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ON THE COVER: Image courtesy of XRadar.
Multichannel acoustic sounding on-site for concrete
delamination evaluation.

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Featured Articles

Project Profile: Integrated Non-Destructive Survey Methods for Mapping Corrosion and Delamination in an Exposed Parking Structure.....	8
Project Profile: FRCM Structural Strengthening of the Pianello Bridge.....	16
Project Profile: Saving a Hidden Hybrid: Strengthening a 1935 Unreinforced Masonry Apartment Building.....	22
Project Profile: Beyond Thicker Concrete: How Forensic Engineering Changed the Repair Philosophy for a Repeatedly Failing Industrial Water Tank Foundation.....	30
Fatigue in the Construction Workforce: An Overlooked Risk in Concrete Repair and Structural Rehabilitation.....	36
Repairs for Deteriorated Stem Walls.....	40

Departments

President's Message	3
Executive Director's Message	5
Supporting Members.....	6
Concrete Insights.....	45
Mental Health Matters.....	48
TAC Talk.....	50
Industry News	54
Committee News	58
Chapter News	60
Chapter Calendar	64
People on the Move	65
Product Innovations.....	65
Women in ICRI.....	66
New Members.....	67
Ad Index	68

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President's Message

Opportunities to Gain New Perspectives



One of the main sources of value of ICRI to our members is the opportunity to network among people who are eager to support each other's success. As president, I've had the tremendous privilege to meet lots of ICRI members who I didn't previously know. In this role, I am also provided with a unique perspective on the relationships among committee members, event attendees, chapter leaders and industry colleagues. I am continually impressed by how much our people want to help each other, often at great personal sacrifice.

Early in my career, I learned the value of mentorship. We've all heard the truism: "Give a person a fish and they will eat for a day; teach a person to fish and they will eat for life." It is extremely rewarding to see the success of people we help and teach. In addition to satisfaction, we often get better ourselves, learning new things and gaining new perspectives from fresh minds. ICRI does this as well as any organization I've seen, and for this, I thank all of you.

The leadership of ICRI has been busy so far this year. In my previous messages, I wrote about our planning retreat and international initiatives. Since that time, the executive director, staff, Executive Committee and Board of Directors have been working to carry forward these initiatives. We are refining the roles of the Administrative Committee, shoring the financial health of the organization, expanding the reach of ICRI and enhancing its value to its members. We hope that you can already see the fruits of this labor and look forward to the coming months and years as these initiatives take effect. Please feel free to reach out to me with any feedback, concerns or ideas.

As we reach the end of summer, our thoughts turn to the ICRI Fall Convention. We are excited about the upcoming event in Phoenix at the Gila River Resort & Casino Wild Horse Pass. There will be lots of people to meet and things to learn, and of course lots of fun. I look forward to seeing you there!

David Karins
2026 ICRI President

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Executive Director's Message



ICRI's Exciting Changes

With our twins, Ellie and Eamon, hitting stride in their mid-20s, my wife, Rebecca, and I decided to make some life changes, which included selling our much-loved home of 23 years. Change is hard, but it's necessary if you want to gain new perspective and experiences. The time was right, and the entire family agreed that letting go and moving forward was what we all needed.

This personal experience of change parallels a lot of what's been happening at ICRI. As David Karins notes in his President's Message, ICRI's leadership has been focused lately on change that leverages ICRI's amazing past, while charting some important new directions.

We've mentioned it before — ICRI is charging down the Road to 40, its 40th anniversary year, which happens in 2028. If we just plod along, we're not truly embracing new opportunities that benefit our members and this industry. In addition to the behind-the-scenes evolution of ICRI's operations and becoming a stand-alone organization, we're working hard to implement some new strategic initiatives to better advance the needs of this great industry.

Here's a quick snapshot.

President-Elect Dan Wald is leading a new task force exploring the build and launch of ICRI's first national demo and training expo, designed to showcase products and equipment and provide hands-on applicator training based on ICRI's consensus guidelines.

Secretary Kenny Hopfensperger is leading an effort to update ICRI's policy manual to ensure that ICRI's governance structure reflects our present and future direction as an organization. Aamer Syed, ICRI vice president, and Committee Chair Ed Kluckowski have taken the lead on reinventing ICRI's marketing committee, with a focus on new product impact to ensure that ICRI's technical and training innovations meet the needs of our market and the strategic direction of the organization.

ICRI staff are assessing new revenue-generating services that tap unmet member needs and build a stronger financial foundation for the organization. In particular, we hope to launch ICRI's first-ever repair "career center," giving employers and prospective candidates a one-stop shop to fill openings in the repair industry.

Everything we do, we do with the goal of advancing our members' success, careers and professional opportunities. We hope these changes deepen and broaden ICRI's positive impact on the Road to 40.

We hope to see you at an upcoming ICRI convention or future training event. For now, thank you for your membership and commitment to ICRI!

Eric Hawth

ICRI Executive Director

Supporting Members

ICRI would like to thank its Supporting Members, whose dedication to ICRI is greatly appreciated, and your continued support greatly enhances programs both within ICRI and the concrete repair industry as a whole.

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INTEGRATED NON-DESTRUCTIVE SURVEY METHODS FOR MAPPING CORROSION AND DELAMINATION IN AN EXPOSED PARKING STRUCTURE

BY MICHAEL NEALE

Overview/Background of Project

Parking structures are particularly vulnerable to deterioration caused by moisture ingress, chloride contamination and repeated freeze-thaw cycles. These mechanisms can initiate corrosion of reinforcing steel, leading to cracking, spalling and delamination of the concrete surface. When such deterioration becomes visible, determining its full extent can be difficult, particularly when the affected area spans several thousand square meters (Figure 1).

A multilevel parkade in Kelowna, British Columbia, began exhibiting widespread signs of distress across the suspended slab of its main parking level. Visual observations included cracking, localized spalling and areas suspected of delamination. Historical information indicated that the slab had originally been constructed without a waterproofing membrane. As a result, the structure was exposed to years of water infiltration and chloride contamination, likely introduced by vehicles carrying deicing salts during winter months. The exposed nature of the slab also subjected it to seasonal freeze-thaw cycles.

A parking deck coating was applied in recent years; however, concerns remained that deterioration had already developed before the protective system was installed. Because the extent of reinforcement corrosion and concrete delamination was unknown, a non-destructive investigation was



Figure 1: Suspected area of delamination.

commissioned to characterize the condition of the slab and produce spatial mapping of deterioration.

The investigation focused on two objectives:

- Identify potential corrosion and deterioration of reinforcing steel within the suspended slab.
- Detect and map areas of concrete or surface coating delamination.

To achieve this, investigators implemented a two-part survey approach combining ground-penetrating radar (GPR) with an objective acoustic sounding system (Figure 2).

In addition to identifying deterioration, the investigation aimed to generate spatial datasets that could support long-term asset management. By documenting the distribution and severity of deterioration indicators across the structure, the results could be used to guide targeted intrusive verification, prioritize repair work and establish a baseline condition for future monitoring.

Existing Conditions

The surveyed parking level consisted of approximately 4,645 m² (50,000 ft²) of exposed suspended concrete slab used for vehicle parking. At the time of the investigation, the surface was generally clean and dry, with isolated puddles present.

Visual inspection revealed scattered deterioration including cracking, minor spalling and locations suspected of delamination. These conditions suggest that corrosion activity may be occurring beneath the surface.

The field investigation was conducted over approximately 3.5 days using a three-person team. Two technicians operated separate ground-penetrating radar systems simultaneously, each collecting data in a different orientation across the survey grid, while a third technician operated the acoustic delamination survey device. Running two radar systems in parallel significantly improved survey efficiency while still maintaining the strict grid spacing required for reliable corrosion interpretation.

Given the large area and the need to maintain access for building occupants,



Figure 2: Ground-penetrating radar (GPR) and objective acoustic sounding system.

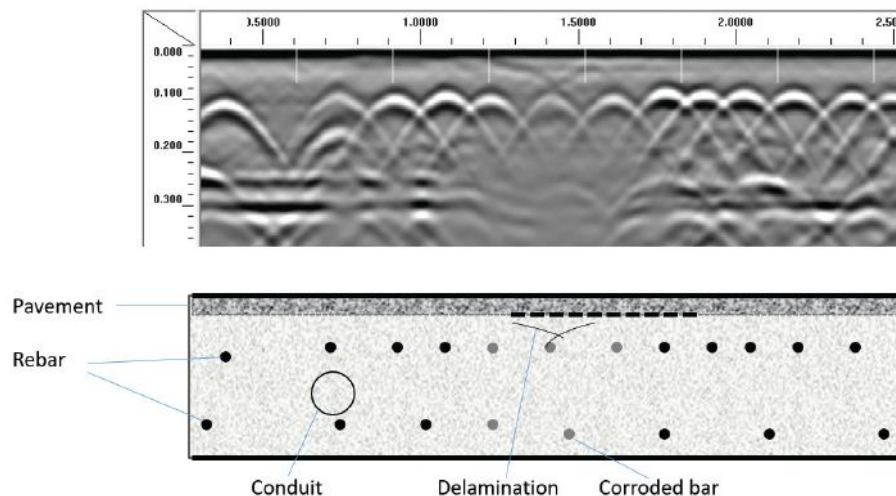


Figure 3: Example of a corrosion anomaly — courtesy of Radex Inc.

the investigation required methods capable of surveying extensive surfaces efficiently while maintaining consistent spatial resolution.

The grid-based survey methodology was selected to ensure full coverage of the parking surface. Profiles were collected at fixed intervals to prevent gaps in the data, a common limitation of traditional sounding methods performed without defined grid spacing. This approach also allowed the resulting datasets to

be spatially referenced and integrated with site drawings and 3D models.

Application/Work Completed

Ground-Penetrating Radar Survey

GPR was used to evaluate the condition of reinforcing steel within the slab. GPR operates by transmitting electromagnetic pulses into the concrete and recording reflections from subsurface features such as reinforcing bars or voids (Figure 3). The investigation used a 1.6 GHz



Figure 4: On-site GPR survey.

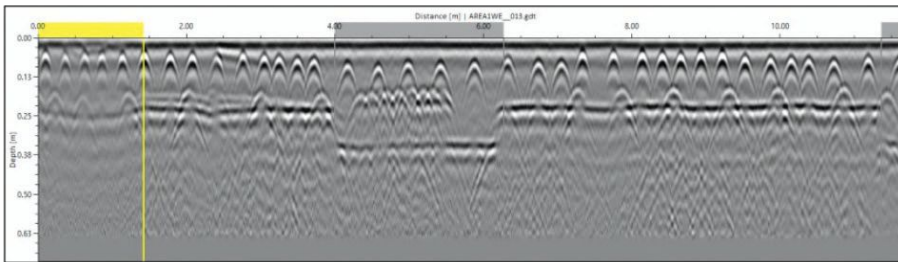


Figure 5: On-site GPR survey.

antenna system, which provides a balance between depth penetration and resolution suitable for reinforced concrete investigations. High-frequency antennas offer improved resolution for identifying reinforcing steel reflections, while slightly lower frequencies can improve penetration in thicker structural regions (ACI 228.2R-13, ASTM D6432).^{1,2}

Depth penetration for antennas in this frequency range is typically 250-500 mm (10-20 in.), depending on the electrical properties of the concrete.¹

Radar wave propagation is influenced by both antenna frequency and the electrical conductivity of the material being scanned. The conductivity of concrete varies based on moisture content, chloride contamination and age. Structures exposed to salts or

environmental contaminants may exhibit higher conductivity, which reduces radar signal penetration, a condition resulting in the amplitude attenuation used to identify corroded areas.

Reinforcing steel strongly reflects radar energy because of its high electrical conductivity. This allows reinforcement to be detected reliably; however, closely spaced steel may also limit signal penetration beyond the first reinforcement layer.

To obtain detailed spatial coverage, radar profiles were collected at 0.25 m (10 in.) intervals across the survey areas. Because GPR analysis of reinforcement is most effective when the reinforcement runs perpendicular to the direction of profile collection, the entire slab was surveyed in two orthogonal directions.

Profiles were collected both north-south and east-west so that reinforcement in both orientations could be analyzed independently.

This dual-orientation approach reduces the likelihood that isolated corrosion affecting individual reinforcing bars will be overlooked and provides additional confidence in interpreting corrosion patterns (Figure 4).

Radar Calibration and Corrosion Interpretation

Before data collection, the radar system was calibrated to account for the electrical properties of the concrete. Radar depth calculations depend on the relative dielectric permittivity (RDP) of the material, which influences wave velocity.

Calibration is typically performed using a known depth reference such as an exposed reinforcing bar or slab edge. The dielectric value is adjusted until the radar-derived depth matches the known measurement.

When direct calibration points are not available, hyperbola matching may be used. Reinforcing bars appear as hyperbolic reflections in radar profiles, and adjusting the assumed radar velocity until the modeled hyperbola matches the observed reflection allows estimation of the dielectric constant.

Corrosion assessment using GPR relies on identifying signal attenuation caused by the release of corrosion products into the surrounding concrete from the corroding reinforcement.

The amplitude of the reinforcement hyperbola typically decreases. The reduced amplitude of reflections can occur as the difference in dielectric properties between the reinforcement and the concrete becomes lower contrast (Figure 5).

Also, corrosion of reinforcement causes a change of the dielectric properties of the surrounding concrete. Increased dielectric properties in deteriorated regions slow the radar velocity, causing the apparent bottom of the slab to appear deeper in radar profiles. This visual “sagging” effect reflects signal velocity changes rather than actual structural deformation.³

This signal attenuation and velocity change can be mapped spatially across the survey area.

It is important to understand that amplitude variations and signal attenuation may also be influenced by moisture, surface coatings or localized repairs. Therefore, corrosion interpretation requires evaluation of multiple radar characteristics and professional interpretation, and raw amplitude values cannot be relied upon solely, a critical step.³

Some delamination can be detected by GPR also; however, it depends on the angle and width of the cracking and debonding. Therefore, GPR cannot be relied on to find all delamination. The delamination itself has minimal effect on the signal attenuation due to the air gap being very thin in nature.

As a result, the use of acoustic sounding in addition to GPR is necessary.

Acoustic Delamination Survey

Concrete delamination was evaluated with a multichannel objective acoustic sounding system that expands upon the traditional chain drag method (Figure 6).

Conventional chain drag testing relies on an operator listening for changes in sound produced when a chain is dragged across the concrete surface.⁴ Delaminated areas often produce a hollow sound due to separation within the concrete. However, the method is subjective and typically performed without strict spatial control.

The system used in this investigation employs multiple channels containing brass spheres that drag across the surface while integrated microphones record the resulting acoustic response. As the brass spheres excite the concrete surface, the microphones measure the frequency characteristics of the vibrations, aligning this objective approach with the principles of an electro-mechanical device.⁴

Delaminated concrete produces frequency responses distinct from solid concrete due to the reduced stiffness and density associated with separation layers. These signals are processed and interpreted using dedicated analysis software.

