through the space.

Real-world applications and testing

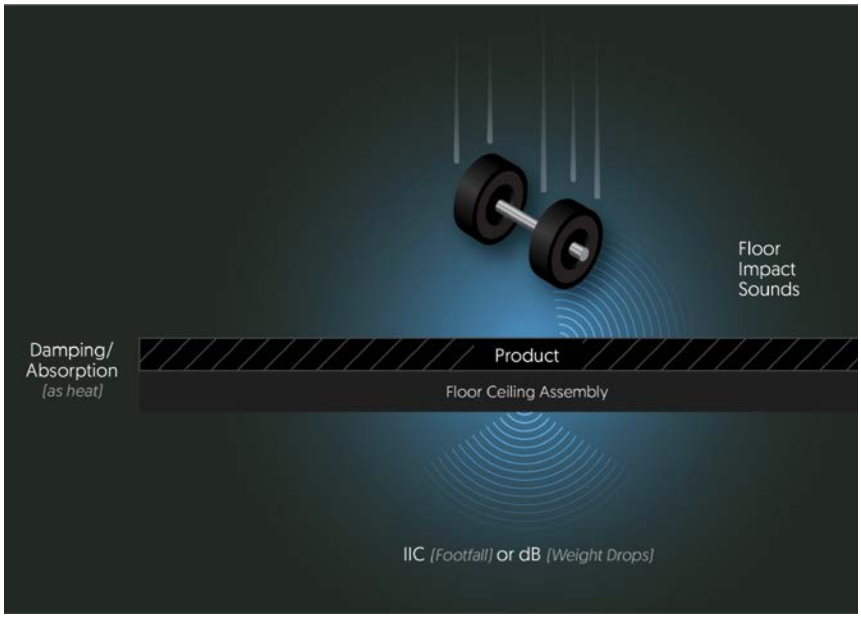
Engineered flooring systems sometimes include dissimilar materials factory-laminated to achieve otherwise impossible performance. Such technology can enhance force reduction and energy restitution characteristics and change the way sound is generated and transmitted to help control both in-room and transmitted impact noise. Independent testing has shown that some proprietary surfaces can achieve a notable reduction in perceived loudness compared to common hard-surface materials. For example, common VCT and LVT can generate a perceived increase of well more than 100 percent in in-room loudness relative to certain factory-laminated floor surfaces.[5]

Designing for acoustics in any building type

Selecting the right flooring for a space requires balancing multiple priorities: acoustics, durability, maintenance, hygiene, comfort, and aesthetics. In hospitals, this might mean choosing



A healthcare worker walks across resilient flooring designed to minimize impact noise and support a quieter healing environment.



Flooring assemblies help damp impact sounds from footfalls or weight drops, reducing transmitted noise, and improving acoustical performance as measured by Impact Insulation Class (IIC) or decibel levels.

a surface that can withstand frequent cleaning while reducing noise from rolling equipment. In hotels, it might mean using flooring with sound-absorbing properties in hallways above guest rooms. In educational facilities, it could mean specifying impact-reducing materials in multipurpose rooms or gymnasiums to protect classrooms nearby.

Ultimately, good design is a balance of the project's many performance goals. Flooring is one of the few elements that directly affects a range of outcomes, including impact noise in the room itself, transmitted noise to surrounding spaces, maintenance, and visual appeal—making it a critical piece of the acoustical design puzzle.

Conclusion

As the demand grows for healthier, more comfortable, and more productive indoor environments, acoustics continue to play a defining role in the built environment. From hospitals to hotels, offices to fitness centers, flooring choices can make a measurable difference in reducing noise, supporting wellness, and improving the overall experience for every occupant.

By incorporating evidence-based design principles and selecting materials engineered for acoustical performance, designers and facility managers create spaces that sound and feel better.

NOTES

[1] See aamc.org/news/hospitals-are-noisy-they-don-t-have-be

[2] Refer to alertify.io/how-hotels-can-reduce-noise-complaints-and-improve-guest-satisfaction/

[3] Read "Structureborne Sound Isolation" in *Handbook of Acoustical Measurements and Noise Control*.

[4] Visit pubs.aip.org/asa/jasa/article/136/4_Supplement/2219/640594/Contribution-of-floor-treatment-characteristics-to

[5] See ecoreathletic.com/news-press/updated-surface-generated-noise-test-data-available-ecore

additional information

AUTHOR

Justin Reidling is an acoustic engineer at Ecore, bringing years of multi-faceted experience as a product engineer and acoustical consultant. He holds a bachelor's degree in mechanical engineering with a minor in acoustics from Kettering University in Flint, Mich.

KEY TAKEAWAYS

Effective acoustics support occupant health, productivity, and comfort. Flooring plays a key role in managing impact noise, with material choice, underlayments, and engineered solutions influencing sound transmission. Evidence-based design and performance-focused flooring reduce noise, enhance wellness, and create more functional, satisfying spaces across healthcare, residential, educational, and commercial buildings.

MASTERFORMAT NO.

09 69 00—Resilient Flooring

UNIFORMAT NO.

C3020—Floor Finishes

KEYWORDS

Division 09
Acoustics
Flooring

How to Weld to Vintage Structural Steels

By Alan O. Humphreys Ph.D. P.E. and Dustin A. Turnquist P.E.
PHOTOS COURTESY SIMPSON GUMPERTZ & HEGER (SGH)

Structural steel has been used in buildings since the early 1900s. Many of these buildings are still in existence, particularly in New York, Philadelphia, and Chicago, and are now being repurposed, requiring rehabilitation and/or extension of the original structure. Often, these modifications require welding to the original structural members, which can present challenges regarding the weldability of these vintage steels. This article discusses the issues with welding to vintage structures, the steps involved in conducting a weldability assessment, and some recent project examples.

Steel weldability

ASTM International defines the weldability of a material as “the capacity of a material to be welded under the imposed fabrication conditions into a specific, suitably designed structure, and to perform satisfactorily in the intended service.” Issues with poor weldability of steel can involve limited weld penetration, weld or base metal cracking, and poor mechanical properties of a joint. Cracking can occur through hot tearing during weld solidification, cold cracking of the heat-affected zone (HAZ) after cooling, or lamellar tearing of the joint. Note that structural welding codes, such as American Welding Society (AWS) D1.1, *Structural Welding Code for Steel*, do not permit the presence of cracks of any size in a welded structure.

Weldability is affected by the alloy composition of the base and filler metals, the thickness of the structural members being joined, and the joint restraint (resistance to thermal shrinkage forces). The skill of the welder is not considered in the weldability of a material, as the welder’s qualifications are designed to ensure that they have the skill to adequately weld a particular joint. Laboratory and field testing have been developed for different materials and joint geometries to ensure that these combinations can be welded without cracking or a deterioration in joint strength or ductility. Historical testing and welding experience have led to the development of welding codes to ensure adequate weldability of joints, such as AWS D1.1, which establishes qualification of the welded assembly and the welder using welding procedure specifications (WPS) and procedure qualification records (PQR).

History of structural steel

Until the mid-1800s, cast iron, which has a carbon content of approximately two to four percent, was the structural ferrous metal of choice, but its applications were restricted by the material’s low ductility and poor structural integrity in tension. Techniques had previously been developed for producing “crucible steel” with a lower carbon content in

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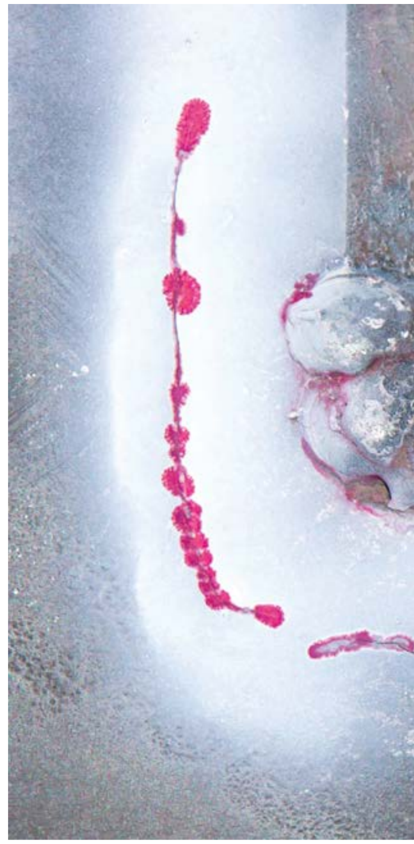


1889 Vintage Structural Steel, St. Martin's Episcopal Church in New York City.

limited quantities. However, it was not until 1856 when Henry Bessemer developed the "Bessemer Converter" that steel could be manufactured in suitable quantities for mass construction (Figure 1). This steelmaking technique blew oxygen through liquid pig iron, resulting in an exothermic reaction that oxidized impurities in the metal and lowered the carbon content to a level of one-quarter to one percent typical of modern steels. Further modifications to steelmaking, such as the Siemens-Martin Open Hearth Furnace, refined the steelmaking process to improve composition control and lower impurities of the product.