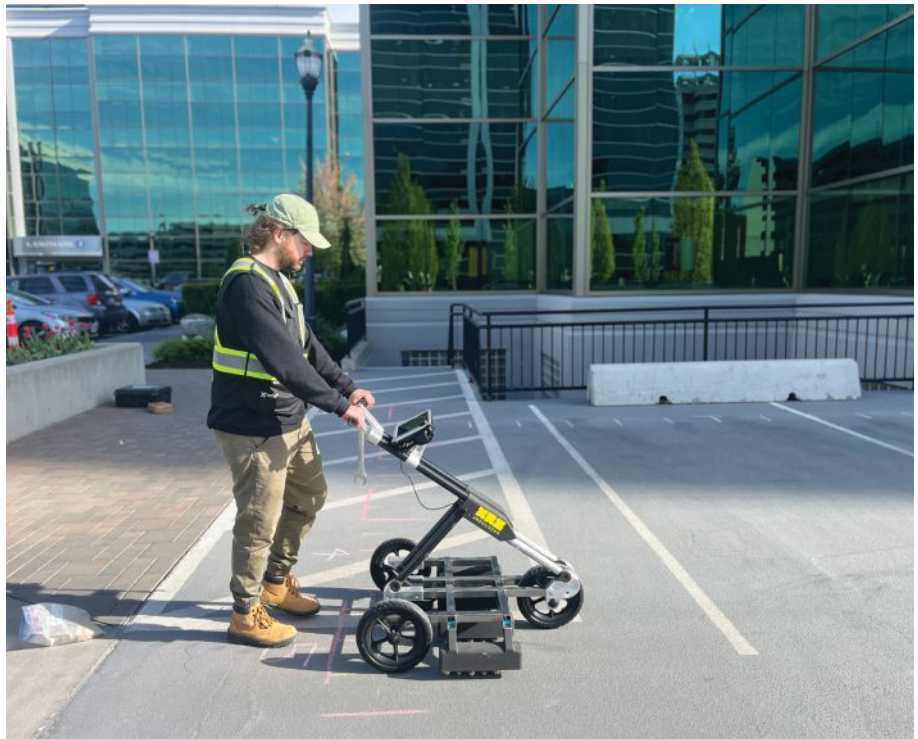


Figure 6: Multichannel acoustic sounding on-site for concrete delamination evaluation.

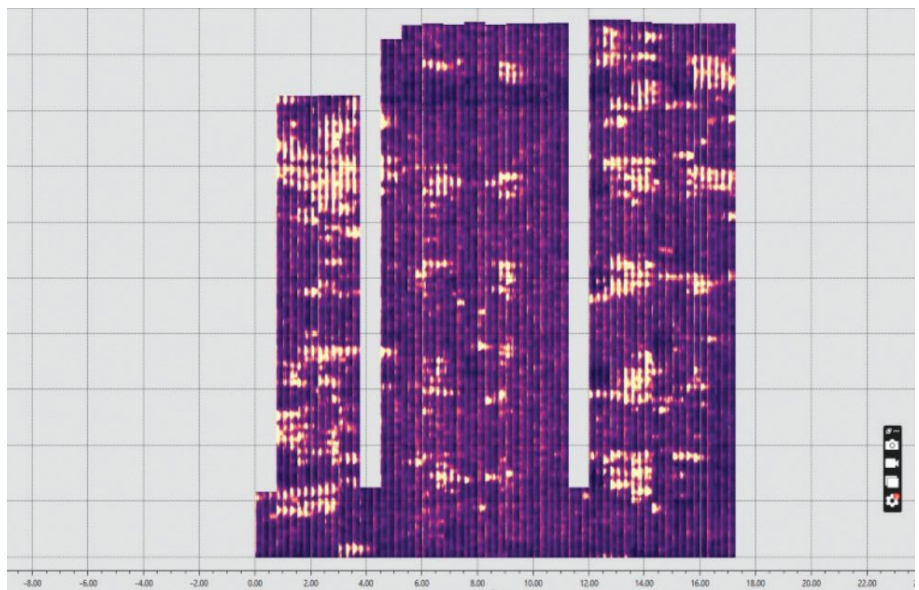


Figure 7: Example of acoustic sounding data.

The device used in this survey included four parallel channels spaced at 0.25 m (10 in.) intervals, producing a survey swath of approximately 1 m (3.3 ft) per profile. Profiles were collected along a defined grid across the structure to ensure consistent spatial coverage.

This approach reduces subjectivity while ensuring systematic coverage of the survey area.

Data Processing and Spatial Integration

Both survey methods produced large volumes of spatially referenced data. To interpret the results across the entire structure, specialized analysis software was used to combine individual survey profiles into a unified map, validating the utility of integrated NDT methodologies for mapping concrete deterioration.



Figure 8: Laser scanning.

For the GPR survey, analysts reviewed radar profiles and identified intervals where reinforcement reflections exhibited characteristics associated with potential corrosion. These intervals were digitized and compiled into a heat-map-style representation illustrating the distribution of corrosion indicators.

The multichannel acoustic sounding data was analyzed to identify frequency patterns associated with delaminated concrete. These areas were converted into polygonal regions representing suspected delamination (Figure 7).

To ensure accurate spatial positioning, a 3D laser scan of the site was also performed. The scan generated a scaled point cloud and mesh model representing existing conditions. Photographic imagery captured during scanning recorded the survey grid lines and surface features, allowing results to be accurately positioned within the model (Figure 8).

The data processing and interpretation phase required approximately one week of analysis. Once finalized, corrosion maps from both radar orientations were overlaid with the delamination results and referenced to the 3D model and site drawings.



Figure 9: On-site GPR corrosion results.



Figure 10: On-site sounding delamination results.



Figure 11: Combined results of GPR and sounding results.

By aligning the radar data, multichannel acoustic sounding data and laser scan model, investigators produced a comprehensive spatial map of deterioration. The corrosion maps derived from the two orthogonal radar surveys were overlaid with the delamination results, enabling direct comparison between subsurface reinforcement conditions and surface distress.

Challenges and Safety Considerations

Conducting large-scale non-destructive surveys within active parking structures requires careful coordination. Access to survey areas must be managed to minimize disruption while maintaining systematic data collection.

Ensuring consistent spatial coverage across large areas is also critical. The grid-based survey approach addressed this challenge by enforcing fixed spacing between profiles.

Environmental conditions can influence survey results. Moisture, contamination and standing water may affect radar signal propagation and acoustic response. For this reason, the surveys were conducted during conditions when the slab surface was largely dry.

Results

The integrated investigation identified areas exhibiting indicators of both reinforcement corrosion and concrete delamination.

The most concentrated deterioration zones were located near the western entrance of the parkade and in portions of the northern parking area. Corrosion patterns identified in the two orthogonal radar surveys correlated well in several locations, suggesting deterioration affecting reinforcement in multiple orientations (Figure 9).

Delamination was detected across multiple areas of the slab and was generally more extensive than the areas identified as containing corrosion indicators. This outcome is common because delamination may propagate beyond the immediate location of corroding reinforcement. In addition, acoustic sounding methods are sensitive to separation within surface coatings or shallow concrete layers (Figure 10).

Despite these differences, many of the largest delaminated areas corresponded closely with regions showing strong corrosion indicators in the radar data (Figure 11).

Summary/Conclusion

The investigation demonstrated how combining complementary non-destructive methods can provide a detailed understanding of deterioration across large reinforced concrete structures.

Grid-based GPR surveys allowed investigators to evaluate the condition of reinforcing steel across the slab while maintaining high spatial resolution. At the same time, multichannel acoustic sounding provided objective detection of surface and near-surface delamination.

Integrating these datasets within a spatially referenced model of the structure enabled visualization of the relationship between reinforcement corrosion indicators and concrete delamination across the parking level.

This approach offers several advantages for owners and engineers responsible for maintaining aging parking structures:

- Large areas can be surveyed efficiently with systematic coverage.
- Multiple deterioration mechanisms can be evaluated simultaneously.

- Results provide quantifiable maps supporting repair planning and budgeting.
- Because the methods are non-destructive, surveys can be repeated to monitor changes over time.

As reinforced concrete parking structures continue to age, integrated non-destructive investigation methods can support proactive maintenance strategies and help extend the service life of critical infrastructure.

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AUTHOR



Michael Neale is a technical specialist and NDT analyst with Xradar who specializes in non-destructive testing and subsurface investigation of concrete structures. His work focuses on integrating multiple survey technologies, including ground-penetrating radar (GPR), acoustic sounding (Xradar's XRSounder), ultrasonic methods and laser scanning, to map deterioration in reinforced concrete infrastructure. He has contributed to numerous investigations of parking structures, bridges and building slabs throughout North America. Over the years, Neale has built up his knowledge working with Xradar and been integral in passing this onto others through Xradar Academy.

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FRCM STRUCTURAL STRENGTHENING OF THE PIANELLO BRIDGE



BY ALESSANDRO SCIERI

Bridges and civil infrastructure require periodic intervention to preserve serviceability, control deterioration and preserve appropriate safety levels. The rehabilitation of Ponte Pianello in Muro Lucano (Italy) is a representative case of structural strengthening applied to an early reinforced concrete arch bridge with significant historical, engineering and landscape value. The project combined condition assessment, corrosion mitigation, concrete repair and FRCM (fabric-reinforced cementitious matrix) reinforcement to improve the durability and extend the service life of an infrastructure asset that remains essential for local mobility (Image 1).

Historical Significance and Construction

Constructed between 1916 and 1918, Ponte Pianello is recognized as the first reinforced concrete bridge built in Europe (Image 2). The structure connects the Borgo Pianello area with the Capodigiano area, approximately 1.9 miles (3 km) from the urban center, and crosses a deep valley that has made the bridge a recognizable feature of the local landscape. Its construction took place when reinforced concrete was still an innovative material, giving the bridge architectural and heritage value beyond its transportation function. Due to its age, structural configuration and visibility, the project required a rehabilitation strategy

Image 1: Over the years, the bridge has shown significant deterioration of the reinforced concrete, particularly in the support areas; it therefore became necessary to take action to reinforce and secure the structure.



Image 2: The Pianello Bridge on a vintage postcard. Built between 1916 and 1918, it is one of the first reinforced concrete structures built in Southern Italy.



Image 3: The restoration of the Pianello Bridge in Italy using FRCM has secured one of the earliest reinforced concrete structures in Europe.

capable of improving performance while preserving the original structural and aesthetic characteristics.

The bridge is a reinforced concrete parabolic arch structure with an overall length of approximately 253 ft (77 m) and a deck width greater than 16.5 ft (5 m). The central span is approximately 131 ft (40 m), and the elevation from the valley floor is about 344 ft (105 m). The deck extends along the full length of the bridge with a continuous-beam structure supported by 21 columns, spaced on average 12.8 ft (4 m) apart. The primary load-bearing system consists of four parallel parabolic arches, with a span

of 125 ft (38 m) and a rise of 36.7 ft (11 m), connected transversely. Resting on these arches are the columns, directly anchored to the rock, which support the upper structure.

Deterioration

After more than a century, the bridge showed widespread deterioration typical of an exposed reinforced concrete structure (Image 3).

The most evident forms of deterioration included deep cracking and loss of concrete cover, corrosion of reinforcing steel, localized degradation near bearings and reduced material integrity in portions

of the arch and deck. These conditions were consistent with moisture exposure and carbonation. The assessment indicated that the intervention needed to address both the underlying causes and the visible effects of deterioration.

Evaluation and Strengthening Considerations

Before selecting the strengthening approach, the project team carried out a diagnostic and structural assessment program that included concrete core sampling, reinforcement location surveys, carbonation investigations and structural modeling.

The combination of field testing and analytical evaluation supported the identification of critical zones, the definition of repair priorities and the design of strengthening systems compatible with the existing concrete substrate. This approach was particularly important because the bridge geometry and access conditions required careful planning.

The adopted strengthening strategy used a fiber-reinforced cementitious matrix (FRCM) system with PBO fiber (poly-paraphenylenebenzo-bisoxazole) (Image 4).

This technology was selected because it provides high tensile capacity with limited added weight and good compatibility with historic concrete elements. Unlike epoxy-based composite systems, FRCM systems provide vapor permeability and compatibility with the substrate, which are important where moisture, durability and conservation requirements must be considered. The use of an inorganic matrix also supports application in situations where organic resins may be more sensitive to temperature, substrate moisture or long-term environmental exposure. For this project, the FRCM was designed and installed per European and Italian guidelines.^{1,2,3}

Strengthening systems that were not thin and lightweight were excluded from the beginning, both to preserve the bridge's appearance and because it was not possible to install adequate conventional scaffolding. The entire jobsite and all work activities were carried out using suspended scaffolding anchored directly to the bridge structure.

The FRCM system provides ductile behavior that contributes to improved



Image 4: The PBO-FRCM system, based on a bidirectional mesh combined with the inorganic matrix, installed on the bridge.



Image 5: View of the bridge's structural elements addressed by the reinforcement work using the FRCM system.

flexural and shear capacity, crack control and confinement, without substantially changing the mass or geometry of the original structure. This was particularly important in this project, where the strengthening system had to improve safety and durability while minimizing visual and structural intrusion.

Sequencing

The work sequence began with removal of deteriorated and unsound concrete to reach a stable substrate.

Exposed reinforcing steel affected by corrosion was cleaned and treated with a passivating corrosion protection treatment to reduce further oxidation. Where section loss or concrete removal had altered the original geometries, repair mortars were used to restore the original profile before installation of the FRCM. Surface preparation was critical to provide adequate bond and ensure effective stress transfer between the existing concrete and the strengthening layer.

A surface roughness between a Concrete Surface Profile (CSP) 4 and CSP 5 was required.⁴ This was achieved using:

- Medium- to large-grained repair mortars;
- High-pressure hydrodemolition/hydro-jetting; and
- Grinding pads in hard-to-reach areas.

The use of hydro-jetting also allowed the substrate to be pre-moistened.

The PBO-FRCM system was then applied to the arches, bearings and deck. Installation consisted of applying a first layer of inorganic matrix to the roughened and saturated-surface-dry substrate, placing the PBO mesh into the fresh mortar, and completing the system with a second matrix layer, applied wet-on-wet, to fully embed the mesh.

Because it is composed of a flexible mesh, the FRCM system adapted effectively to the bridge geometry without altering its overall appearance, while also allowing straightforward installation under difficult access conditions (Image 5).

Conclusion

The Pianello Bridge's rehabilitation was completed in 2025 and was funded by the Italian government, with an investment of approximately \$2 million (USD).

Approximately 53,800 sq ft (5000 m²) of FRCM was installed. The intervention also included surface protection to limit water ingress and environmental exposure, along with ancillary safety works for nearby services and infrastructure elements. The combined repair and strengthening measures were intended to extend service life, improve durability and allow the bridge to be reopened to traffic.

The completed rehabilitation allowed Ponte Pianello to be reopened to ordinary traffic in 2025. The project demonstrates

how modern FRCM systems can be integrated into the repair of historic and large-scale infrastructure (Image 6).