The expansion of the steelmaking industry led to the incorporation of steel into building structures, and in 1889, construction was completed of the Rand McNally Building in Chicago—the world's first all-steel-framed skyscraper (Figure 2). These early steel structural members were primarily reliant on the iron ore composition for alloy chemistry and were often brittle due to high impurity elements such as sulfur and phosphorus. Issues with quality control and failures led to the formation of the ASTM in 1902. ASTM developed guidelines for the fabrication procedure and test methods to ensure that steels had adequate structural integrity and developed two standards for this purpose: ASTM A7, *Structural Steel for Bridges and Ships,* and ASTM A9, *Structural Steel for Buildings* (Figure 3). These steel standards were combined in 1939 and further refined to develop the ASTM A36, *Standard Specification for Carbon Structural Steel,* which is used today.

Development of arc welding of structural steels

Forge welding, which involves the heating of two pieces of metal and combining them under pressure, has been used for joining metals since ancient times, but is not suitable for mass production. The structural steel elements of the Rand McNally building, which predated arc welding, were joined using rivets. Subsequently, techniques for arc welding were developed, and in 1919, the AWS was formed to advance welding science and technology. However, the shipbuilding industry was the primary adopter of welded joints, and it was not until after World War II that welded joints became commonplace in building structures.

Early steel standards considered only the mechanical properties of the base metal and not the weldability of the material. For example, an early 1909 ASTM A9 standard for structural steel specified tensile testing to ensure a tensile strength of 345 to 414 MPa (50 to 60 ksi) for rivet steel, with a yield strength greater than half that of the tensile strength and a minimum elongation of 26 percent. The only limitations on composition were on the impurity elements, sulfur and phosphorus (0.06 and 0.08 percent respectively), as these were known to embrittle the material. In the words

Cold crack adjacent to weld.

PHOTO ©NONGASIMO/COURTESY ISTOCK

of the standard, "where the physical properties desired are clearly and properly specified, the chemistry of the steel, other than prescribing the limits of the injurious impurities, phosphorus and sulphur, may in the present state of the art of making steel be safely left to the manufacturer."

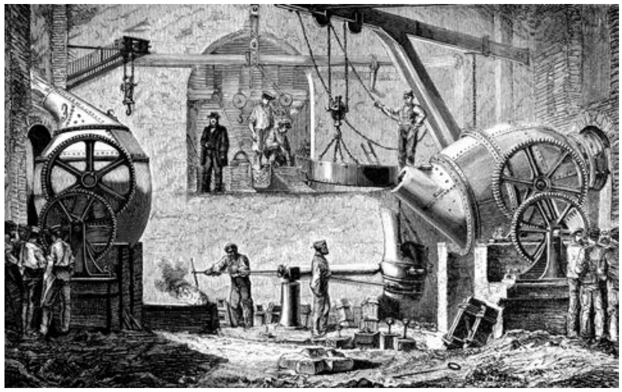
This lack of control of alloying elements in early structural steel creates issues when welding to these materials, as the alloy composition is now known to significantly affect the weldability of a steel. Therefore, when welding is required to vintage steel structures, the welding process must be approached with caution.

Welding to vintage steels

Note that this article is focused on the weldability of steels. When field welding to existing structures, other considerations, such as the effect of welding heat and stress on the original structure, must be considered. Numerous references, such as Ricker's American Institute of Steel Construction (AISC) publication, discuss these considerations and provide common techniques for structural support and reinforcement.

Welding standards such as *AWS D1.1* ensure the weldability of steels using qualification testing of test welds. This involves mechanical testing of the joint using tensile or bend tests, and microstructural assessment (the macroetch test). Testing is required whenever the material, geometry, or welding process is changed. To alleviate the need for this qualification testing, commonly used structural steels, such as ASTM A36 and A572, are prequalified by *AWS D1.1* for

Figure 1



Bessemer Converter.

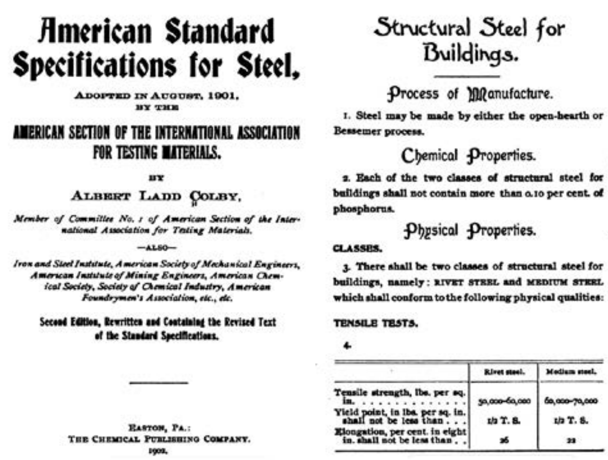
IMAGE BY ISTOCK/NASTASIC

Figure 2

1889 Rand McNally Building, Chicago.

PHOTO COURTESY THE NEWBERRY LIBRARY VIA WIKIMEDIA COMMONS (PUBLIC DOMAIN)

Figure 3



American Standard Specifications for Steel,

ADOPTED IN AUGUST, 1901,
BY THE
AMERICAN SECTION OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

BY
ALBERT LADD COLBY,

Member of Committee No. 1 of American Section of the International Association for Testing Materials.

—ALSO—

Iron and Steel Institute, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Chemical Society, Society of Chemical Industry, American Foundrymen's Association, etc., etc.

Second Edition, Rewritten and Containing the Revised Text of the Standard Specifications.

EASTON, PA.:
THE CHEMICAL PUBLISHING COMPANY.
1902.

Structural Steel for Buildings.

Process of Manufacture.

1. Steel may be made by either the open-hearth or Bessemer process.

Chemical Properties.

2. Each of the two classes of structural steel for buildings shall not contain more than 0.10 per cent. of phosphorus.

Physical Properties.

CLASSES.

3. There shall be two classes of structural steel for buildings, namely: RIVET STEEL and MEDIUM STEEL which shall conform to the following physical qualities:

TENSILE TESTS.

4.

	Rivet steel.	Medium steel.
Tensile strength, lbs. per sq. in.	50,000-60,000	60,000-70,000
Yield point, in lbs. per sq. in. shall not be less than . . .	1/2 T. S.	1/2 T. S.
Elongation, per cent. in eight in. shall not be less than . .	26	22

Extract from 1902 ASTM Standard for Structural Steel.

PHOTO COURTESY ASTM

Early welding of structural steel.

PHOTO BY SHUTTERSTOCK/EVERETT COLLECTION

AWS D1.1 Macroetch Test.

PHOTO COURTESY SIMPSON GUMPERTZ & HEGER (SGH)

different geometries and section thicknesses. The chemical composition control of the base metal, the weld process variables, and the qualification of the welder ensure the joint can be readily fabricated without defects.

However, prequalified welding is designed for new construction using known materials. When welding to existing structures containing vintage steels, the original material is unknown. If sections of the original vintage steel can be removed, then qualification testing is possible. There is a chapter within *AWS D1.1* (Clause 11 Strengthening and repairing of Existing Structures) that deals with this process. However, in many situations, there is no spare original material that can be removed for testing, so the weldability of the material must be determined using a more fundamental method.

Testing vintage steel for weldability

The easiest method to determine the weldability of a vintage steel structure is to determine if existing welds have been successfully made to the structure. If welds are present and visual inspection reveals the joints to be sound, then the weldability of the steel is likely adequate. However, in most cases, joints will have been formed using riveting or bolting, so additional investigation is required.

The chemistry of the existing steels can be determined using laboratory analysis techniques according to standards such as ASTM E350. These techniques typically require only a small section of material (less than 1 oz weight) and can be removed from a low-stressed location so as not to significantly impact the original structure. Note that when removing a sample, it is important not to overtly heat the metal, which can oxidize it and change its properties. Therefore, reciprocating or abrasive saws should be used for sample extraction, never flame cutting. In a pinch, cuttings from drill swarf can also be used for composition testing, but solid material is always preferable for uniformity.