By combining condition assessment, targeted concrete repair, corrosion mitigation and FRCM reinforcement, the intervention improved structural reliability while preserving the bridge's architectural and engineering identity. It also illustrates the value of selecting strengthening materials and installation methods that are compatible with the existing structure, particularly when the objective is both to restore performance and preserve the authenticity of the structure.

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Image 6: The bridge is also a major scenic attraction and offers a stunning view of the mountainous landscape of Basilicata.

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SAVING A HIDDEN HYBRID: STRENGTHENING A 1935 UNREINFORCED MASONRY APARTMENT BUILDING

BY MARK GARRISON, PH.D., AND SUDARSAN VAKUL SRINIVASAN, M.S. – CIVIL/STRUCTURAL

On October 17, 1989, the Loma Prieta earthquake struck Northern California, and its toll on Santa Cruz was severe. In the city's Pacific Avenue Historic District, unreinforced masonry (URM) buildings were damaged so badly that the district was struck from the National Register of Historic Places. As a result, more than half of its old brick buildings were subsequently demolished, and another sixth were red-tagged as unsafe to enter.¹

Weeks later, as California cities moved under state law to assess their URM inventories, the City of Santa Cruz mailed a notice to the owners of a modest two-story, five-unit apartment building from 1935 (Figure 1) that it was exactly the kind of structure that, in the city's words, "historically has exhibited little resistance to earthquake motion." It was the first of two earthquake-hazard notices the building would receive — the second arriving in 2013 — and the start of a path that would, decades later, lead to an innovative repair.

The path following the second noncompliance notice led to a full structural rehabilitation of the building (Figure 2). The project included assessment, design and repair efforts with complexities beyond expectation because the original assessments proved inaccurate. A project that appeared to be a routine URM retrofit turned out to be a hidden hybrid repair when it was discovered that the building's load path threaded unpredictably through masonry, wood and concrete. This article offers a useful template for evaluating and strengthening the many aging, irregularly built masonry structures still in service today.

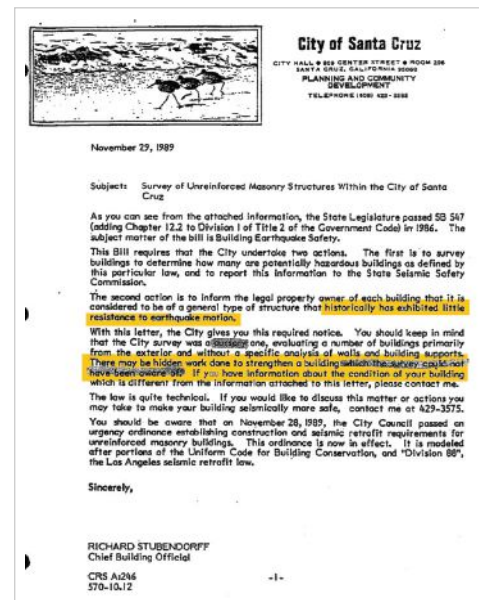


Figure 1: Notices of noncompliance.

A Tale of Two Red Tags

The 1989 notice carried an unintentionally prophetic caveat about the city's initial survey. The notice warned that hidden conditions might exist that the survey had failed to capture. The 2013 notice identified the building as a medium-risk URM structure under the city's earthquake-hazard reduction ordinance and required the owners to design and implement a seismic retrofit on a fixed schedule. In response, an independent scanning subcontractor ran electromagnetic rebar scans across the exterior walls. Reinforcement was detected in most exterior areas — horizontal bars at roughly 7 in. (178 mm) spacing, about 2 in. (50 mm) deep — but interior scans were inconclusive. This complicated everything. If the walls were reinforced, was the building URM? The scan results were sufficient to call the classification into question but not to answer it. This question drove the entire project to our firm. We performed an exploratory analysis to determine whether the building was, in fact, URM, to document its as-built and current condition, and to recommend repairs for the new owner to maximize his building valuation and rental income from this very desirable location near the Santa Cruz beach and pier.

Looking Behind the Plaster

A non-destructive scan alone could not resolve the question, so the investigation combined non-destructive and partially destructive methods: selective removal of finishes and exploratory openings alongside scanning. The exterior walls were confirmed to be hollow concrete masonry units (CMU), with mortar at the horizontal and vertical joints, but the interior cells were ungrouted and hollow.

The interior was where the building revealed its true, hybrid character. Behind the masonry envelope were wood-framed interior walls, wood roof and floor diaphragms, and a concrete foundation system — four different structural materials, each behaving differently under load. Investigators also found balloon-framed walls meeting the roof framing with negligible connections, repurposed railroad ties embedded in the structure and active termite damage. These were not academic curiosities. Negligible connections and ungrouted



Figure 2: Structure exterior — before.



Figure 3: Masonry wall cavity with smooth ties.



Figure 4: Exterior wall cavity with railroad track and ties.



Figure 5: Wall interior — mixed materials.

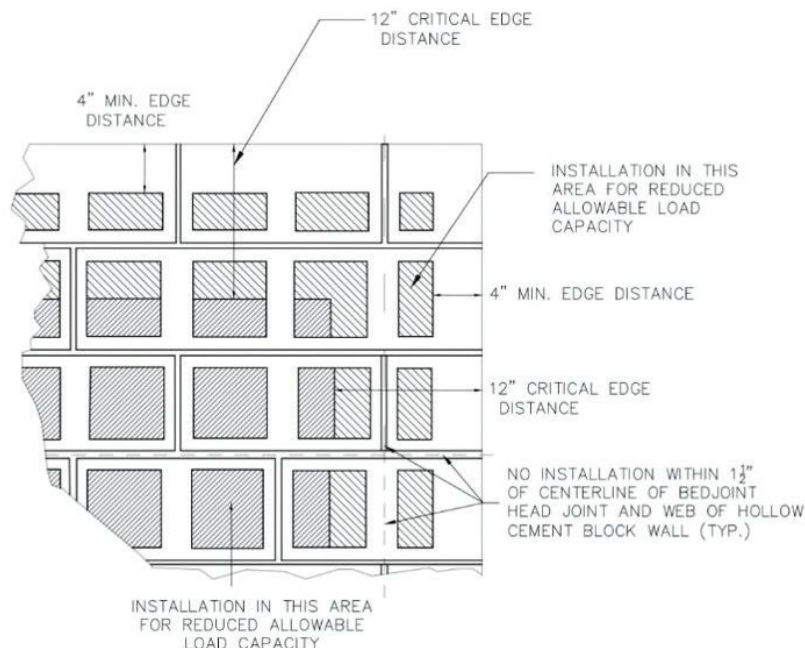


Figure 6: Critical distances for masonry wall anchors.

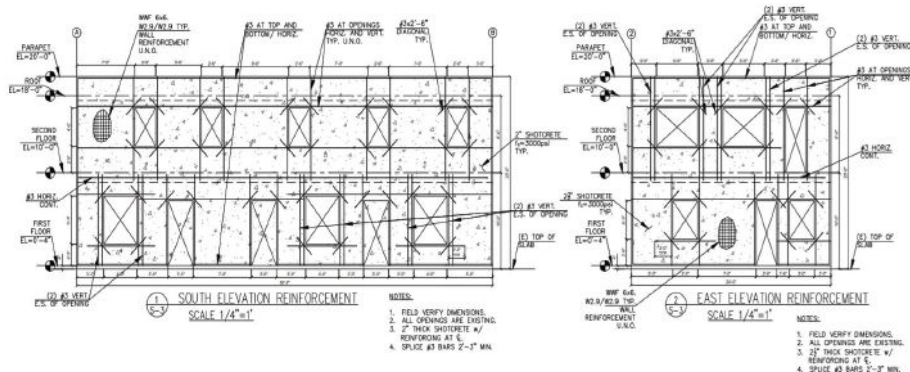


Figure 7: Shotcrete curtain reinforcement elevations.

cells resulted in discontinuous load paths; lateral force had no reliable, continuous route from the roof to the foundation. A building could stand for decades in that condition and still be dangerously deficient when the ground moves.¹

Reading the Reinforcement

The reinforcement that the earlier scan had detected turned out to be real, but not the kind that counts. Where bars were present, they were approximately 3/8 in. (No. 3) smooth horizontal bars, held in position by bar ties at irregular spacing. Critically, the masonry cells containing this reinforcement were not grouted. Reinforcement that is not encased in grout cannot bond with or transfer force to the surrounding masonry; mechanically, it is little more

than steel laid in a hollow void. This distinguished the previous scan from the current evaluation: While a scan can confirm that steel exists, only a structural assessment could (and did) determine whether that steel supported the structure (Figures 3, 4 and 5).

As a result of the in-depth evaluation, we classified the reinforcement as unreliable and insufficient and determined that the building was *URM without grout*. By the time this conclusion was reached, the governing code had advanced, and the project fell under the 2019 California Building Code² — a reminder that on long-running rehabilitation projects, the applicable code itself can change underfoot. Project teams must be apprised of these code changes as work evolves.

Establishing the Design Basis

With the structure correctly characterized, the team established a design basis in accordance with existing and relevant regulations.²⁻⁹ The site carried demanding seismic parameters: mapped spectral accelerations of approximately 1.63 (short-period) and 0.62 (one-second), with design values of roughly 1.09g and 0.71g, Site Class D, Risk Category II and the highest Seismic Design Category, D. Design wind was taken at 110 mph under Exposure C. We considered both gravity and lateral impacts; ultimately, the seismic demand governed this design.

Several strengthening strategies were on the table, each with real trade-offs given the as-built conditions:

1. **Conventional grouting and added reinforcement:** filling cells and adding bars to make the existing masonry work.
2. **Partial grouting:** a lighter-touch version of the same idea.
3. **Removing sections of wall and replacing them with columns:** converting the bearing wall to frame action.
4. **Fiber-reinforced polymer (FRP) overlays.**
5. **Fiber-reinforced cementitious matrix (FRCM) systems.**
6. **A structural shotcrete curtain:** a reinforced, sprayed-concrete (wet or dry) layer applied to the existing walls.

The single most consequential modeling decision followed directly from the field investigation. Because the existing ungrouted masonry could not be relied upon, its in-plane shear value was conservatively assumed to be zero. The proposed strengthening system could not simply supplement the walls; it must *replace* them as the primary lateral-force-resisting system. The lateral system was evaluated as an ordinary plain masonry shear wall using the special procedure for seismic strengthening of URM bearing-wall buildings,⁴ with the new structural overlay carrying the full lateral demand (Figures 6 and 7).

Not every element required intervention. The existing roof was framed with 1x straight sheathing over the ceiling joists and an over-framed sheathing layer above. Analyzed conservatively

using only the lower sheathing and neglecting the over-framing, the roof diaphragm produced a demand-capacity ratio of approximately 4.8, which fell within acceptable limits for the special procedure. On that basis, the roof diaphragm was evaluated but not strengthened — a deliberate, documented decision rather than an oversight, and an illustration of targeting reinforcement where it is genuinely needed.

Grouting an entire building of irregular, ungrouted, partially obstructed cells is slow work, difficult to verify and would potentially be unforgiving of the haphazard reinforcement already in place. However, removing and reframing would sacrifice the fabric that the owners wanted to preserve. FRP and FRCM are elegant for supplementing sound substrates, but here, there was little sound substrate to supplement. For these reasons, the structural shotcrete curtain was selected as the most effective and efficient solution for this particular building.

Structural Shotcrete Curtain Considerations

Shotcrete — concrete wet-sprayed onto a prepared surface — is well established for slope stabilization, retaining walls, tunneling, water-retaining structures and structural retrofitting (Figure 8). In this application, it was specified not as a cosmetic or supplemental coating but as the main force-resisting system, with a specified compressive strength of 2,500 psi (17.2 MPa) when applied in layers over the reinforcement.

Several attributes made the curtain the right fit for a hidden hybrid. It could be detailed to form genuine structural connections across the building's mixed masonry, wood and concrete elements, knitting a discontinuous load path back together. It required minimal temporary shoring. It was cost-effective given the as-built conditions and far less intrusive than gutting and reframing, preserving the building's footprint and character. And as a proven, durable technology, it gave the owners confidence in its performance over decades.



Figure 8: Structural shotcrete curtain construction.

Detailing the Load Path

A structural shotcrete curtain is only as good as its connection to the building it strengthens. To establish this connection, the construction sequence followed a disciplined progression: assess and plan; prepare the surface; install reinforcement and anchorage; apply shotcrete in layers; and finally, finish, cure, inspect and test throughout the process.

The heart of the design was the wall anchorage that ties the new curtain to the old masonry. Threaded rod anchors were installed into the existing CMU using an injected epoxy adhesive and a screen-tube sleeve sized for hollow masonry, which confines the adhesive within the hollow cell, allowing the anchor to develop its capacity. Detailing was exacting: Rods were hooked around the curtain reinforcement; that reinforcement was centered at the mid-depth of the shotcrete; and each anchor was positioned clear of the centerlines of the bed joints, head joints and CMU webs to seat in sound material rather than a mortar line or void. Anchors



Figure 9: Curtain reinforcement template and installation.

Random Anchors
Torque Testing



Calibrated Torque Wrench



Torque Test on Wall Anchors



Figure 10: Wall anchor torque test.



Figure 11: Wall anchor tension test.



Figure 12: Structure exterior — after.

were placed at roughly 12 in. (305 mm) on center at the roof and second-floor levels — where diaphragm forces concentrate — and at about 24 in. (609 mm) on center between levels (Figure 9). Because the connection, not the panel, is where retrofits typically fail, the detailing earned the scrutiny it received.

Trust, but Verify: Anchor Testing

Detailing on paper is a hypothesis; field testing is the proof. The anchorage program required special inspection of each anchor prior to adhesive placement, followed by a two-part verification regimen. Five percent of the embedded wall anchors were subjected to a direct tension test, holding 1,500 lb. for five minutes. An additional 20 percent were checked with a calibrated torque wrench, with 3/8-in. bolts torqued to 30 ft-lb. Each test report documented the maximum load; a pass/fail result; the anchor size, type and orientation; installation details; the testing apparatus and embedment; wall thickness; and the proximity of nearby joists (Figure 10).

The verification earned its keep. During testing, some anchors failed (Figure 11). Rather than rationalize the results, the team treated the failures as data: The failed anchors were removed and replaced, then retested — and passed. It is an unglamorous episode, and precisely the kind that belongs in a case study. A testing program that never catches a failure is not necessarily proof of perfect work; sometimes it is proof of

an insufficiently demanding test. Here, the protocol did exactly what it was designed to do.

Lessons for Hybrid URM Buildings

The completed structural shotcrete curtain gave the 1935 building a continuous, reinforced lateral system where it previously had none, extending its service life well beyond baseline code compliance while keeping the original structure standing (Figure 12). For a building twice cited as an earthquake hazard, this is a meaningful outcome.

The broader lessons extend well beyond a single structure. First, classification is an engineering judgment, not a scan readout: Detecting steel is not the same as confirming reliable reinforcement, and the difference can decide whether a building is treated as reinforced or unreinforced. Second, aging buildings are frequently hybrids, and their hazards live in the problematic connections — the discontinuous, negligible or absent links between dissimilar materials — more than in any single element. Third, a strengthening system that doubles as the primary lateral-force-resisting element must be anchored and sequenced with the load path explicitly in mind, and that load path must be verified in the field rather than assumed. Approached that way, even a hidden hybrid can be honestly assessed, durably strengthened and economically saved.

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AUTHORS



Mark Garrison, Ph.D., M Eng. Const., ASCE, ICRI and NCSEA, is the founder and principal of MG Constructors & Engineers (MGC&E), a Bay Area construction engineering firm established in 2001 that specializes in structural evaluation, repair design, and complex foundation and drainage challenges. Garrison has worked in the heavy civil and structural industry for over 50 years, and in more than two decades, his firm has completed thousands of projects involving commercial, industrial and residential structures, and has developed a reputation for diagnosing difficult structural performance problems in the region's expansive clay soils and aging building stock. He completed his Ph.D. through the Plaster School of Business and Technology from the University of the Cumberland in May 2026. His dissertation study examined the use of parametric and analogous modeling methods to interpret structural measurement data and to support cost valuation and engineering decision-making in complex field environments.



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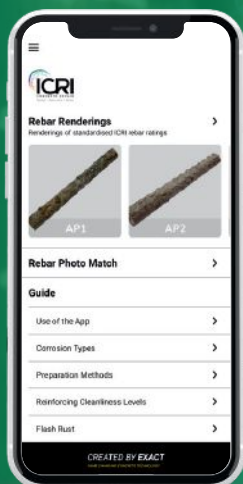


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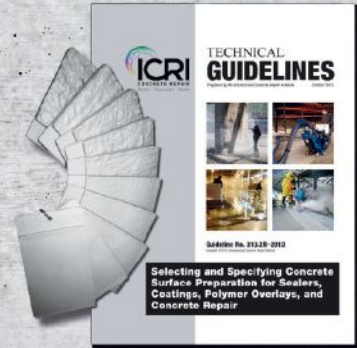
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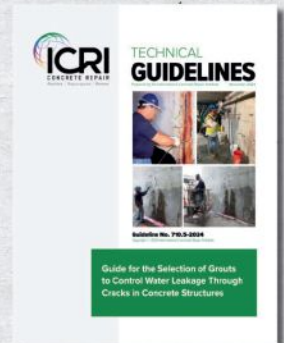


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BEYOND THICKER CONCRETE:

HOW FORENSIC ENGINEERING CHANGED THE REPAIR PHILOSOPHY FOR A REPEATEDLY FAILING INDUSTRIAL WATER TANK FOUNDATION



BY ENGR. SURV. DR. JUSTINE ADUA AVOGO

Project at a Glance

The first repair failed not because it lacked concrete, but because it failed to change how the foundation behaved.

The project involved the rehabilitation of an industrial steel water tank foundation in Ghana that had experienced persistent leakage, circumferential cracking, differential settlement and the premature failure of a previous repair. A comprehensive investigation was undertaken, including visual assessment, crack mapping, cover-meter survey, rebound hammer testing, ultrasonic pulse velocity (UPV) testing, carbonation testing and concrete core sampling to evaluate the condition of the structure. The investigation identified the primary causes of distress as weak substrate concrete, differential settlement,



inadequate boundary restraint and loss of composite action. Based on these findings, a mechanism-based repair engineering approach was adopted to address the underlying deterioration mechanisms rather than merely treating the visible defects. The effectiveness of the rehabilitation was confirmed through successful hydrostatic testing at the full operating water level, which demonstrated no leakage, crack reactivation or measurable structural movement.

When More Concrete Wasn't the Answer

The initial repair consisted of a new 300 mm (11.8 in.) reinforced concrete topping slab placed over the existing foundation, creating what looked like a stronger and more robust structural system. At first glance, the repair appeared sound; instead, the repair failed within a short period after the tank was returned to service.

As the tank was refilled, familiar distress reappeared. Leakage developed again at the wall-floor junction, circumferential cracks reopened around the perimeter, debonding occurred between the new topping slab and the original foundation, and localized settlement became visible. This repair had reproduced almost the same failure pattern as the original structure.

The failure raised an important engineering question. If adding a substantial reinforced concrete topping slab could not solve the problem, what was actually causing the structure to fail?

That question fundamentally changed the direction of the project. Rather than designing another repair based solely on the visible defects, the engineering team suspended further construction activities and began a comprehensive forensic investigation. The objective was not simply to document cracks and leakage but to understand how the foundation behaved under service conditions and why the previous intervention had been unsuccessful.

This change in thinking marked the beginning of a different repair philosophy. Instead of treating deterioration as the problem, the investigation focused on identifying the structural mechanisms responsible for producing that deterioration. Only after

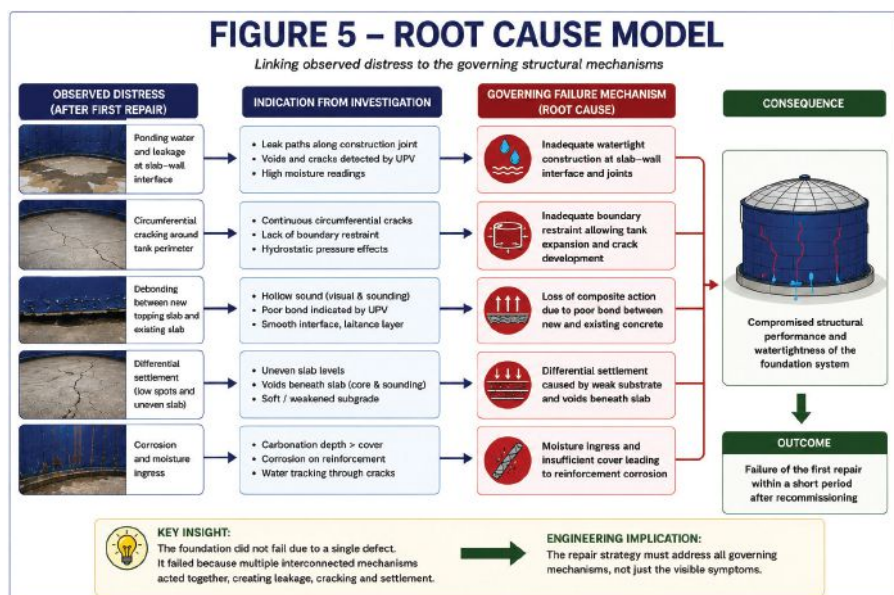
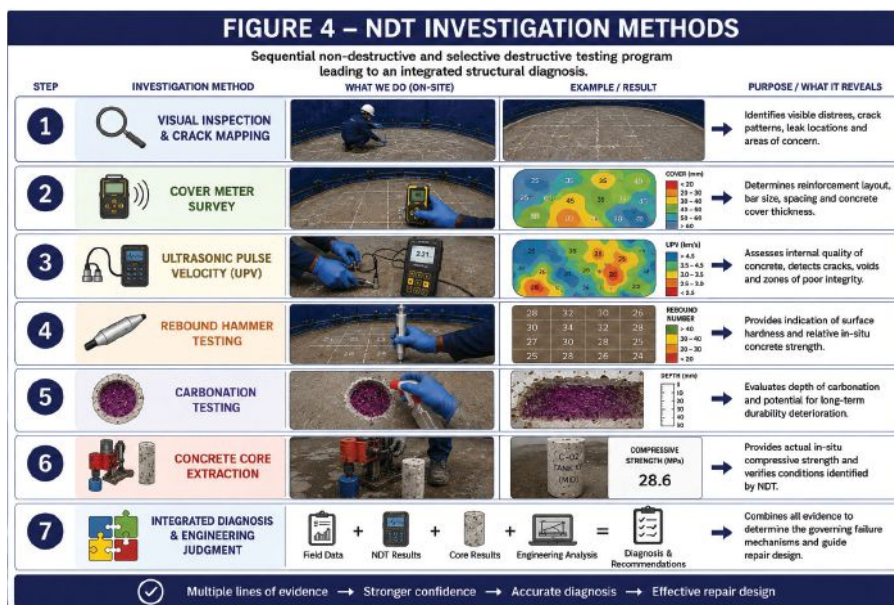
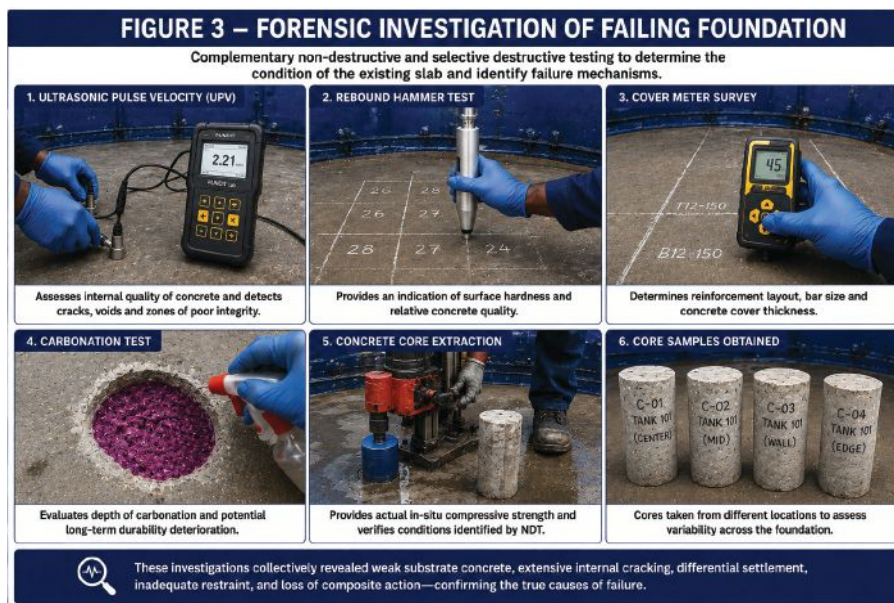
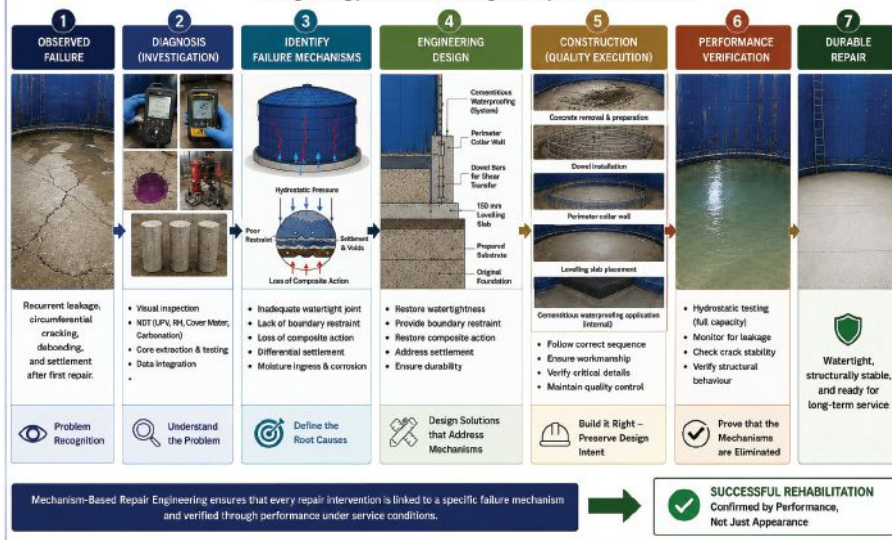


FIGURE 6 – MECHANISM-BASED REPAIR STRATEGY

An engineering process that links diagnosis to performance verification



those mechanisms were fully understood would a new rehabilitation strategy be developed.

Figure 1 introduces the industrial steel storage tank and its reinforced concrete foundation before rehabilitation, while Figure 2 illustrates the distress observed after the first repair, including leakage, circumferential cracking, debonding and differential settlement. Together, these figures show that increasing slab thickness alone did not change the behavior of the foundation.

The visible defects were only the final expression of deeper structural problems. Determining why the repair had failed required moving beyond surface observations and building a diagnosis from multiple complementary investigation methods. The next phase of the project therefore focused on gathering evidence that could explain the foundation's structural behavior rather than simply describing its condition. The engineering team adopted a forensic approach to understand how the structure behaved under service conditions.

Looking Beneath the Surface

The investigation combined complementary assessment techniques. Visual inspection and crack mapping established the distribution and pattern of distress throughout the foundation. Cover-meter surveys confirmed reinforcement layout and concrete cover, while rebound hammer testing provided an initial indication of surface hardness. Ultrasonic pulse velocity (UPV) testing was then used to assess internal concrete integrity and determine the extent of hidden cracking. Carbonation testing evaluated whether durability-related deterioration had contributed to the failures, and carefully selected concrete cores provided reliable in-situ compressive strength data.

No single test provided the answer. Instead, each investigation contributed one piece of the structural puzzle. As the evidence accumulated, a consistent pattern emerged. The original concrete exhibited areas of reduced strength, internal cracking extended well below the surface and the topping slab installed in the first repair had lost composite action with the existing foundation. Site observations

FIGURE 7 – CONSTRUCTION SEQUENCE (REPAIR WORKS)

Step-by-step execution of the mechanism-based repair strategy



FIGURE 8 – INSTALLATION OF STEEL DOWELS AND CONSTRUCTION OF THE REINFORCED PERIMETER COLLAR WALL

External reinforced concrete collar wall to restore boundary restraint and prevent water ingress at the base



also confirmed differential settlement beneath parts of the structure, while the perimeter ring wall lacked sufficient restraint to resist hydrostatic loading effectively.

Equally important was what the investigation did not reveal. Carbonation testing indicated that deterioration associated with reinforcement corrosion, although a contributing factor, was not the governing cause of failure. The principal problem was structural behavior as a whole rather than simply material degradation.

Figures 3 and 4 illustrate the investigation process and the complementary testing methods used on-site. Figure 5 summarizes the findings by linking every observed defect to its governing structural mechanism. Rather than treating cracks, leakage and debonding as isolated problems, the investigation showed that they were all symptoms of four interacting mechanisms: weak substrate concrete, differential settlement, inadequate boundary restraint and loss of composite action.

This diagnosis transformed the project. The engineering team no longer viewed the foundation as damaged concrete requiring replacement. Instead, it was recognized as a structural system whose behavior had to be restored. That understanding became the basis for every repair decision that followed and marked the transition from conventional repair practice to mechanism-based repair engineering.

Once the governing failure mechanisms had been identified, the rehabilitation strategy became much clearer. Rather than selecting repair materials first, every intervention was designed to eliminate a verified cause of failure. The next section explains how each repair element was deliberately matched to a specific structural mechanism.

Repairing the Mechanism, Not the Symptoms

Once the investigation established why the foundation had failed, the rehabilitation strategy changed completely. Instead of asking which repair material should be used, the engineering team asked a more important question: Which verified

failure mechanism will this intervention eliminate?