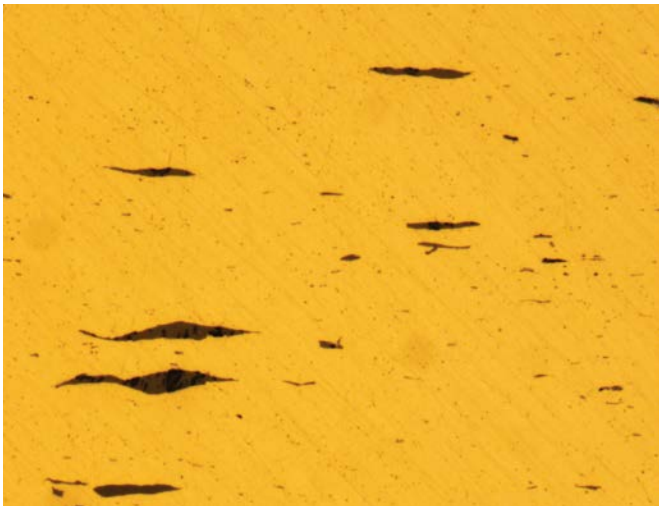
It is important to note that field measurement of carbon steel composition cannot reliably be conducted using handheld XRF detectors. The instruments are primarily designed for the identification of non-ferrous metals and have poor resolution of the carbon and impurity content necessary to determine weldability.

When measuring the composition of vintage steel members, it cannot be assumed that all components were fabricated from the same heat lot; therefore, testing of multiple members is desirable.

The results of the steel composition analysis can be used to determine the material's susceptibility to cracking. Hot cracking or tearing of weld metal occurs when impurity elements, such as sulfur and phosphorus, segregate during solidification, creating areas of low-melting-point metal that are vulnerable to cracking during thermal shrinkage. ASTM A36 requirements limit the sulfur and phosphorus composition to 0.05 and 0.04 percent respectively. If the steel composition analysis shows these impurity elements do not significantly exceed these limits, then hot cracking is unlikely to occur.

Cold cracking in steels occurs when a brittle microstructure is formed during cooling. The susceptibility of the formation of this brittle microstructure increases with the alloy content; hence, preheating is used during the welding of higher alloy steels to slow the cooling rate and reduce the probability of the formation of this deleterious microstructure. The susceptibility of an alloy to cold cracking can be quantified by the carbon equivalent (CE) and the standard AWS calculation for this is:

$$CE = \%Carbo + \frac{(\%Manganese + \%Silicon)}{6} + \frac{(\%Chromium + \%Molybdenum + \%Vanadium)}{5} + \frac{(\%Nickel + \%Copper)}{15}$$



ASTM A770 metallographic section to quantify inclusion content from 1898 vintage structural steel, Boston.

PHOTOS COURTESY SIMPSON GUMPERTZ & HEGER (SGH)

The composition analysis of the vintage steel can therefore be used to calculate its CE. As a general rule, if the CE is less than 0.4 percent, then the likelihood of cold cracking after welding is minimal. However, at high levels of CE, preheating of the joint will be required.

Finally, lamellar tearing can be an issue for vintage steels, which is a mechanism where cracking/tearing of the material occurs when a rolled plate or shape is subjected to through-thicknesses stress. This is caused by intermetallic (primarily manganese sulfide) inclusions that form in the rolling plane during processing, creating weaknesses along the through-thickness axis. These inclusions, known as stringers, are common in vintage steels. There is a metallurgical test, ASTM A770, that can be conducted on a small 13 x 13 mm (0.5 x 0.5 in.) section of original material to determine the susceptibility to lamellar tearing. If the material is found to be susceptible to lamellar tearing, then the AISC *Steel Construction Manual* and AISC *Design Guide 21* have guidelines for the modification of joint design to mitigate the risk of lamellar tearing.

Welding procedure modification and inspection techniques

Composition analysis of vintage steel ofteOOS reveals that it meets the requirements of ASTM A36 steel, and thus, it can be considered a prequalified material and readily welded. However, for materials where composition testing has suggested that the weldability of the original steel is less than ideal, weld procedure modification and inspection techniques can be employed to ensure that a sound weld is produced.

If the composition analysis shows that high levels of sulfur and/or phosphorus are present, then the occurrence of hot cracking can be minimized by lowering the heat input of the weld. Using stringer beads along the weld and extending interpass time is a common technique. After

Magnetic particle inspection of welded joint.

welding, 100 percent inspection of the weld metal is preferred to search for hot tears. As these cracks can form under the surface of the weld metal, non-destructive examination (NDE) techniques such as magnetic particle (MT) inspection or ultrasonic (UT) are preferred, if the weld geometry allows this technique to be employed.

If the CE of the material is greater than 0.4 percent, then preheat of the joint must be conducted prior to welding. *AWS D1.1* contains guidelines for determining the appropriate preheat according to steel composition, joint thickness, and weld restraint. In addition, appropriately-stored low-hydrogen electrodes must be used to minimize the probability of cracking. Hundred percent visual inspection and/or dye penetrant (PT) testing of the HAZ is required. Per AWS guidelines, inspection for cold cracking should be delayed at least 48 hours after welding, as these cracks can form over time.

Unfortunately, the composition of some vintage steels can be so extreme that welding is not possible. If weld process modifications are unable to prevent joint cracking, then an alternate joining method (bolting) must be employed.

Project examples

Recently, there was a weldability analysis of a number of steel-framed buildings in New York and Chicago constructed before 1909, when the ASTM A9 specification was developed. The composition analysis of these steels is listed in Table 1 and compared to the modern requirements of ASTM A36 steel.

Table 1

Composition analysis of vintage steels compared to ASTM A36 requirements

Element percent	1898	1900	1902	1905	1909	ASTM A36
Carbon	0.18	0.06	0.11	0.18	0.21	<0.25
Manganese	0.45	0.36	0.29	0.82	0.68	0.8-1.2
Silicon	0.02	0.05	0.01	0.03	0.09	<0.4
Sulfur	0.35	0.027	0.023	0.27	0.041	<0.05
Phosphorus	0.11	0.07	0.036	0.09	0.031	<0.04
Carbon Equivalent (CE)	0.26	0.13	0.16	0.32	0.34	-

Compositions with red font do not meet the ASTM A36 requirements.

It can be seen that the composition of these vintage steels is generally not extreme and is indeed similar to that of modern steels. The CE of these steels is all less than 0.35 percent. The manganese levels of these steels tend to be lower than modern materials, but this impacts the hot workability of the material rather than the weldability. Apart from the 1898 and 1905 dated steels, the sulfur and phosphorus levels were close to modern requirements and should be considered weldable with the weld modification and inspection techniques mentioned above.

Conclusion

In conclusion, structures containing vintage structures can be implemented with a cautious approach. This article introduces the concept of weldability in steel. Material composition analysis must be conducted to determine the weldability of the steel, and depending on the findings, subsequent modifications in the welding procedure and post-weld inspections are implemented to achieve satisfactory results.

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additional **information**

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KEY TAKEAWAYS

Structural steel used in early 20th-century buildings is often still in service today, requiring careful evaluation when welding to original members. This article explains how weldability is influenced by alloy composition, impurities, and carbon equivalence, and outlines methods for assessing vintage steels through material testing and modified welding procedures. It also highlights inspection practices and real-world project examples demonstrating how thoughtful analysis enables safe, reliable rehabilitation of historic steel structures for modern use.

MASTERFORMAT NO.

05 12 00–Structural Steel Framing
05 01 50–Maintenance of Metal Fabrications
05 05 23–Metal Fastenings

UNIFORMAT NO.

B1010–Floor Construction
B1020–Roof Construction

KEYWORDS

Division 05
Carbon equivalent
Composition analysis
Structural steel
Vintage buildings
Weldability

Building Up, Not Out

Columbia's Vision for Resilient Urban Athletics

By Neall Digert, Ph.D., MIES

PHOTOS COURTESY KINGSPAN LIGHT + AIR

Designing large-scale athletic facilities in dense urban areas poses distinct challenges. Hemmed in by surrounding development and natural barriers, these structures must adapt to restricted footprints while still delivering safe, high-performance environments suited for intense physical activity. They must also incorporate resilient features that address environmental risks, while simultaneously complementing the culture and fabric of their host cities.

Columbia University's Philip & Cheryl Milstein Family Tennis Center is located on the northern tip of Manhattan between the Hudson and Harlem rivers. This facility exemplifies how design can meet these demands. Built on a compact, flood-prone site, the National Collegiate Athletic Association (NCAA) compliant facility provides 12 courts—six indoors and six outdoors on the roof—alongside training, locker, and social spaces. Its design relies on a vertical building strategy supported by translucent curtain wall systems, which together enhance performance, sustainability and resilience.