Every repair component addressed one of the four governing mechanisms identified during the forensic investigation. The 300 mm (12 in.) topping slab and portions of unsound concrete in the original slab were removed using hand-operated breakers until a competent substrate was exposed, ensuring that new construction would not rely on weakened material. Surface preparation by mechanical grinder to a Concrete Surface Profile (CSP) of 5 was then carried out to create a sound bonding interface capable of transferring forces between the existing and new concrete leveling slab.¹

Steel dowels were installed into the external face of the existing reinforced concrete ring wall to restore structural continuity between the original foundation and the new reinforced perimeter collar wall. Reinforcement for the collar wall was then fixed to the dowels, creating an integrated structural system that improved composite action and significantly increased boundary restraint around the tank. Unlike the earlier repair, which relied primarily on increasing slab thickness, the new 1.5 m tall (59 in.) by 200 mm thick (8 in.) collar wall directly addressed the lateral forces generated during filling and emptying of the tank.

Construction sequencing also reflected the engineering philosophy. After the reinforced collar wall was constructed externally around the existing ring wall, a 150 mm (6 in.) reinforced leveling slab was placed. The internal floor and wall surfaces received a two-component cementitious waterproofing system with an embedded reinforcing mesh. A second waterproofing coat completed the lining, while the internal wall-to-floor junction was sealed with a flexible joint sealant to provide continuous watertightness. No protective screed was placed over the waterproofing, allowing the cementitious system to remain the final exposed finish.

Figures 6, 7 and 8 illustrate how every stage of the rehabilitation corresponded directly to a verified structural deficiency. The repair became more than a construction exercise; it was the physical implementation of the

forensic diagnosis. Each intervention restored load transfer, confinement, composite action or watertightness, ensuring that the repaired foundation behaved as a single structural system rather than a collection of independent components.

With construction complete, the final question remained: Had the rehabilitation genuinely eliminated the mechanisms responsible for failure? The answer would only come through full hydrostatic testing under normal operating conditions.

Proving the Repair

The success of any rehabilitation project is determined not when construction is completed but when the structure returns to service and performs as intended. For this project, the repaired foundation underwent full hydrostatic testing to verify that the governing failure mechanisms had been eliminated.

Following the specified curing period, the tank was progressively filled to its full operating level. The tank was filled until the internal ladder was completely submerged, representing the maximum service condition. The foundation was then monitored throughout filling, full-capacity storage and controlled emptying for any signs of leakage, crack reactivation or structural movement.

Unlike the previous repair, the rehabilitated foundation remained stable throughout the entire loading cycle. No leakage was observed along the wall-to-floor junction, the repaired concrete remained fully bonded and no new cracks developed. The reinforced perimeter collar wall provided the additional confinement required to resist hydrostatic forces, while the internal cementitious waterproofing system maintained a continuous watertight barrier.

Figure 9 illustrates the completed rehabilitation during hydrostatic testing. The full-capacity water level, absence of leakage and stable structural response confirmed that the repair had successfully addressed the mechanisms identified during the forensic investigation rather than simply concealing their symptoms.

This performance verification represented the final stage of the

FIGURE 9 – COMPLETED REHABILITATION DURING HYDROSTATIC TESTING

Fully restored, watertight and structurally reinforced tank base system under full water head

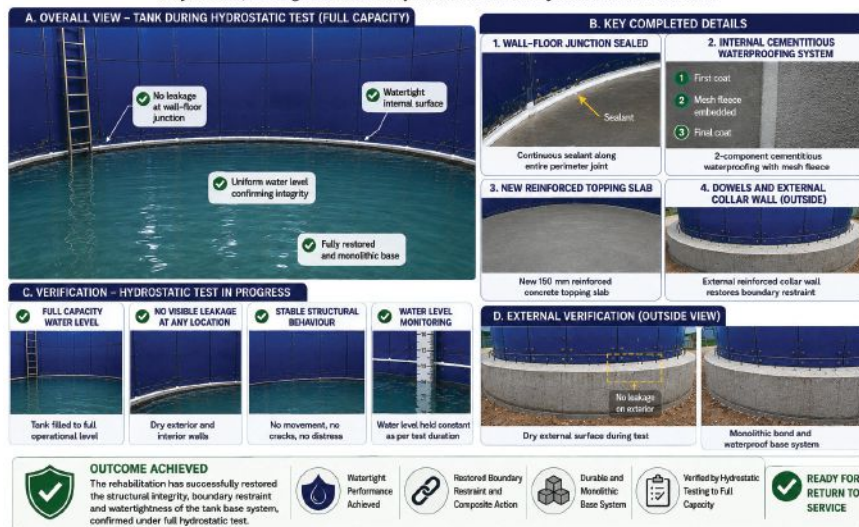


FIGURE 10 – BEFORE-AND-AFTER COMPARISON OF THE REHABILITATION PROJECT

Transformation achieved through mechanism-based repair strategy, external reinforced collar wall, and internal cementitious waterproofing system



rehabilitation process. It demonstrated that restoring structural behavior, improving boundary restraint and reestablishing composite action produced a durable repair capable of withstanding normal operating conditions.

For asset owners, consultants and repair contractors alike, the project reinforced an important lesson: Durable rehabilitation must be validated by performance under service conditions, not by appearance immediately after construction. A structure should only be considered successfully repaired once it demonstrates that the causes of failure have been eliminated.

Beyond delivering a successful repair, the project provided practical lessons that can be applied to many other concrete rehabilitation projects. The final section distills those lessons into a concise framework for repair engineers and concludes with the broader significance of mechanism-based repair engineering.

Lessons for the Repair Industry

Although this project focused on one industrial water tank foundation, the engineering lessons extend well beyond water-retaining structures. The rehabilitation demonstrated that durable concrete repair is achieved by understanding and correcting structural

behavior rather than simply replacing damaged materials.

Six practical principles emerged from the project.

1. Diagnosis must always precede design. A repair strategy should be based on verified evidence rather than visible symptoms alone.
2. Multiple investigation methods provide a more reliable diagnosis than any individual test because independent findings strengthen confidence in the final conclusions.
3. Every repair intervention should address a specific failure mechanism. If an activity cannot be linked to a verified cause of failure, its long-term value should be questioned.
4. Structural continuity, composite action and boundary restraint are often more important than increasing member thickness. The earlier repair increased the amount of concrete but failed to change the behavior of the foundation. The final rehabilitation succeeded because it restored the structural system rather than simply adding material.
5. Construction quality is an engineering requirement. Correct sequencing, surface preparation and reinforcement detailing ensured that the design intent was achieved on-site.
6. Performance must be verified under actual service conditions. Hydrostatic testing confirmed that the repaired foundation remained watertight and structurally stable at full operating level.

Figure 10 summarizes the transformation from repeated failure to verified structural performance. The comparison highlights how forensic investigation, mechanism-based design and disciplined construction combined to produce a durable outcome.

Conclusion

This project demonstrates that successful rehabilitation is not determined by the quantity of repair material applied but by the engineer's ability to understand why a structure has failed. The first intervention addressed the symptoms of deterioration; the final rehabilitation addressed the mechanisms responsible for producing them.

By integrating forensic investigation, engineering analysis, targeted

rehabilitation and performance verification, the project restored the foundation to reliable service and established a practical framework for future repair projects. Mechanism-based repair engineering offers a practical framework for transforming investigation findings into durable repair solutions.

For repair engineers, consultants and asset owners, the message is straightforward: Before deciding how to repair a structure, first understand how it behaves. Successful rehabilitation is measured by performance, not by the amount of repair material installed.

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FATIGUE IN THE CONSTRUCTION WORKFORCE:

AN OVERLOOKED RISK IN CONCRETE REPAIR AND STRUCTURAL REHABILITATION

BY SCOTT GREENHAUS

Introduction

Concrete repair work requires sustained attention, coordination and execution in environments dominated by high-energy hazards. While industry efforts have focused heavily on physical hazards, fatigue remains a largely unmanaged risk factor that directly impacts worker performance.

Fatigue is best understood as a biological drive for recuperative rest.¹ When unmet, it results in measurable degradation in cognitive and physical performance, including slower reaction time, impaired decision-making and reduced vigilance.^{2,3,4,5} These impairments are directly linked to increased incident risk (Figure 1).

Field Indicators of Fatigue

Watch for these real-time indicators on the jobsite:

- Frequent yawning or head nodding
- Slowed reactions or delayed responses
- Missed steps in routine processes
- Poor communication or confusion
- Increased errors or near misses

Supervisor Action: If two or more indicators are present, implement immediate controls (break, task rotation, increased oversight).

High-Risk Conditions for Fatigue in Concrete Repair

Fatigue risk is significantly elevated when work involves:

- Night or early morning operations

- Extended shifts (>10 hours) (Figure 2)
- Consecutive workdays without recovery
- Difficult ergonomic conditions (Figure 3)
- Heavy manual labor required to remove deteriorated concrete

Key Insight: These conditions often coincide with high-energy hazards — making fatigue a critical risk multiplier.



CRITICAL SAFETY INSIGHT

Fatigue does not cause incidents directly. It degrades the worker's ability to recognize, assess and respond to hazards, especially high-energy hazards common in concrete repair work.

“Fatigue is a biological drive for recuperative rest”

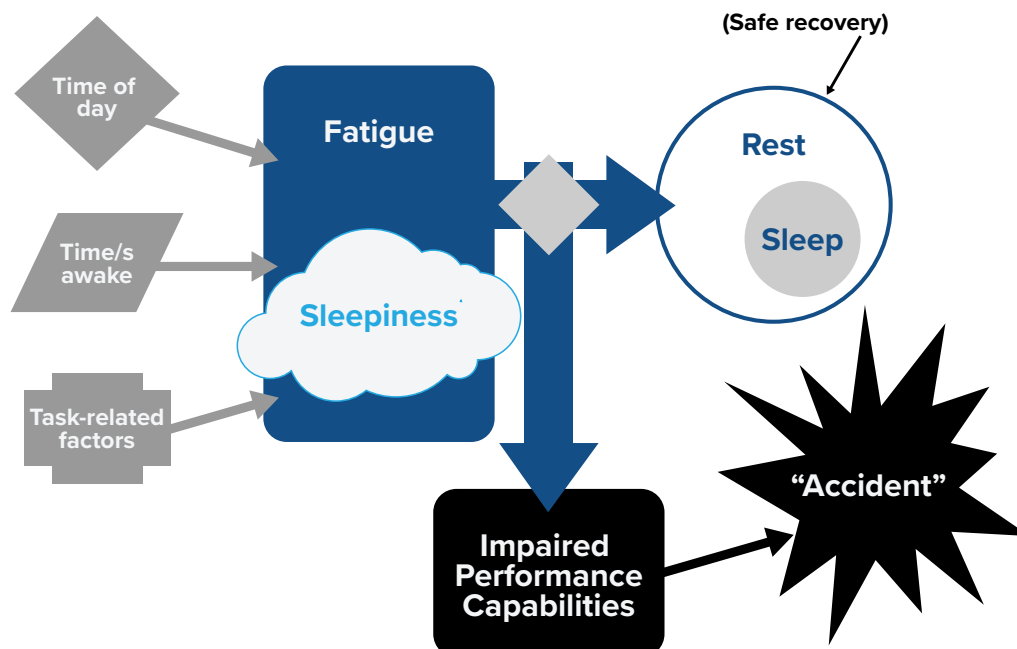


Figure 1: Sleep loss, circadian disruption and task demands contribute to fatigue, which degrades human performance and increases the likelihood of incidents and serious injuries.¹

Understanding Fatigue: A Systems Perspective

Fatigue results from the interaction of three primary factors:

Sleep Requirements

Sleep loss and extended wakefulness create a biological drive for rest. Both acute and chronic sleep restriction impair performance (Figure 4).

Circadian Influences

Human alertness follows a 24-hour biological rhythm, with peak fatigue occurring during nighttime and early morning hours.

Task Demands

Monotonous tasks and high workload conditions both contribute to fatigue through different mechanisms, reducing alertness and increasing mental strain.

These factors combine to impair performance capacity, which is the direct pathway to increased safety risk.¹

Fatigue and Performance Challenges

Fatigue impacts critical functions required for safe construction operations:

- Reaction time and coordination
- Attention and vigilance
- Decision-making ability
- Memory and situational awareness

Research shows that failures in attention and delayed responses are key contributors to accidents across multiple industries.¹ In construction, these failures often manifest as missed hazards, delayed actions or incorrect decisions during high-risk activities.

Construction-Specific Risk Factors

Concrete repair operations align closely with known fatigue drivers^{2,3,4,5}:

- Long work hours and extended shifts
- Night work and irregular schedules
- Physically demanding labor (Figure 5)
- Repetitive or monotonous tasks
- Environmental stressors (heat, cold, noise)
- Long commute times

These conditions create a high-risk environment where fatigue is both prevalent and cumulative.



Figure 2: Long work hours contribute to fatigue risks.⁴



Figure 3: Working in cramped and confined spaces increases worker fatigue. (Courtesy of Structural Preservation Systems)



Figure 4: Injury risk increases with sleep deprivation.³

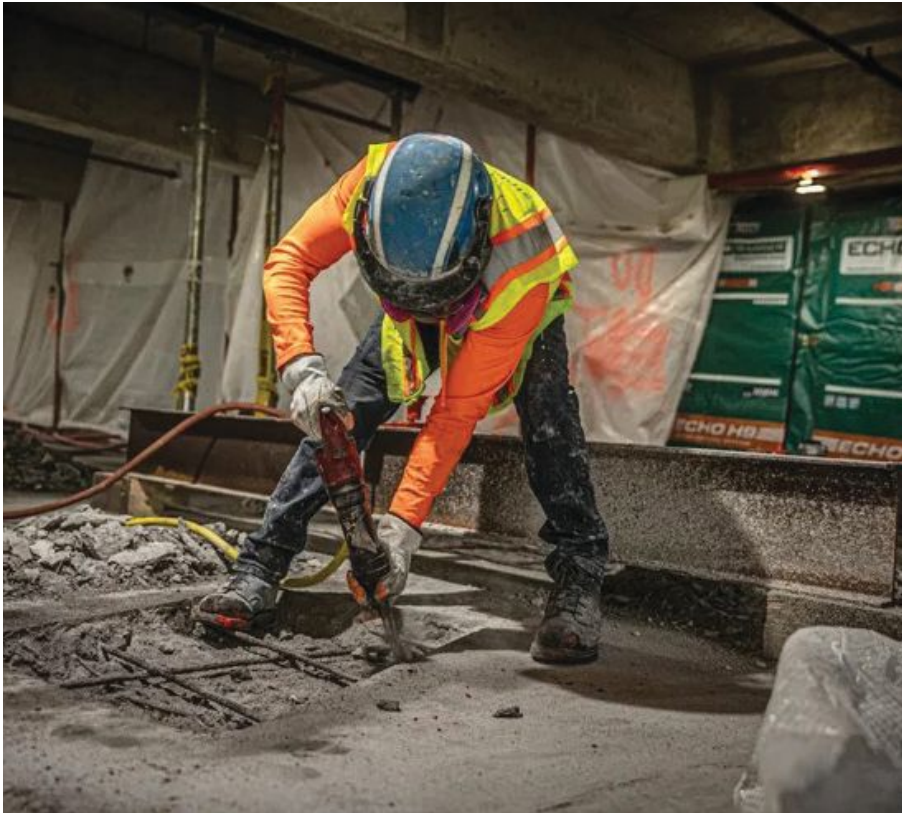


Figure 5: Physically demanding tasks increase fatigue risks. (Courtesy of Structural Preservation Systems)

Task Design

- Rotate tasks to reduce monotony and repetitive motion injuries
- Balance physical and cognitive workload

Rest and Recovery

- Implement structured rest breaks
- Provide adequate recovery time between shifts

Supervisor Engagement

- Monitor worker fatigue indicators
- Intervene when performance degradation is observed

Safety Culture

- Encourage reporting of fatigue and create an environment of open and honest communication
- Eliminate punitive responses to fatigue disclosure

Integration with Safety Systems

Fatigue should be incorporated into existing safety management systems as a controllable hazard.^{2,4,5} This includes:

- Integrating fatigue into pre-task planning
- Tracking fatigue-related indicators
- Adjusting controls based on fatigue risk conditions
- Establishing and adhering to a fatigue management policy and procedure (Figure 6)

Conclusion

Fatigue is a measurable and manageable risk factor that directly impacts safety performance in construction. By recognizing fatigue as a hazard and integrating it into safety systems, organizations can reduce risk, improve performance and protect workers in high-risk environments.

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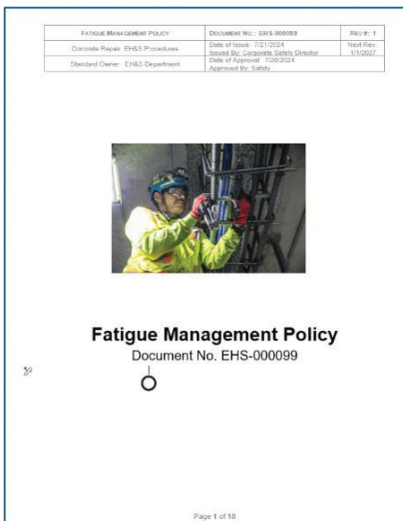


Figure 6: Example of a "Fatigue Management Policy."

Impact on Safety Outcomes

Fatigue contributes to increased risk of incidents and injuries by degrading human performance. Studies indicate that fatigue is a contributing factor in a significant percentage of workplace injuries and accidents.^{1,3,4}

Night work further increases risk, with accident rates significantly higher during periods when workers would normally be asleep.^{1,2} Additionally, cumulative fatigue from repeated sleep restriction poses a substantial and often unrecognized risk.^{1,3}

Managing Fatigue in Construction Operations

There are actions we can take to mitigate the deleterious effects of fatigue in the concrete repair industry. The actions may include:

Work Scheduling

- Limit consecutive long shifts
- Reduce quick turnaround times between shifts
- Manage night work exposure

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REPAIRS FOR DETERIORATED STEM WALLS

BY ROBERT BROWN

Stem wall deterioration in some parts of the country, particularly in the Southwest region, is a pervasive problem. Some neighborhoods have nearly every house affected. A look into the unique conditions of that region explains why conventional repairs fail there and points to a better solution. As the mechanisms examined below show, chloride loading, carbonation and sulfate attack converge at rebar depth within 4-10 years under Southwest irrigation conditions, which makes any ferrous embed left in or returned to that concrete a temporary fix and non-ferrous composite replacement the only durable one, including the use of non-ferrous reinforcement (Figures 1 and 2).

Chloride Ion Penetration, Sulfate Attack and Carbonation

1. Capillary Absorption: Dominant

Irrigation creates repeated wet/dry cycles. Each cycle pulls chloride solution into the pores from irrigation water and from chlorides in the in-situ soils (Figure 3). Chlorides in the water originate primarily from reclaimed or blended municipal supply and from applied fertilizers, while soil-borne chlorides come from the native saline-sodic soils common across the region. As the water evaporates, chlorides stay behind. Over hundreds of cycles, the concentration ratchets upward toward the corrosion threshold. This is the primary loading mechanism of chlorides and sulfates into the concrete.^{1,2}

2. Diffusion: High

Diffusion operates continuously in the background, slowly redistributing chlorides deposited by absorption deeper toward the rebar (Figure 4). Diffusion also



Figure 1: Typical rust jacked stem walls in the Southwest in corrosive conditions. Notice decorative landscape rock.

dominates on the below-grade soil face where moisture is more constant rather than cyclic.^{3,4}

3. Carbonation: Critical Amplifier

Over time, CO₂ from acid rain deposition reacts with calcium hydroxide [Ca(OH)₂] in concrete, dropping pore solution pH from approximately 13 down below 9. This does two damaging things simultaneously: It destroys the passive film protecting the rebar and other embeds, and it releases previously bound chlorides back into free solution. When the carbonation front and chloride front converge at rebar depth, corrosion initiates rapidly *regardless of whether chloride threshold has been formally reached*. Decomposing mulch and irrigated soil against the wall also generate elevated CO₂, accelerating deterioration at the below-grade face.^{5,6,7,8}

4. Convection: Moderate

Heavy or prolonged irrigation can saturate soil against the wall, creating enough hydraulic pressure to push chloride solution through cold joints, cracks and tie holes. In hot arid climates, thermal cycling between daytime heating and cool post-irrigation nights adds a pumping effect that draws moisture inward independently of capillary suction.⁹

5. Sulfate Attack and Micro-Cracking

Sulfates present in in-situ soils and in decorative landscaping rock add another dimension to the attack on stem wall concrete (Figure 5). Sulfates attack concrete chemically by reacting with calcium aluminate hydrates to form expansive ettringite and with calcium hydroxide to form gypsum, with both reactions consuming the same calcium hydroxide alkalinity reserve that the carbonation front is simultaneously



Figure 2: Typical rust jacked stem walls in the Southwest in corrosive conditions. Notice decorative landscape rock.

Cyclical wetting and drying through pores and capillaries. Each cycle deposits more chemicals on water evaporation

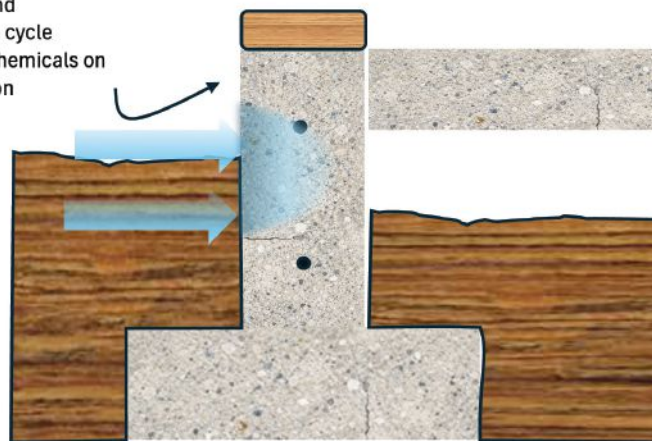


Figure 3: Pore and capillary absorption..

depleting, accelerating pH collapse at rebar depth. The expansive micro-cracking from ettringite formation opens direct convective pathways through the cover zone, multiplying the effective chloride delivery rate by 3-10 times in cracked zones. When sulfate ions are cyclically delivered against the stem wall by irrigation water alongside chlorides, all three mechanisms operate on the same chemical system simultaneously.^{10,11}

The Key Takeaway: Chloride loading, carbonation and sulfate attack are individually manageable; their simultaneous convergence at rebar depth is what causes premature failure. In irrigated landscapes where reclaimed water delivers chlorides and sulfates, acid rain accelerates carbonation and sulfide-bearing landscape rock cyclically leaches additional ions with every irrigation event, each mechanism accelerates the others in a compounding cycle. Sulfate depletion of calcium hydroxide speeds carbonation-driven pH collapse while ettringite micro-cracking multiplies chloride transport rates by 3-10 times.

Integrated Timeline: How All Mechanisms Interact

Note: The following timeline describes worst-case conditions in the Southwest: reclaimed irrigation water, sulfate-bearing landscape rock, chloride loading from fertilizers and native saline-sodic soils, daily thermal cycling exceeding 80-100°F (27-38°C) and residential stem wall concrete frequently built with noncompliant water-cement ratios. This is a distinct extreme exposure class that standard single-mechanism corrosion

literature does not model. The staging below applies established carbonation, chloride-binding and cracked-media transport kinetics to these regional exposure conditions; it is a synthesis of those sources rather than a published timeline.^{5,8,12}

Years 1-3

- Capillary absorption dominates; rapid Cl⁻ loading of outer 15-20 mm (0.59-0.79 in.).
- CO₂ begins carbonating surface zone; carbonation coefficient K starts accumulating.
- Sulfate ions from landscape rock and soil begin penetrating outer matrix.
- Early ettringite nucleation in outer 10 mm (0.39 in.); no visible damage yet.
- pH still high at rebar depth; passive film intact.

Years 3-5

- Carbonation reaches 10-15 mm (0.39-0.59 in.) depth, accelerated by calcium hydroxide depletion from sulfate reactions.
- Ettringite expansion producing micro-cracking in outer cover zone.
- Micro-cracks opening direct convective chloride pathways; effective transport rate increases 3-10×.
- Free Cl⁻ concentration rises nonlinearly as bound chlorides are released.
- Hold-down strap zinc coating depleting at concrete interface.

Years 4-10: Critical Convergence Zone

- All three fronts (chloride, carbonation and sulfate damage) converging at rebar depth simultaneously.
- Calcium hydroxide substantially depleted; passive film threshold critically sensitive to any further attack.

- Corrosion initiating; rust jacking beginning at defects, low-cover zones and hardware interfaces.
- Sulfate damage visible at wall surface; map cracking, soft friable paste, white efflorescent gypsum deposits.
- In worst-case conditions (reclaimed irrigation water, sulfide-bearing landscape rock, organic mulch, shallow cover, standard OPC concrete), rust jacking fully initiated within this window.^{5,8,12}

Once this threshold is reached, any ferrous embeds, new or old, will rapidly deteriorate due to corrosion, with rust jacking as a consequence.

Corrosion and Rust Jacking Rebar

Rebar corrodes along its length, so rust jacking produces continuous expansive pressure in a cylindrical pattern around the bar. With typical stem wall cover of 2-3 inches (50-76 mm), the concrete shell cracks relatively quickly once corrosion initiates. Cracking follows the bar: Horizontal bars produce horizontal cracks. Visible spalling with an exposed bar indicates significant section loss has already occurred, and that section loss may be well beyond the threshold at which visual assessment can reliably gauge it.

Hold-Down Straps

Straps present a more complex rust jacking pattern because corrosion concentrates at the concrete-to-air interface where moisture, oxygen and chlorides all converge simultaneously. The flat strap geometry means expansion pressure acts laterally, wedging the concrete apart along the strap plane rather

Long term wetting facilitates diffusion... the disbursement of chemical in the already wetted concrete

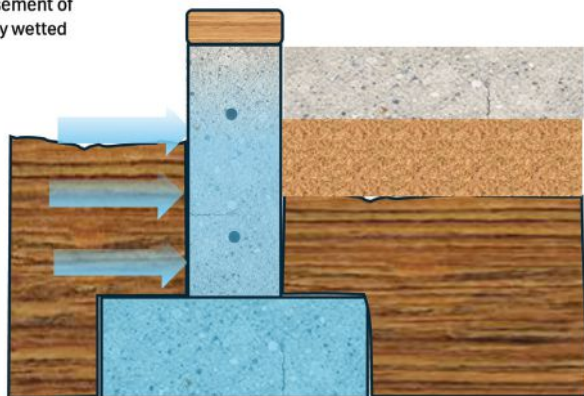


Figure 4: Diffusion.

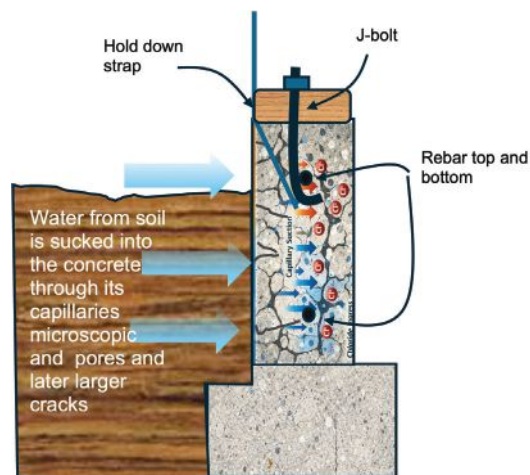


Figure 5: Sulfate attack.

than radially like a round bar. The strap itself may look acceptable above the wall while the anchorage zone below is compromised; capacity loss is hidden until the connection is tested or the concrete spalls away.

Anchor Bolts

Anchor bolts corrode preferentially at two locations: the concrete surface interface (highest combined exposure) and at the base anchor. Anchor failure is particularly consequential because it is the primary shear and tension connection between framing and foundation; loss of even one anchor in a short mudsill segment significantly reduces lateral load capacity.^{13,14,15}

Repair Guidance Per ICRI 310.1R-2008 and ICRI 320.2R-2018^{16,17}

Adapted for stem wall applications.

Step 1: Concrete Removal

Per ICRI 310.1R-2008, all unsound concrete must be removed plus a minimum 19 mm (3/4 inch) clearance behind the rebar on all sides, or 6 mm (1/4 in.) larger than the repair material's coarse aggregate, whichever is greater.¹⁶ Preferred removal methods: hydrodemolition (not practical for stem walls), pneumatic chipping or jackhammer as last resort due to micro-cracking risk.

Step 2: Rebar and Hardware Treatment

Rebar under 25 percent section loss: Blast clean to SSPC-SP 10/NACE No. 2 near-white and apply zinc-rich or epoxy primer.¹⁸ In practice, visible cracking typically indicates section loss has already exceeded this threshold.

Rebar over 25 percent section loss:

Replace or supplement with new bar, lap spliced per engineer of record per ACI 318.¹⁹

Hold-down straps: Replacement strongly preferred over treatment. Reliably coating the critical interface zone in the field is not consistently achievable.

Anchor bolts: Replace in virtually all cases. Replace with non-ferrous composite anchors or epoxy-grouted GFRP threaded rod where possible.

Exterior moisture control: Waterproofing the exposed face of the stem wall is generally not recommended. Moisture entering from the below-grade face and from other paths still requires a route to escape, and the above-grade face is that route. Sealing it does not stop ingress; it concentrates moisture behind the coating and can accelerate the deterioration the treatment was intended to prevent. Where any surface treatment is used, it should be a breathable penetrating hydrophobic treatment rather than a film-forming membrane, and it should be understood as a consumable on a maintenance cycle. No surface treatment removes the chlorides already bound in the cover zone, and none protects the concrete-to-air interface where strap and anchor bolt corrosion concentrates.