Urban athletics and design challenges on constrained sites

Urban land scarcity is increasingly shaping development strategies, particularly for facilities that require expansive footprints such as athletics complexes. Population growth, zoning restrictions, and geographic limitations continue to intensify competition for space, with UNICEF projecting nearly 70 percent of the global population will live in cities by 2050.[1] As urban congestion increases and land prices rise, design teams are being pushed to think vertically, maximizing every square metre of available space. Within this context, urban planning has shifted toward more space-efficient solutions, including stacked sports centers, rooftop gyms, and multilevel recreation facilities that can accommodate growing demand without expanding outward.[2,3]

The Philip & Cheryl Milstein Family Tennis Center reflects these pressures and responses. Designed to replace an aging facility within Columbia University's Baker Athletics Complex, it occupies a compact site in the nation's most

The Philip & Cheryl Milstein Family Tennis Center stacks 12 National Collegiate Athletic Association (NCAA) compliant courts on a compact Manhattan footprint, maximizing space efficiency in the nation's most densely populated county.

densely populated county. Flanked by the Hudson and Harlem rivers, the location eliminated the possibility of outward expansion, requiring a vertical solution that would deliver a full NCAA-compliant program. Beyond the courts themselves, the project scope also included training areas, locker rooms, and gathering spaces for students, faculty, and visitors, that needed to be carefully integrated within the building's limited footprint.

Simultaneously, the university prioritized maintaining visual and physical connections to the adjacent parkland and waterfront. The flood-prone nature of the site introduced another layer of complexity, necessitating resilience strategies that can withstand rising water. Meeting these diverse requirements necessitated an integrated architectural and engineering response—one that balanced programmatic performance, environmental resilience, and contextual design within the realities of a constrained urban site.

Vertical design and technical demands

To resolve the challenges of a constrained, flood-prone site, the design team implemented a vertical building strategy. Six indoor courts were stacked above flood-resilient support spaces, while six additional courts were placed on the roof. This tiered arrangement enabled the delivery of a full NCAA-compliant facility, while remaining sensitive to both the surrounding landscape and the urban fabric of northern Manhattan.

Vertical stacking, however, presents unique engineering and operational demands. The foundation must be capable of distributing substantial loads evenly, while additional reinforcement is necessary to resist seismic and wind forces.[3] Interior systems must also address the "stack effect," where rising warm air alters comfort conditions at upper levels. For an athletic facility, these challenges are compounded by the need for floors that can support heavy equipment and absorb high-impact use, as well as acoustic treatments that minimize noise and vibration transfer. Taken together, these measures ensure athletes and spectators alike can experience a safe and comfortable environment.

Curtain wall systems as a design tool

While structural strategies enabled the Milstein Center to achieve its vertical program, the overall success of the facility relied on more than engineering alone. A holistic approach was needed to ensure the building not only functioned efficiently but also created an environment that supported visibility, comfort, and athlete performance.

To achieve this, the design team incorporated translucent curtain wall systems with integrated windows to the indoor court level. Serving as both enclosure and design element, these assemblies provided a lightweight, resilient envelope that delivered consistent, diffused natural daylight, reduced energy demand, regulated interior thermal conditions, and clearly defined the facility's architectural identity.

Daylighting and athlete performance

The decision to prioritize daylighting was rooted in data linking natural daylight to both health and human performance. Research from the National Institutes of Health suggests that exposure to daylight is associated with higher levels of physical activity among young adults.[5] Additional studies from the Lighting Research Center suggest it also affects serotonin levels and alertness, reducing fatigue, and sharpening cognitive function—factors that are especially important in high-intensity environments such as athletic training and competition.[6] Complementary research published in the Journal of Clinical Sleep Medicine found that individuals with greater exposure to daylight reported higher vitality, better sleep quality and longer rest duration than those in windowless settings.[7] In athletic facilities, these findings underscore daylighting as a critical performance strategy, supporting sharper concentration, faster reaction times and improved overall well-being.

Building on this evidence, the Milstein Center incorporates translucent curtain wall systems that diffuse daylight evenly across the indoor courts. By minimizing glare and reducing localized hotspots, the assemblies provide consistent illumination that enhances visual comfort during play while allowing athletes to maintain focus without distraction.[8] Tennis was created as an outdoor sport, and the athletes at the Milstein Center continue to reap the intended benefits of playing this outdoor sport.

Thermal comfort and energy efficiency

Daylighting strategies at the Milstein Family Tennis Center also support broader sustainability goals. By reducing reliance on electric lighting during peak daytime hours, the facility lowers overall energy consumption at times when occupancy is highest. Research has shown that electric lighting in commercial buildings can represent 35 to 50 percent of annual energy use.[9] Reducing this demand lowers carbon emissions while generating long-term operational savings, a critical consideration for high-use facilities that still require electric lighting for evening activities.

Thermal comfort was an equally critical factor. The curtain wall assemblies admit natural daylight while reflecting a significant portion of solar radiation, preventing overheating during play. Their insulating properties limit heat transfer between interior and exterior spaces, reducing the load on mechanical heating, cooling and ventilation systems. This design approach can reduce cooling demand by approximately 15 percent, thereby enhancing both energy performance and occupant comfort.[10] Supporting evidence from building performance research suggests that improved daylighting can produce measurable energy savings, with some facilities reporting reductions of up to 27 percent.[11]

Views and psychological well-being

In addition to managing light and temperature, the curtain wall assemblies enhance athlete well-being by incorporating carefully curated vision glass for views of the surrounding rivers and parkland. These carefully placed openings establish a visual connection to nature, creating a restorative environment that supports focus and

By integrating vertical stacking, advanced daylighting, and resilient design, the Milstein Center sets a model for future athletic facilities in dense, climate-impacted or coastal cities.

reduces stress. Research cited by the National Library of Medicine has found proximity to nature can bolster psychological resilience and concentration, both of which directly influence athletic performance.[12]

Facade integration and urban contextualization

The design team aimed to create an exterior that was contemporary in appearance yet grounded in the cultural and historical context of Manhattan. This required carefully balancing modern architectural expression with references to the city's existing fabric. The resulting facade employs a vertical rhythm of translucent wall panels, metal fins, and white cladding; a nod to the area's maritime and industrial heritage while presenting a clean, modern aesthetic.

This outcome illustrates the design flexibility of modular facade systems. Capable of supporting minimalist compositions and geometric patterns, these assemblies offer uniformity and rhythm while allowing variation in texture, color, and form to respond to diverse architectural contexts.

Resilience and climate adaptation

Resilience was equally critical to the project's success. Positioned between two rivers, the facility required flood protection strategies that would safeguard long-term structural integrity. Rather than relying on dry floodproofing, which involves sealing the exterior to keep water out, thereby risking structural failure at higher flood levels, the design team employed a wet floodproofing approach. Flood vents at the ground level permit water to flow into and out of the building, equalizing hydrostatic pressure and reducing the chance of wall or foundation failure. Mechanical and electrical systems were elevated above projected flood lines to avoid damage. These strategies, designed in accordance with Federal Emergency Management Agency (FEMA) guidelines and New York City building codes, minimize long-term material degradation and enable faster recovery following flood events.[13,14]

The Milstein Family Tennis Center's climate-adaptive strategies illustrate a broader design lesson for athletic facilities in vulnerable areas. By integrating resilient facade materials, floodproofing methods and climate-responsive planning, the project demonstrates how design can simultaneously protect occupants, reduce potential damage and prepare for accelerated climate change. With the Environmental Protection Agency (EPA) projecting more frequent extreme weather events in the coming decades, such approaches will be increasingly relevant for urban development.

Results and broader impacts

The Philip & Cheryl Milstein Family Tennis Center achieved its functional, aesthetic, and environmental goals, resulting in a high-performance athletic facility that benefits both the university and its surrounding community. By integrating sustainable, resilient, and contextually sensitive strategies, the project provides visual connections to the waterfront, mitigates environmental factors, and reduces energy demand. With NCAA-compliant courts and year-round gathering spaces, the facility supports campus well-being while setting a precedent for athletic development in dense, flood-prone urban areas.

Equally important are the broader lessons the project offers to design professionals. As one of the region's first vertically stacked tennis centers, the facility demonstrates:

- How curtain wall systems can maximize daylight while controlling glare and thermal loads
- How facades can reinforce cultural and historical context
- How resilient design strategies can mitigate the risks of climate change

These integrated approaches demonstrate a balanced methodology that addresses technical, environmental, and contextual imperatives within a single design solution.