ICRI 310.1R-2008 states clearly that concrete repair is not restoration to original condition; it is arresting deterioration and extending service life.¹⁶ Repair without addressing the ongoing ingress mechanism will result in a repair service life of 5-10 years or sooner. Repair material selection should follow ICRI 320.2R-2018,

which sets out criteria for matching repair material properties to the exposure and substrate conditions of the repair.¹⁷ Refer to ICRI 510.1-2013 and ACI 546R-14 for comprehensive corrosion mitigation and repair guidance.^{20,21}

Superiority of Non-Ferrous Replacements

Non-ferrous rebar, composite hold-down straps and composite anchor bolt replacements completely bypass the electrochemical corrosion circuit (the micro-currents of 0.1 to 10 $\mu\text{A}/\text{cm}^2$, roughly 0.05 to 4.6 mils per year of steel section loss, that drive oxidation) by removing² the anode entirely. There is nothing to oxidize and therefore no rust jacking can ever occur.

Design considerations: Composites are not a drop-in substitute for steel. Bars cannot be field bent, so hooks and bends must be shop fabricated, and development and lap lengths are longer than for steel. Composite anchors and threaded rod carrying sustained tension are governed by creep rupture limits rather than short-term strength. Products should conform to ASTM D7957 and carry a current evaluation report; and because anchor and hold-down replacements transfer framing loads to the foundation, they should be sized and detailed by the engineer of record. One further condition warrants attention: Composites lose capacity at elevated temperature, so embeds in a structure that has been through a fire should be evaluated before they are relied on.^{22,23}

Problems with Current Stem Wall Repair Systems

Hold-down straps and anchor bolt replacements currently available in the market are manufactured from alloys

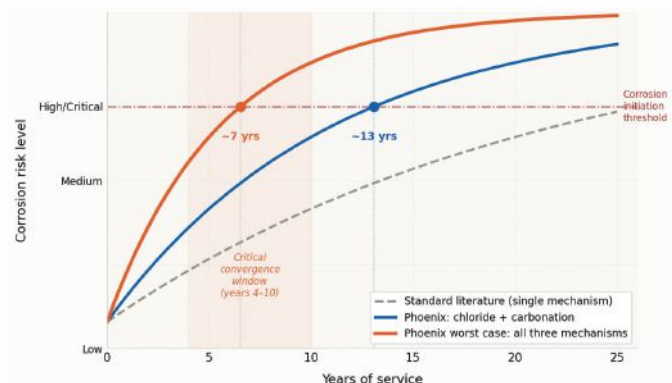


Figure 6: Corrosion initiation timeline comparing standard single-mechanism literature (dashed) against Southwest worst-case combined mechanisms. Markers show approximate initiation year at threshold.

including B7 steel and 1144 carbon steel. Neither is appropriate for carbonated concrete environments with reduced alkalinity, chlorinated cyclic wetting, thermal cycling and sulfate attack.

B7 (Chrome-Moly Alloy Steel)

B7 is essentially a high-strength steel with no meaningful corrosion resistance in concrete service. It relies entirely on concrete alkalinity for passive film protection. Once carbonation reduces pH below the passive threshold, B7 corrodes rapidly and is prone to stress corrosion cracking at thread roots. The unprotected wet service life in carbonated stem wall conditions is approximately 5-15 years.²⁴

1144 (Free Machining Carbon Steel)

In the case of 1144, it actually performs worse than plain carbon steel in this environment. The high sulfur content, added to improve machinability, creates built-in pitting initiation sites (MnS inclusions) throughout the material. The unprotected wet service life in carbonated stem wall conditions is approximately 2-8 years.²⁵

Hot-Dip Galvanizing: A Finite Consumable System

Where ferrous hardware must be used, hot-dip galvanizing plus epoxy overcoat is the minimum acceptable protection. Hot-dip galvanizing per ASTM A123 typically provides 3-6 mils (0.076-0.15 mm) of zinc thickness. Galvanizing provides sacrificial protection by corroding preferentially to protect the underlying steel, but it is a consumable system with a finite service life. In carbonated concrete environments, zinc consumption accelerates significantly because zinc is amphoteric. Wet conditions accelerate zinc consumption 3-5 times over drier environments.^{26,27,28}

Conclusion

The combined mechanism analysis presented here makes clear that leaving any ferrous embeds in existing carbonated concrete exposed to chlorides and sulfates from cyclical irrigation is a temporary solution at best. The convergence timeline of 4-10 years under worst-case conditions in the Southwest is well within normal residential ownership horizons (Figure 6).

Composite non-ferrous replacements (GFRP rebar, composite hold-down straps and epoxy-grouted composite anchor rods) represent the ideal long-term solution in these environments. They eliminate the electrochemical circuit entirely, are unaffected by pH reduction from carbonation and provide a transferable lifetime warranty against rust jacking failure.

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AUTHOR



Robert Brown graduated from Arizona State University with a degree in architecture and finance. He is a 35-year veteran of the concrete and foundation repair industry and former owner and CEO of Arizona Foundation Solutions, a foundation repair company and a licensed forensic engineering company. He is semi-retired as an author and is a patented inventor.

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Amplify Durability Through Innovative Repair

BY FRED GOODWIN, FICRI, FACI, FASTM

In physics, entropy is the natural, inevitable tendency of things to move from a state of organized structure to one of disorder, chaos and decay, or in simpler terms: “Entropy is just a fancy way of saying: things fall apart.”¹ The universe expands, deterioration occurs, paint peels, concrete cracks and steel rusts due to mechanisms caused by entropy. These things are just going to happen eventually. Durability is simply postponing the inevitable for an acceptable length of time called service life.

There are three categories of service life: technical, functional and economic.² Technical service life is usually about safety issues reaching an unacceptable level, such as structural issues. Functional service life is when the structure no longer meets its intended purpose either through unacceptable aesthetics, changed service requirements (i.e., clearances, weight limits), obsolescence or adaption to another use. Economic service life is when operating, maintenance and repair costs exceed the replacement cost. When any of these categories is reached, the structure’s service life is over. Guessing when this will happen with a new or existing, functioning structure is difficult, requiring condition assessment and evaluation.

What is durability? *ICRI Concrete Repair Terminology*³ defines it as the ability of a material or structure to resist weathering action, chemical attack, abrasion and other service conditions to maintain serviceability over a specified time or design service life, referring to the ACI 562 Repair Code⁴ as the source of the definition. A more general durability concept

is the ability of an object, material or system to last a long time without breaking, wearing out or requiring excessive maintenance. It represents a product’s capacity to withstand normal wear and tear, pressure or damage while retaining its original function,⁵ or, in other words, to resist entropy.

Like most attempts at success, durability starts with a plan. Most times, we think of “the plan” as the construction documents, which are the records used to understand the structure’s original construction, including materials, detailing, performance and later repairs. They may include original design and contract documents, original construction submittals, other construction documentation, shop drawings, material submittals, condition surveys, repair and maintenance documentation, and historic standards. For existing concrete, the worthiness of the repair (i.e., replace vs. quick fix vs. extensive repairs) is determined from the deterioration extent and mechanism(s), the corrective actions required and constraints about the job (such as work period, weather precautions, constructability, utility services, surface preparation, material selection, return to service criteria), and defining project success must be determined, preferably prior to initiating the repair.

The symptoms of poor durability are usually shown by leakage, settlement, deflection, excessive wear, spalling, disintegration and cracking, typically in various combinations. Repairs are required due to safety issues, structural catastrophe, use dysfunction, leakage, environmental concerns, unacceptable aesthetics and required maintenance. The criteria for repairs

mainly come from three sources: the owner, the engineer and the contractor. The owner's expectations typically are based on the urgency, cost, service life and aesthetics of the project. The engineering requirements are structural needs, durability, constructability, impact to the environment, material selection, safety and compliance with codes, standards and jurisdictional adherence. The contractor's needs somewhat overlap with the engineering requirements but also include work period, noise and dust abatement, accessibility, equipment required, labor management and utility access. Material selection involves not just the material properties but also the surface preparation requirements, application methods and return to service needs. For a successful repair, all of these factors must be considered concurrently, making repair more complex than initial construction.

Once the repair is completed, maintenance is required for durability. A detailed maintenance plan should be documented providing anticipated service life, periodic assessments and inspections. ACI 365.1R-17⁶ refers to a useful public-domain software program and mathematical model, LIFE-365,⁷ that estimates service life and life-cycle costs for various concrete mixture designs and corrosion protection systems. While useful, LIFE-365 focuses mostly on new construction, but the complexity of repair makes modeling tools difficult to adapt to a given situation.

A useful guide to assessments is ASTM E2018,⁸ *Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process*, which provides guidance for conducting a baseline property condition assessment (PCA) of commercial real estate by performing a walk-through survey and conducting research. Monitoring and inspection technologies are discussed in various references including ACI 201.1R,⁹ *Guide for Conducting a Visual Inspection of Concrete in Service*, and ACI PRC-444.2-21,¹⁰ *Structural Health Monitoring Technologies for Concrete Structures*. Sun et al.¹¹ provides a recent systematic review of monitoring technologies and sensing methods.

Maintenance can be classified into five types:

- Special maintenance occurs when emergency repairs, strengthening or updating of a structure is needed.
- Prescriptive maintenance uses codes' exposure classes and specifications' limits to minimize maintenance needs using higher-durability materials and design requirements such as non-corroding reinforcement, low-permeability concrete with a dense microstructure to minimize ingress of deleterious materials, use of appropriate concrete protective systems and other proactive measures. In order to achieve prescriptive maintenance, serviceability and durability thresholds should be specified along with a maintenance plan. Initial costs hopefully are offset by the increased service life.
- Corrective or reactive maintenance is when repairs are implemented upon observation of deterioration, such as fixing cracks when they appear or reapplying a coating when deterioration has already occurred. Use of deterioration to trigger maintenance often results in reduced durability, higher costs and unscheduled downtime.
- Preventive maintenance is proactive upkeep and scheduled at a predicted interval or based on experience. Examples of

A useful guide to assessments is ASTM E2018,⁸ *Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process*, which provides guidance for conducting a baseline property condition assessment (PCA) of commercial real estate by performing a walk-through survey and conducting research.

preventive maintenance include reapplying a penetrating sealer every five years, dowel bar stitching, recaulking of joints and recoating of the structure.

- Predictive maintenance is where the industry needs to advance. It is based on when data indicates an emerging problem, such as use of corrosion monitors or strain gages indicating unsatisfactory loading, or the example of the "Maintenance Minder Oil Life Indicator" light on my car when the oil needs changed. Predictive maintenance can be complex and requires comparison to a baseline of initial readings and how these readings change as the structure ages. It also requires conditions that are monitored, inspected and assessed, with the implementation of preventive measures using modeling to assemble the data and produce meaningful estimations leading to the optimum repair strategy. This is an opportunity for artificial intelligence applications for our industry resulting in truly innovative repairs.

Innovative repairs will also be driven by the cost of replacing aging infrastructure as well as expanding urbanization requiring new infrastructure and housing. Climate change is necessitating increased sustainability and resilience of our habitats, where changes to construction practices and materials will evolve to reduce the carbon footprint, energy use, resource depletion and waste generation associated with concrete construction. This will involve the use of recycled aggregates, increased supplementary cementitious materials and industrial by-products, as well as evolving technologies like alternative reinforcement and binders, 3D-printed or additive manufactured concrete, permeable concrete, self-healing concrete, ultra-high-performance concrete, photocatalytic and high-albedo or reflective concrete, insulating concrete, carbon-captured concrete and many other new and innovative materials and techniques.¹² As these technologies evolve, innovative repair materials and techniques will also need to evolve, since entropy always wins in the long term.

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stucco, flooring and concrete repair materials. He is a former chair of ACI 364 Rehabilitation, ACI 515 Protective Systems, ICRI 320 Materials and Methods, and the ICRI Technical Activities Committee as well as the inventor of seven patents. He received the 2011 ACI Delmar L. Bloem Distinguished Service Award, the 2015 Strategic Development Council Jean-Claude Roumain Innovation in Concrete Award, and the 2016 ASTM C09 Award of Merit. In the spring of 2026, Fred was recognized as an ACI Honorary Member for his "lifelong leadership and creativity in the research, development, and use of materials related to new concrete construction and repair."

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MENTAL HEALTH MATTERS

NATIONAL SUBSTANCE USE AND MISUSE PREVENTION MONTH: SMALL STEPS, LASTING IMPACT

BY CAL BEYER, CWP, NAC

When we think about workplace safety, we often picture hazard assessments, hard hats, high-visibility clothing and emergency preparedness plans. But one of the greatest opportunities to improve safety does not begin on the jobsite. It begins long before a crisis occurs.

Each October, National Substance Use and Misuse Prevention Month reminds us that prevention is not simply about telling people what not to do. It is about creating workplace environments that support healthy choices, reduce risk and connect employees with resources before problems escalate.

For contractors and suppliers engaged in concrete repair, prevention is already enmeshed in safety culture and practices. Organizations work every day to identify hazards, reduce risks, and prevent incidents and injuries before they happen. The same proactive mindset can be applied to substance use and mental health.

At SAFE Project, prevention is rooted in education, reducing stigma and expanding access to practical resources. By helping workplaces understand the factors that contribute to substance misuse and mental health challenges, organizations can take meaningful steps to strengthen employee well-being before a crisis occurs.

Effective prevention does not require launching an extensive new program. It often starts with small, intentional actions that become part of an organization's overall safety culture.

Examples include:

- Promoting employee assistance programs (EAPs) and behavioral health resources throughout the year.

- Reducing stigma by reinforcing that seeking help is a sign of strength.
- Training supervisors to recognize changes in behavior and to respond with empathy.
- Including mental health and substance use education in safety meetings or toolbox talks.
- Encouraging healthy stress management and work-life balance activities.
- Promoting mental health screenings.
- Encouraging sober curiosity by sharing recipes for refreshing summer and seasonal beverages in newsletters and bulletin boards.
- Educating employees about safe disposal options of leftover prescription pain management.
- Offering inclusive workplace events with nonalcoholic beverage options.
- Sharing information about 12-step and non-12-step recovery pathways.
- Providing naloxone education and overdose response resources in workplaces and worksites.

These efforts help create workplaces where employees know their mental health and overall well-being matters as much as their physical safety. The impact of these small but intentional efforts can yield outcomes when employees recognize that the organization is committed to helping its employees address challenges to achieving holistic health.

Prevention also means recognizing that substance misuse rarely develops in isolation. Stress, chronic pain, mental health challenges, financial pressures and workplace demands all affect a person's well-being. Addressing these factors early helps reduce the likelihood that challenges become larger crises. Supporting mental

health, reducing stigma and increasing awareness of available resources all contribute to stronger employees and safer workplaces.

The encouraging news is that prevention works. Every conversation that reduces stigma, every supervisor who checks in with an employee and every resource shared helps build a healthier workplace culture.

Workplace safety has always been about preventing harm before it occurs. As our understanding of health continues to evolve, that commitment must extend beyond physical hazards to include mental health, substance misuse and overall well-being. Whole-person well-being looks at this as preventive health for an organization and preventive maintenance for the individual employees and their families. This Prevention Month, consider one small step your organization can take to strengthen its culture of prevention. Whether it is starting a conversation, sharing a resource or reviewing an existing policy, today's actions can help prevent tomorrow's challenges.