Conclusion

The Milstein Family Tennis Center establishes a repeatable model for space-efficient, climate-adaptive facilities. The combination of vertical stacking, envelope-integrated daylighting, contextual facade design and resilient construction strategies extends well beyond athletics, offering practical guidance for educational, civic, and community projects navigating the complex realities of today's urban environments.

NOTES

See notes online at constructionspecifier.com/resilient-urban-athletics

additional information

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KEY TAKEAWAYS

Columbia University's Milstein Family Tennis Center demonstrates vertical, flood-resilient athletic design. Its translucent curtain walls enhance daylight, comfort, and energy efficiency while integrating contextual aesthetics and climate-adaptive strategies within a compact urban footprint.

MASTERFORMAT NO.

08 44 13—Glazed Aluminum Curtain Wall Assemblies
13 34 19—Athletic and Recreational Buildings

UNIFORMAT NO.

B2020 – Exterior Walls
G2030—Open Spaces and Recreation Areas

KEYWORDS

Division 08, 13
Athletics facility
Curtain wall
Flood-resistant design

Enhancing Community Safety

Effective Wildfire Mitigation and Building Practices

By Tony Crimi, P. Eng., MASc.
and Antoine Habellion, P.Eng., M.Eng.
PHOTOS COURTESY ROCKWOOL NORTH AMERICA

In recent years, wildfire incidents such as the Camp (2018), Eaton (2025), Palisades (2025), and Tubbs Fires (2017) in California, which are collectively the four most destructive fires in the state's history, have tragically claimed lives and destroyed thousands of structures.[1] Similarly, the Panhandle Wildfires (2024) in Texas (the largest in the state's history)[2] and the Marshall Fire (2021) in Colorado (the costliest in the state's history)[3] have also caused significant devastation.

The expansion of Wildland Urban Interface (WUI) areas, which are at greater risk for catastrophic wildfires, combined with more frequent extreme weather conditions, has amplified the impact of these incidents.[4] The response to, and recovery from, these increasingly complex wildfire events have strained budgets, disrupted economies, and affected countless individuals and communities. Mitigating these risks requires a multifaceted approach, focusing on both community and individual home hardening efforts. Research indicates that measures such as home hardening could reduce wildfire losses by up to 75 percent, potentially lowering insurance premiums by up to 55 percent.[5]

The escalating threat of wildfires

Over the past three decades, the WUI areas have experienced rapid expansion across the United States, significantly increasing the risks associated with wildfire incidents. By 2018, nearly one-third of the U.S. population lived in WUI zones, placing their homes in harm's way. This substantial growth encompasses an estimated 70,000 communities and 46 million residential buildings, collectively valued at approximately $1.3 trillion.[6]

The intensified threat posed by wildfires is particularly evident in California. Since 2015, seven of the 10 most destructive wildfires in the state's history have occurred, resulting in the destruction of nearly 50,000 structures, and since 2017, nine of the largest wildfires have burned through nearly 2 million ha (5 million acres).[7] To put this into perspective, the area affected by these nine large wildfires is roughly equivalent to the combined size of Connecticut and Delaware.

The hidden health hazards of wildfires

Beyond the devastating loss of life and personal and economic impacts measured in billions of dollars, wildfires also pose significant environmental and health risks to affected communities.

Wildfire smoke contains a variety of hazardous air pollutants, including gaseous pollutants such as carbon monoxide, hazardous air pollutants (HAPs) like aromatic hydrocarbons, ozone and lead, as well as particle pollution such as fine particulate matter (PM2.5).[8] Additionally, the combustion of structures further contributes to the release of myriad harmful chemicals and particulate contaminants

By 2018, nearly one-third of the U.S. population lived in Wildland Urban Interface (WUI) zones, placing their homes in harm's way.

into the air, water, and the surrounding ecosystem. This occurs because materials commonly found in the built environment, such as plastics, certain types of insulation, chemical treatments, and electronic devices, produce a range of toxic substances when burned.

These toxicants pose both acute and long-term health risks to humans through multiple exposure pathways, including inhalation, ingestion, and dermal absorption.[9] Inhalation of smoke and airborne particles can lead to respiratory issues, cardiovascular problems, and other serious health conditions. These risks are particularly severe for first responders and individuals involved in wildfire cleanup.[10] Contaminants can also infiltrate water supplies, leading to potential ingestion of hazardous substances. Further, skin contact with contaminated materials can result in dermatological conditions and systemic toxicity. The long-term health implications of exposure to these toxicants are still being studied, but they raise concerns about chronic illnesses and the overall well-being of populations residing in or near affected areas.[11]

Lastly, wildfires contribute to climate change by emitting large quantities of CO2 and other greenhouse gases into the atmosphere, thereby exacerbating global warming.

Beyond minimum standards

To mitigate damage from the exponential increase in the number of lost structures that is directly attributed to the growth of WUI zones and the increasing complexity of wildfire events,[12] it is essential to carefully plan the arrangement and placement of structures and vegetation, as well as consider building and infrastructure design. The materials used in construction, the design of homes, and the surrounding landscaping all play a significant role in determining a home's likelihood of surviving a wildfire; an effective strategy must include reducing available fuel loads to minimize fire spread.

California is a national leader in addressing wildfire impacts on the built environment through its comprehensive statewide building code and property-level vegetation requirements. Applicable to all new developments located in State Responsibility Areas (SRAs), and the highest fire severity zones in Local Responsibility Areas (LRAs), the 2022 *California Code of Regulations*, *Title 24*, *California Building Standards Code*, Part 2, *California Building Code*, Chapter 7A (Chapter 7A) and the future 2025 *California Wildland-Urban Interface Code* (*CWUIC*),[13] are intended to reduce the vulnerability of homes to wildfire.

However, given the magnitude of California's wildfire risks and the increasing home development in wildfire-prone areas,[14] it is crucial for design professionals, builders, trade contractors, homeowners, property owners, and policymakers to recognize the option to exceed the minimum standards established by local codes and regulations. Taking measures beyond basic requirements can include using noncombustible materials and implementing comprehensive landscaping plans that prioritize fire resistance.

Exceeding these standards, specifically those of Chapter 7A and the 2025 *CWUIC*, may be necessary and undoubtedly beneficial. These actions will enhance the safety of individual properties and contribute to the collective wildfire resilience of entire communities.

Figure 1

Burnt hillside with smoking homes in Colorado Springs, Colo.

Strategies for resilience

Given that few places are entirely free from wildfire risk, it is fundamental for communities and legislators to prioritize enhancing community resilience to effectively address and mitigate these threats.

Recognizing the importance of a unified understanding of "resilience,"[15] 50 organizations across various sectors, including planning, design, construction, ownership, operations, regulation, and insurance have adopted the definition proposed by the National Academies in their 2012 Consensus Study Report, "Disaster Resilience: A National Imperative":[16]

The ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

This shared definition underscores the urgent need for comprehensive hazard assessments and robust mitigation strategies. By strengthening both structures and landscapes, communities can better protect themselves against the dangers posed by embers and wildfires.

Best practices for fire mitigation in WUI areas include the following:

- Defensible space—Establishing a buffer zone between a building and its surrounding vegetation (fuel) to decrease the risk of home ignition and assist firefighting efforts. This barrier also slows or halts the progress of fire, ensuring the safety of firefighters defending the property.
- Building and maintenance codes—Enforcing codes that mandate ignition-resistant construction for various structural components, including but not limited to exterior walls, roofs, glazing, and doors. These measures significantly enhance the fire resistance of buildings, ensuring greater protection against wildfire hazards.
- Fuel mapping and condition testing—Performing detailed fuel mapping and condition testing to assist fire behaviorists in identifying high-risk areas.[17] This involves analyzing the type, quantity, and distribution of combustible materials, such as vegetation, building materials, and other potential fuel sources. By understanding the characteristics and extent of available fuel, fire behaviorists can better predict fire behavior and develop targeted strategies for wildfire mitigation.
- Assessing current capability—Conducting a thorough evaluation of existing fire mitigation strategies to determine their effectiveness and identify areas for improvement. This includes reviewing physical fire barriers, defensible space creation, building materials, and community preparedness plans. Implementing these proven strategies will enhance overall fire preparedness and response, ensuring communities are better equipped to handle wildfire events.

To illustrate the importance of these practices, it is worth noting the considerable discussion about the need for defensible space between structures in the aftermath of the 2025 Los Angeles fires.[18] However, this approach is often not feasible in California, given the existing housing crisis. This crisis has led to densely populated areas with limited available land, making it challenging to create the necessary buffer zones around structures.

As a result, alternative strategies must be considered to enhance wildfire resilience in such contexts, emphasizing

Figure 2

Remains of homes destroyed in a California wildfire.

the importance of individual home hardening efforts. By focusing on fortifying homes against fire hazards, communities can enhance their overall resilience despite the challenges posed by limited spatial separation.[17]

The role of embers and firebrands

Structure losses are often attributed to exposures from fire (radiation and/or convection), embers and firebrands, which are significant sources of ignition. Embers, which are small, glowing particles of burning material, can become trapped in the cracks of walls, window openings, roof vents, and door trim boards, igniting combustible materials. Firebrands, which are larger pieces of burning debris, can ignite wall coverings or roofing materials.

Findings from a National Institute of Standards and Technology (NIST) case study of the California 2018 Camp Fire identified significant ember exposure as a primary factor in fire spread. As stated in the case study:[19]

In agreement with the other NIST case studies of WUI fires, the Camp Fire has demonstrated that embers can have significant impact on WUI communities. Laboratory and field work by NIST [57] has demonstrated that embers with enough energy to cause ignitions are readily generated from parcel-level combustibles such as landscaping mulch, fences, and firewood piles. These parcel-level fuels can cause ignitions over 40 m (130 ft) downwind. Ember ignitions downwind from parcel-level combustibles enable fire to readily spread from parcel to parcel. In high hazard areas, WUI structures therefore need to be able to withstand the exposures generated from both wildland and parcel-level combustibles.

Fire resistance of exterior walls

Exterior walls of residential buildings are particularly vulnerable to wildfire flames, conductive heat, and radiant heat, all of which have the potential to ignite combustible materials installed on or within these structures. Their fire performance is significantly influenced by the type of construction materials used and the proximity of external fuel sources, such as vegetation and other potential ignition sources.[20]

According to WUI codes, such as the 2024 *International Wildland Urban Interface Code* (2024 *IWUIC*) or Chapter 7A, certain common combustible building materials used in exterior wall coverings of residential buildings can be used in constructions classified as Class 1, 2, and 3 ignition-resistant (IR) constructions.[21] However, despite these classifications, these materials can still readily become sources of fuel for an ambient fire. This is particularly concerning because materials such as wood, vinyl, and other typical exterior wall components, while potentially offering some degree of fire resistance when used in specific combinations, are still combustible. These materials can ignite, especially under extreme wildfire conditions, and contribute to the spread of the fire.[22] By selecting highly ignition-resistant materials, such as noncombustible materials,[23] and ensuring structures maintain a safe distance from potential external fuel sources, the overall resilience of residential buildings in wildfire-prone areas can be significantly enhanced.

It is also necessary to evaluate the ability of an exterior wall assembly to resist fire penetration from exterior fire exposure. In California, this evaluation can be conducted

Figure 3

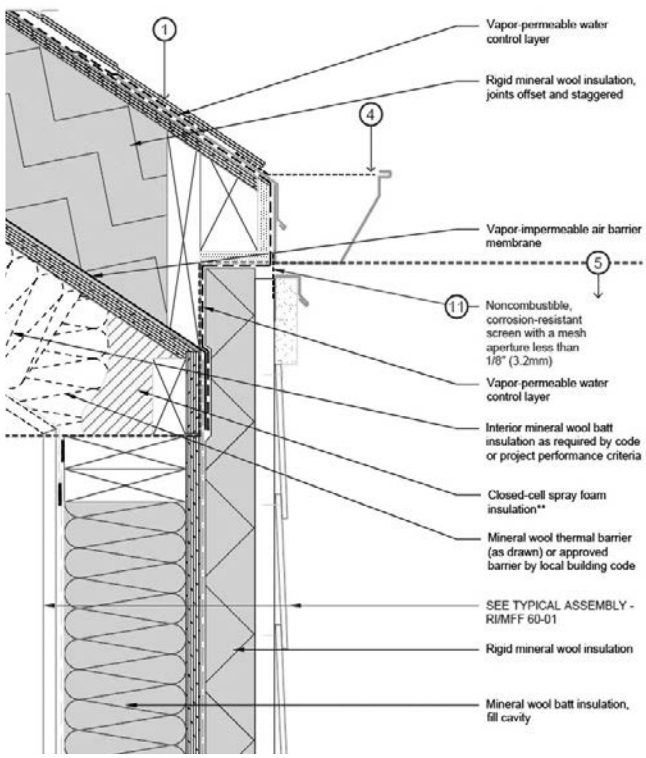

Figure 4

Figure 3: Fire-resilient assembly utilizing noncombustible mineral wool insulation.

Figure 4: Wall assembly subject to ASTM E119 fire test.

using the test described in the *State Fire Marshal* (*SFM*) *Standard* 12-7A-1,[24] which is mandated in jurisdictions referencing Chapter 7A. This test specifically addresses direct flame penetration through residential exterior wall assemblies in WUI areas. However, it does not consider flame propagation along the exterior wall into attics through eaves, or the subsequent risk of spreading to the building's interior by these paths. For this reason, using noncombustible materials in the exterior building envelope is highly beneficial, as it significantly improves a structure's resistance to both flame propagation along, and flame penetration through exterior wall and roof coverings.

When combined with noncombustible cavity and continuous exterior mineral wool insulation,[25] exterior wall coverings such as fiber-cement panels or siding, Portland cement-based stucco, masonry, stone, and metal can all be highly effective in improving fire resistance. An exterior insulation finish system (EIFS) that uses noncombustible mineral wool insulation board as a substrate, a very common type of cladding in Europe, can likewise provide increased fire protection compared to systems that use foam plastic board as a substrate,[26] which are much more susceptible to flame spread and flame penetration and can add considerable additional fuel load to an ambient fire.

Flame spread on exterior surfaces of combustible materials risks fire spreading to other parts of buildings. A post-fire analysis of the Camp Fire, as discussed in the 2022 report by Headwaters Economics and the Insurance Institute for Business & Home Safety (IBHS) titled "Construction Costs for a Wildfire-Resistant Home: California Edition,"[27] revealed the survivability of homes was closely linked to the proximity of destroyed structures and the density of development. The primary factors influencing a home's survival included exposure to radiant heat from nearby burning structures and flame contact from combustible materials close to the home. This indicates homes should be designed and maintained to reduce direct flame contact, resist ember ignition, and withstand prolonged exposure to radiant heat.

Another standard test method for reducing wildfire risk to residential structures that addresses the response of materials, products, or assemblies to heat and flame is the fire resistance rating of exterior walls in accordance with ASTM E119 (or UL 263), as referenced, for instance, in the 2024 *IWUIC* and Chapter 7A.[28] The use of fire-resistance rated assemblies helps minimize the risk of an exterior fire igniting building contents, or an interior structure fire igniting exterior vegetation and adjacent structures via direct flame impingement or radiation. The rated assemblies also provide crucial extra time for firefighting and rescue operations.

Exterior wall assemblies are typically asymmetrical. According to the ASTM E119 standard, asymmetrical walls must be tested from both sides. This necessitates standard fire resistance testing to be conducted from both the interior and exterior sides. Despite this requirement in the test standard, it is common practice to test asymmetrical walls without the outboard insulation and wall coverings, effectively rendering them symmetrical and allowing testing from a single side without incorporating combustible exterior wall claddings or combustible outboard insulations. This approach can save time and money during testing and offer greater design flexibility in choosing exterior finishes; however, it fails to assess the potential impact of additional fuel loads mounted over fire-resistance-rated walls. Therefore, while testing without the exterior finish is often accepted, it should not be considered best practice.

Wildfire smoke contains a variety of hazardous air pollutants, including gaseous pollutants such as carbon monoxide, hazardous air pollutants (HAPs) like aromatic hydrocarbons, ozone and lead, as well as particle pollution such as fine particulate matter (PM2.5).

Including the exterior finish in testing provides a more representative evaluation of real-world performance. Although outboard insulation and coverings are less likely to diminish the fire rating when tested from the interior side, this may not be the case when assessing an exterior wall assembly from the exterior side, especially with combustible insulation and coverings installed. Consequently, when combustible outboard materials are installed, it is crucial that exterior walls undergo fire resistance testing from both the interior and exterior sides.

Despite the existence of various assessment approaches, new tests may be needed to effectively measure the ability of exterior wall assemblies to resist fire propagation and limit the entry of flames into open eave and attic spaces. Additionally, concerns persist regarding the safety of combustible materials due to flame spread on their exterior surfaces. For instance, the report "California Wildfire Public Policy: Mapping the Wildfire Hazard" by the Insurance Institute for Business & Home Safety (IBHS)[29] suggests the current requirements of Chapter 7A are insufficient to ensure a house will resist a wildfire. Therefore, it is recommended that Chapter 7A, and other WUI codes, be improved to better address the growing wildfire risks and enhance the resilience of buildings in wildfire-prone areas.

Reducing the roof vulnerability

Roofs are highly vulnerable to ignition because of their relatively large horizontal surface area. Additionally, they require regular maintenance and eventual replacement of their coverings due to exposure to various climatic conditions, including wind, rain, and sun. Consequently, WUI codes such as the 2024 *IWUIC* and Chapter 7A, typically require Class A roof coverings for their high level of fire performance.[30] These coverings help prevent fire spread and penetration through the roof deck from burning embers during wildfires. They are also durable against environmental factors such as high winds and UV exposure, ensuring long-term protection. Numerous Class A roof covering options are available, including asphalt-fiberglass composite shingles, which are effective against severe fire test exposure when installed over underlayments.

Where the roofing profile has an airspace under the roof covering, these same codes also require a cap sheet, the topmost layer in a multi-layer roofing system, that complies with ASTM D3909[31] and is designed to provide the final layer of protection against the elements, installed over the combustible roof deck. NFPA 1144,[32] a standard that provides a methodology for assessing wildland fire ignition hazards around existing structures and provides requirements for new construction to reduce the potential of structure ignition from wildland fires, includes a similar requirement.

Another significant element contributing to the roof's vulnerability is the roof edge. Gutters and roof-to-wall intersections, where roof covering meets other materials (*e.g.* siding used in dormers and split-level homes), can be exposed to ember ignition. These areas must be adequately protected. Vents in the under-eave area, being inlet vents, allow air to enter the attic space. During a wildfire, vent openings can then permit wind-blown embers to enter the interior attic space. If combustible materials in the attic ignite, the house can burn from the inside out. The critical need to prevent ember and flame entry through vents during a wildfire, as outlined in Chapter 7A for instance, has led to the development of vents designed to resist the intrusion of flames and embers. Using noncombustible attic insulation can further minimize the risk of attic fires from wind-blown embers.

Although this paper primarily focuses on residential buildings, it is important to note that non-residential structures, such as commercial and institutional buildings, are also located within WUI areas. The inclusion of combustible insulation within Class A roof assemblies is permitted in commercial and industrial buildings constructed in accordance with the *International Building Code* (*IBC*). Addressing fire safety in these types of constructions is also important, as they are equally susceptible to wildfire risks and may be co-located with residential structures.

To further enhance the performance of these roofs, builders can install mineral fiber board cap sheets based on ASTM C726, a standard specification which covers the composition and physical properties of mineral fiber insulation board for roof decks as a base for built-up roofing and single-ply membrane systems in building construction.[33] It also covers mineral wool roof insulation used as a base for systems such as single-ply, polymer-modified bitumen, and built-up roofing.

NOTES

See notes online at constructionspecifier.com/effective-wildfire-mitigation

Authors' note: This article is part one of a two-part series on wildfire resilience in the built environment. Part two will examine practical, community-scale measures to enhance the safety and resilience of homes and neighborhoods, including the implementation of fire-safe setbacks and parcel-level risk assessments, strategies for upgrading existing dwellings, and financing and insurance mechanisms to support and scale home-hardening efforts. Part one addressed a range of building-level measures—most notably roof hardening, ember protection, and the use of noncombustible exterior materials—and part two will build on those foundations by focusing on parcel- and community-level implementation and the policy and market instruments necessary to enable broader adoption.

additional information

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KEY TAKEAWAYS

Wildfire risk in Wildland-Urban Interface (WUI) areas has escalated dramatically, driven by expanding development and more extreme fire weather, and mitigation requires both building-level hardening and parcel- and community-scale measures. Exposure to ember and firebrands, radiant heat, and direct flame impingement are the primary ignition pathways; therefore, roofs and exterior walls are critical vulnerabilities that benefit most from targeted interventions. Specifying non-combustible, ignition-resistant materials (*e.g.* continuous mineral-wool exterior insulation and non-combustible claddings), improving roof assemblies (Class-A coverings, cap sheets, edge protection), and incorporating ember-resistant details (vents, enclosed eaves, sealed penetrations) materially reduce ignition probability and damage severity. Parcel-level strategies—adequate setbacks, defensible space, and parcel-specific risk assessments—complement these measures where spatial constraints limit the separation. Retrofitting existing homes and leveraging financing mechanisms (*e.g.* PACE), insurance discounts, and incentive programs are essential to scale adoption and make hardening broadly affordable. Empirical analyses indicate that properly implemented mitigation can reduce losses substantially and lower insurance costs. Finally, robust codes, test standards, and coordinated policy and market mechanisms are necessary to institutionalize resilience. Design professionals, regulators, insurers, and homeowners must work together to adopt evidence-based materials, validated assembly testing, and implementation pathways that collectively enhance community resilience to wildfires.

MASTERFORMAT NO.

02 00 00–Existing Conditions
06 00 00–Wood, Plastics, and Composites
07 00 00–Thermal and Moisture Protection

UNIFORMAT NO.

B2010–Exterior Walls
B3010–Roof Coverings

KEYWORDS

Division 02, 06, 07	Fire resistance
Defensible space	Roof assemblies
Exterior walls	Wildland Urban Interface

From Dim to Dazzling

Bright Ideas Illuminate Old Pool

By Frank Gonzales

PHOTOS COURTESY KENALL MANUFACTURING

Natatoriums are highly specialized spaces, and luminaires in this setting face several challenges. Perhaps the most significant challenge is corrosion, which is exacerbated by high indoor humidity, condensation, and pool chemicals, resulting in material degradation. Fixtures for this application must, at a minimum, be rated for damp locations and offer the highest protection against moisture and chemical vapors resulting from water treatment.

Additionally, because natatorium fixtures are typically difficult to access, maintenance must be limited to a minimum. If glass were to fall into the pool during maintenance, the entire pool would need to be drained—an expensive and time-consuming effort. Life safety and accident prevention are driving forces behind natatorium lighting.

One way to address these issues is by installing LED luminaires. Indirect illumination is recommended to reduce glare and veiling reflections, improving the clarity of underwater viewing and related safety.

Niles West High School natatorium

In Skokie, Ill., Niles West High School's pool and coaches' offices were constructed in 1960. Since then, the facilities have served thousands of students, athletes, numerous coaches, and hosted many meets. However, new code requirements and accessibility regulations, along with an aging infrastructure, compelled major upgrades. The pool is part of a five-year facility improvement project. Renovations include upgrades to the structure and design of the natatorium, as well as the replacement of the pool deck, tiles, and the concrete beneath the pool. New features include the ceiling, additional storage areas, starting blocks, and an entrance to the pool deck that complies with accessibility guidelines.

Additional renovations include changing the gutter system, adding 227 mm (9 in.) of water, completely overhauling the pool's mechanical and HVAC systems, updating timing equipment, remodeling coaches' offices, and adding an enhanced grandstand area including glass railings for unobstructed sightlines, new school

The use of indirect illumination above the pool's perimeter reflects off the dropped ceiling to reduce glare and veiling reflections, and improve the clarity of underwater viewing and related safety.

The new LED pendant luminaires located on the perimeter of the pool are a dramatic improvement over the previous metal halide fixtures—they strike instantly, provide far more lumens, will last for years, and are cost effective.

graphics, updated record boards to celebrate achievements and create a vibrant atmosphere, and new lighting. The $7.3-million pool renovations were covered by funds allocated through the school district's budget.

Stuckey Construction, a pool constructor certified by the Illinois Department of Public Health, began renovations in February 2024 and completed the project by August 2024, in time for the start of the new school year.

Lighting system

The 2,641-m^2 (28,430-sf) complex previously included a metal halide (MH) lighting system installed over the pool. To access the lights for maintenance, the facilities team had to climb onto a non-compliant catwalk above the dropped ceiling, posing safety concerns. MH lamps degrade over time, losing light output and color consistency, and typically have a lifespan of 6,000 to 15,000 hours before the bulbs require replacement.

Marcus Holleran, facilities manager at Niles West High School, knew a new lighting system was critical to the renovation:

- Dim lights made it difficult for spectators to see the swimmers at meets
- The low light levels became a safety issue for lifeguards
- There were concerns for the potential of glass to break and drop into the pool during maintenance, which would require draining 719,228 L (190,000 gal) of water
- MH technology requires 10-15 minutes of "cool down to relight," meaning the bulbs needed to cool down enough before they could be re-lit again

Studio GC was the architectural and design firm retained by the school district for the project and specified indirect lighting above the pool's perimeter to reflect off the dropped ceiling. This design evenly distributes the lighting over the pool. The architectural firm worked with 20/10 Engineering Group to address photometric considerations. Based on these studies, the project required 32 LED luminaires engineered to perform in high-humidity, caustic, and corrosive environments, as well as hard-to-service areas, and feature IP65-certified housing. The International Electrotechnical Commission (IEC) has developed the ingress protection (IP) rating system, which grades the resistance of an enclosure against the intrusion of dust or liquids. Each IP water rating consists of two numbers:

- First digit (solid protection) is rated on a scale from 0 (no protection) to 6 (no ingress of dust)
- Second digit (water protection) rates the enclosure's protection against liquids and uses a scale from 0 (no protection) to 9 (high-pressure hot water from different angles).

"The new lights are terrific," says Holleran. "They strike instantly, provide more lumens than our old MH lights, will last for years, and are cost-effective. In addition to the dramatically longer life of LEDs compared to MH—100,000 [hours] versus 6,000–15,000 [hours]—the facilities team no longer has to precariously balance on a catwalk to change bulbs."

The school's swim team members also welcome the lighting upgrade.

"I appreciate how bright the pool facility is now due to the new lighting. It makes the space shine, feel warmer and more comfortable," says Dr. Dana Krilich, Niles West High School athletic director.

additional information

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KEY TAKEAWAYS

Niles West High School's natatorium renovation features corrosion-resistant, indirect LED lighting designed for safety, efficiency, and longevity—replacing outdated metal halide fixtures while improving visibility, maintenance access, and overall user experience.

MASTERFORMAT NO.

26 51 00—Interior Lighting
26 51 33—Lighting Fixtures, Interior Specialty (Natatorium/Pool Applications)

UNIFORMAT NO.

D5020—Lighting and Branch Wiring

KEYWORDS

Division 26 | Lighting
LED luminaires | Natatorium

Statement of Ownership, Management, and Circulation

1. Publication title: **The Construction Specifier**

2. Publication number: **0563-440**

3. Filing date: **September 29, 2025**

4. Issue frequency: **Monthly**

5. Number of issues published annually: **12**

6. Annual subscription price: **$59.00/$16.50**

7. Complete mailing address of known office of publication:
CSI, 5034 A Thoroughbred Lane, Brentwood, TN 37207
Contact person: **Christina Lindsay, telephone 404-734-3392**

8. Complete mailing address or headquarters or general business office of publisher: **CSI, 5034 A Thoroughbred Lane, Brentwood, TN 37207**

9. Full names and complete mailing address of publisher, editor, and managing editor:
Publisher: Erik Tolles, Kenilworth Media Inc., 30 Leek Cres, Ste 201, Richmond Hill, ON L4B 4N4

Editorial Director: Blair Adams, Kenilworth, 30 Leek Cres, Ste 201, Richmond Hill, ON L4B 4N4

Executive Editor: Jason Cramp, Kenilworth Media Inc., 30 Leek Cres, Ste 201, Richmond Hill, ON L4B 4N4

10. Owner: **The Construction Specifications Institute (CSI), CSI, 5034 A Thoroughbred Lane, Brentwood, TN 37207**

11. Known bondholders, mortgages, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: **None**

12. Tax status: **Has not changed during preceding 12 months.**

13. Publication title: **The Construction Specifier**

14. Issue date for circulation data: **September 2025**

15. Extent and nature of circulation	Average no. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total number of copies (net press run)	**26,280**	**28,442**
b. Legitimate paid and or requested distribution (by mail and outside the mail)		
(1) Outside county paid/requested mail subscriptions stated on PS form 3541	**22,773**	**16,533**
(2) In-county paid/requested mail subscriptions stated on PS form 3541	**0**	**0**
(3) Sales through dealers and carriers, street vendors, county sales and other paid or requested distribution outside USPS.	**0**	**0**
(4) Requested copies distributed by other mail classes through the USPS	**0**	**0**
c. Total paid distribution	**22,773**	**16,533**
d. Free or Nominal Rate distribution (by mail and outside the mail)		
(1) Free or nominal rate Outside-county copies stated on PS form 3541	**507**	**164**
(2) Free or nominal rate in-country copies stated on PS form 3541	**0**	**0**
(3) Free or nominal rate copies mailed at other classes through USPS (e.g. First-class mail)	**0**	**0**
(4) Free or nominal rate distribution outside the mail	**0**	**0**
e. Total Free or nominal rate distribution	**507**	**164**
f. Total distribution	**22,857**	**16,697**
g. Copies not distributed	**0**	**0**
h. Total	**22,857**	**16,697**
i. Percent Paid	**99%**	**99%**

16. Electronic copy circulation	Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Paid Electronic Copies	**3,063**	**12,073**
b. Total Paid Print Copies (Line 15c) + Paid Electronic Copies (Line 16a)	**25,836**	**28,606**
c. Total Print Distribution (Line 15f) + Paid Electronic Copies (Line 16a)	**25,920**	**28,770**
d. Percent Paid (Both Print & Electronic Copies) (16b divided by 16c Í 100)	**99%**	**99%**

I certify that 50% of all my distributed copies (electronic and print) are paid above a nominal price.

17. Publication required and will be printed in the **December 1, 2025** issue of this publication.

18. Signature and title of editor, publisher, business manager, or owner: **Mark Dorsey, CEO**

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form, or who omits material or information requested on the form, may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

Strutting About

Figure 1

Below: Fractured weld connection between strut and strut end plate.

Figure 2

Water flowing from a hole drilled at the base of a fractured strut, in which the drainage hole was sealed during the past sealant replacement program.

PHOTOS COURTESY WISS, JANNEY, ELSTNER ASSOCIATES (WJE)

It is well established that construction materials exposed to exterior environmental conditions can be susceptible to freeze-thaw damage, particularly in climate zones with frequent and concurrent wetting and freeze-thaw cycles. Freeze-thaw distress is typically associated with critically saturated, absorptive materials such as concrete and masonry. However, damage can also occur in non-porous systems during freeze-thaw cycling when water becomes trapped internally, resulting in volumetric expansion that can exert significant pressure on surrounding components.

An example of this situation was encountered during a condition assessment of a geodesic dome structure. The dome's exterior structural framework consisted of a hexagonal array of exposed tubular aluminum struts welded to end plates, which were bolted to node assemblies through folded aluminum panels forming the cladding. Several struts had developed full-thickness longitudinal fractures, raising questions about the cause of the failure and the structural integrity of the affected struts. The fractures were isolated to the bottom ends of the struts and at the lower elevations of the dome, where the struts sloped more steeply.

The original design incorporated sealant at cladding panel joints and gaskets below the strut end plates to mitigate water infiltration. Each strut also included a large fabrication hole centered in the upper end plate (beneath the open end of the hexagonal strut) and a drainage hole on the underside of the lower end.

To address recurring water leakage, a previous repair campaign replaced the sealant protecting the exposed exterior joints—an effort that was not overly successful. The remedial sealant application was found to be poorly executed, with systemic deficiencies including improper profiles and tooling, cohesive and adhesive bond failures, and areas where new sealant was thinly applied directly over the original failed sealant. Additionally, many of the dedicated drainage holes at the base of the struts had been covered with sealant.

Noting that several of the damaged struts exhibited water staining at the bottom tips of the fractures, exploratory holes were drilled into the base of several affected struts. Each released a significant volume of trapped water, indicating that water had migrated into the struts through the fabrication hole at the upper end plate via breaches in the seals and original gaskets, and had accumulated at the base due to blocked drainage holes. Cyclic freezing and thawing of the confined column of water within the near-vertical struts exerted expansive pressures that fractured the struts and several of their connections to the end plates. In comparison, the near-horizontal struts located higher on the dome did not exhibit fractures, as water infiltration did not fill the circumference of those members, resulting in lower confined expansive forces. This finding alleviated previously held structural concerns regarding the long-term fatigue performance of the dome.

Remediation efforts included replacing the fractured struts, reestablishing the dedicated drainage holes, and replacing the sealant. This example highlights the importance of fully understanding failure mechanisms so that repairs intended to address one condition do not inadvertently cause another. In this case, a lack of awareness of the intended water-management approach within the original structural assembly led to blocked drainage provisions, ultimately resulting in strut fractures.

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