Throughout Prevention Month, SAFE Project encourages employers to evaluate how prevention is reflected in their existing safety efforts. Simple actions like sharing educational materials, promoting available benefits or incorporating well-being into routine safety discussions can have a lasting impact. Prevention is most effective when it's not treated as a one-time campaign but as an ongoing commitment woven into everyday workplace culture. Reach out to SAFE Project should you wish to discuss prevention strategies or resources.

Additional Resources:

- **Prevention Points Segments – Subscription Page and Links to Prior Points:** www.safeproject.us/prevention/prevention-point
- **Prevention Perspectives Webinars – Registration Page and Links to Past Webinars:** www.safeproject.us/prevention/#Prevention-Webinars



Cal Beyer, CWP, NAC, is the senior director of SAFE Workplaces for national nonprofit SAFE Project. SAFE stands for Stop the Addiction Fatality Epidemic. SAFE Project also provides tailored guidance and training within its four key initiatives: SAFE Campuses, SAFE Communities, SAFE Workplaces

and SAFE Veterans. Beyer has more than 30 years of experience as a risk management and safety professional. He has been dedicated to construction and manufacturing since 1996 and has been a longtime advocate for workplace mental health and well-being. Reach Beyer at cal@safeproject.us or via cell at (651) 307-7883.

The advertisement for National Waterproofing Supply has a blue background with a subtle water ripple pattern. At the top left is the company logo, which consists of a blue circular icon with a water droplet inside, followed by the text "National Waterproofing Supply" in white and blue. In the center, the slogan "Leading the way with Savings" is written in white. To the right of the slogan is a large, blue piggy bank with a smiling face. Below the slogan, the text "National Waterproofing Supply has hand-picked the most renown manufacturers in the construction and waterproofing industry, enabling us to offer quality materials at highly competitive and client-customized pricing for distribution nationwide." is written in white. At the bottom, a dark blue banner contains the website "www.nationalwaterproofingsupply.com" in white. Below the banner, contact information for Miami, Tampa, Orlando, and Denver is listed in white text.

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TAC TALK

THOUGHTS FROM ICRI'S TECHNICAL ACTIVITIES COMMITTEE

'I'M JUST A DRAFT!' – THE LIFE STORY OF AN ICRI DOCUMENT

A brief (and comical) overview of how a new idea is transformed into a new ICRI document.

BY LIYING JIANG, TAC CHAIR

Hi there.

I'm just a draft.

Well ... not yet, actually. I started as a random idea.

Chapter 1: The Idea

One day, in a committee meeting (or maybe over coffee), someone said: "Why isn't there an ICRI guideline for this?"



There was a pause.

A few nods.

Then someone brave (or unsuspecting) said: "Maybe we should create one."

And just like that ... *I was born.*

Chapter 2: The Proposal

Now I'm a formal proposal heading to TAC.

I've got a title, a purpose and just enough detail to sound convincing.

TAC members lean in thoughtfully.

Some say: "This is needed."

Others ask: "Have you considered scope?"

And one person asks a *very specific question* that no one is quite ready to answer.

But overall ... I survive.

I feel hopeful.



Chapter 3: I Get a Committee (and a Big Family)

Good news: I'm approved!

Better news: I now have a committee and, better yet, a task group within the committee.



Even better news: I now have **many opinions**.

It turns out I don't just belong to one person anymore.

I belong to a group of dedicated experts who all want me to be **just right**.

"We need a good outline."

"Let's expand this section."

"This needs more technical depth."

"Can we simplify this?"

"Can we define every single term?"

I now have ... six parents or sometimes more

Chapter 4: Drafting Begins Within Task Group

After a "million" years ... Version 1 is born!

It's exciting. It's rough. It's ... a start.

Then come the edits.

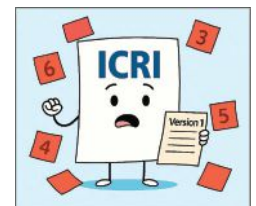
Version 2 ... better.

Version 3 ... evolving.

Version 4 ... complicated.

Version 5 ... no longer resembles Version 1.

Track changes are everywhere.



I'm being shaped, refined, debated and improved.

Occasionally, someone says: "I think we had this in Version 3."

No one can find Version 3.

Chapter 5: The Review Cycle Within Task Group

Now I'm being reviewed more widely.

Comments arrive.

Some are encouraging: "Looks great!"

Others are ... ambitious: "Consider reorganizing the entire document."

And a few are beautifully precise: "On page 27, paragraph 2, line 3 ... is that comma necessary?"

I grow stronger. Sharper. More consistent.

Also ... slightly more nervous.



Chapter 6: The Ballot Within Committee

This is it.

My moment.

Votes come in:

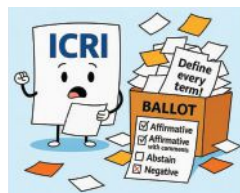
-  Affirmative
-  Affirmative with comments
-  Abstain
-  Negative (with very detailed feedback)

The good news: Most support me!

The other news: The comments are ... extensive.

But that's OK. Because every comment makes me better.

Back to work I go!



Chapter 7: Refinement (Again!)

We (task group) resolve comments. Carefully.

Every suggestion is considered.

Every concern is discussed.

Consensus isn't always fast ...

But it's always worth it.

Slowly, I transform from a good draft into a **trusted document**.



Chapter 8: Reballot Within Committee

We come back — another big moment.

I've grown. I've improved. I've addressed comments.

This time ... I'm ready.

Votes come in again:

-  Affirmative
-  Affirmative with comments
-  Abstain
-  Negative (with very detailed feedback) (*please ... nooooo*)

The best news:  "All Affirmative!"

Celebration! (Quiet, professional celebration ... but still!)

Sometimes, though ...

There's *other* news: "Negative ... but not persuasive."

I'm relieved ... but also slightly confused.

Either way — progress!

Because now ...



Chapter 9: I Make It to TAC

I've made it.

I'm heading back to TAC.

This feels important.

Very important.

TAC members review me carefully:

"Does this align with ICRI standards?"

"Is the scope still appropriate?"

"Did the committee address all the concerns?"

Then comes the TAC ballot.

Votes arrive:

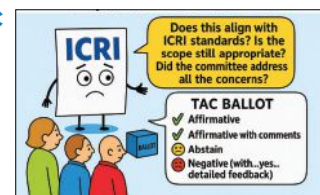
-  Affirmative
-  Affirmative with comments
-  Abstain
-  Negative (with ... yes ... detailed feedback)

I thought I was almost done.

TAC gently reminds me: "Almost."

And just like that ...

I'm heading back **one more time**.



Chapter 10: I'm Getting Refined (Again ... Again!)

Back to the committee and task group I go!

The team gathers: "All right — let's go through TAC comments."

We review everything.

Carefully.

Respectfully.

Occasionally someone says: "I thought we already addressed this"

Someone else replies: "Yes ... but now we'll address it even better."

Sections are clarified.

Language is tightened.

Intent is sharpened.

I'm not just being edited anymore

I'm being *polished*.

At this point, I'm:

- Technically sound ✓
- Clearly written ✓
- Thoroughly reviewed ✓

And yes ... slightly exhausted.



Then:

- ✓ "All comments addressed."
- ✓ "Process complete."
- ✓ "Ready for publication."

I did it.

We did it.



Chapter 12: I Make It!

At last ...

I'm published.

I'm now an official **ICRI Technical Guideline**.

I sit proudly alongside other documents that practitioners rely on every day.

Engineers, contractors, consultants — they use me to solve real-world problems.

I have a purpose.

I make an impact.

Chapter 11: Compliance Check

Back to TAC once more.

This time ... it's different.

This is the **Compliance Check**.

TAC isn't asking: "Should this exist?"

Instead, they're asking: "Did everything get addressed properly?"

They go through:

- Every comment
- Every response
- Every resolution

Carefully.

Systematically.

Almost ... heroically.

I hold my breath.



Epilogue: The Circle Continues

Just when I think I can relax ...

Someone says: "Should we update this?"

And somewhere, a new idea is already being born.

Disclaimer: Images created with the use of AI technology.

RECENTLY ADDED!

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110.1R-2026 - Guide Specifications for Structural Concrete Repair: Section 030130

210.5R-2026 - Guide for Selecting and Specifying Reinforcing Bar Cleaning Levels

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AMERICAN CONCRETE INSTITUTE EXPANDS ACI PLUS PLATFORM WITH ADDITION OF ACI CODE-440.11-22

DIGITAL ACCESS TO GFRP-REINFORCED CONCRETE CODE ENHANCES USABILITY, COLLABORATION AND TECHNICAL EFFICIENCY FOR DESIGN PROFESSIONALS.

The American Concrete Institute (ACI) on July 8 announced that ACI CODE-440.11-22: Building Code Requirements for Structural Concrete Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars – Code and Commentary is now available through the ACI PLUS Platform,¹ providing subscribers with an enhanced digital experience for accessing and applying this important structural concrete code.

ACI CODE-440.11-22² establishes minimum requirements for the materials, design and detailing of structural concrete buildings and, where applicable, nonbuilding structures reinforced with GFRP bars that conform to the requirements of ASTM D7957-22. Developed through ACI's consensus process, the code addresses structural systems, members and connections, including cast-in-place, precast, nonprestressed and composite construction.

The addition of ACI CODE-440.11 to the ACI PLUS Platform reflects ACI's ongoing commitment to delivering industry-leading technical resources through modern, user-friendly digital tools.

Additionally, the PLUS Platform version includes integrated access with the ACI GFRP-Reinforced Concrete Design Handbook, MNL-7(23).³ The GFRP-Reinforced Concrete Design Handbook is a vital reference for professionals interested in the use of nonmetallic GFRP reinforcement for concrete structures. It is meant to provide valuable insight to structural engineers on understanding and utilizing the provisions of Building Code Requirements for Structural Concrete Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars (ACI CODE-440.11). Links to example problems in MNL-7(23) are also provided directly from the code to the manual.

"Engineers and designers working with GFRP reinforcement need fast, reliable access to critical code provisions and supporting information," said Mike Tholen, ACI senior managing director, Technical Operations. "By bringing ACI CODE-440.11 to the ACI PLUS Platform, users can navigate requirements more efficiently, connect related resources instantly and gain a deeper understanding of the code through an interactive digital environment."

More than a digital library, the ACI PLUS Platform is designed to help professionals work smarter. Subscribers benefit from advanced search functionality that allows users to quickly locate provisions by keyword, topic or section; interactive note-taking capabilities that support project-specific documentation and

collaboration; and linked reference materials that connect users directly to related ACI resources without leaving the platform. The platform is regularly updated to ensure users have access to the latest editions, supplemental materials and technical content.

Branded the ACI 440.11 PLUS Platform, key benefits of accessing ACI CODE-440.11 through the digital technology include:

- Faster navigation of code requirements through advanced search tools.
- Improved productivity with searchable, organized notes and annotations.
- Immediate access to related ACI publications and reference materials through integrated links.
- A streamlined, all-in-one environment for exploring, understanding and applying ACI technical resources.

To learn more about the ACI PLUS Platform and available subscriptions, visit the ACI PLUS Platform⁴ landing page.

About the American Concrete Institute

The American Concrete Institute (ACI), a 501(c)(3) nonprofit organization, is the leading global authority for the development, dissemination and adoption of its consensus-based standards, technical resources, and educational, training and certification programs. Founded in 1904, ACI is headquartered in Farmington Hills, Michigan, USA, with a regional office in Dubai, UAE, and Resource Centers located in Southern California, the Midwest (Chicago, Illinois, area) and the Mid-Atlantic (Baltimore, Maryland, area). ACI has more than 90 chapters, 350 student chapters and approximately 40,000 members spanning more than 120 countries. The American Concrete Institute – Always advancing®. Visit www.concrete.org for additional information.

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³ www.concrete.org/store/productdetail.aspx?itemid=mnl723&language=english&units=us_units

⁴ www.concrete.org/publications/concreteresourcesubscriptions/aciplusplatform.aspx



NOW STREAMING: THE WE ARE SAFER TOGETHER PODCAST

The American Concrete Pumping Association launched We Are Safer Together – The Podcast as part of an industrywide safety campaign to reduce accidents on concrete pumping jobsites.

The American Concrete Pumping Association (ACPA) is pleased to announce that *We Are Safer Together – The Podcast* is now available on YouTube and Spotify. The five-part series explores key topics from ASME B30.27, Material Placement Systems, a critical standard that, when followed, ensures safer operations across the industry.

Produced by ACPA and Advancing Organizational Excellence (AOE), a leading consulting firm in the AEC industry, each episode delivers practical safety insights and expert perspectives that help make concrete pump jobsites safer for everyone. The podcast features conversations with industry leaders, safety experts and ASME B30.27 Committee members as they share their real-world experiences and strategies for creating safer jobsites.

In the premiere episode, host Janice Clines sits down with Christi Collins, executive director of the ACPA, to discuss the We Are Safer Together safety campaign. Collins shares the origins of the ACPA, the evolution of safety in the concrete pumping industry and the critical role of ASME B30.27 in ensuring jobsite safety. Listeners also learn about ACPA University and the innovative Coworker Safety Training program, and how it is poised to transform education for contractors working with and around concrete pumps. It is an insightful conversation about making jobsites safer for everyone.

A new episode drops every Wednesday at 6 a.m. Eastern until the series concludes. Episodes will remain available on demand. To subscribe, follow and start listening, visit www.wearesafertogether.org/podcast.

About the We Are Safer Together Safety Campaign

We Are Safer Together brings heightened awareness of ASME B30.27, the safety standard for material placement systems, which, when followed, elevates safety on concrete pump jobsites. The campaign highlights the roles and responsibilities of each trade working with or around a concrete pump under the standard. The ultimate goal is to reduce accidents and injuries through education, awareness and collaboration.

The safety campaign's success relies on the active participation of trade associations, concrete contractors, material suppliers and other stakeholders. Coalition members include the American Society of Concrete Contractors (ASCC), Concrete Foundations Association (CFA), National Ready Mixed Concrete Association (NRMCA), Tilt-Up Concrete Association (TCA) and World of Concrete. To learn more about the campaign and about ASME B30.27, Material Placement Systems, please visit www.wearesafertogether.org.

About the ACPA

The ACPA is a nonprofit association that serves as an advocate for the concrete pumping industry, committed to promotion, education and safety for its members and all those coming into contact with a concrete pump on the construction jobsite. For more information about the ACPA, visit www.concretepumpers.com.



THE CONCRETE FOUNDATIONS ASSOCIATION RELEASES SUMMER ISSUE OF CONCRETE FACTS MAGAZINE

The Concrete Foundations Association (CFA) released the summer issue of *Concrete Facts* magazine. The publication provides concrete foundation construction professionals with guidance, industry updates and practical solutions for modern foundation construction. To ensure widespread accessibility for diverse workforces, the summer issue is available digitally in both English and Spanish flipbook formats.

Readers can access the digital publications directly through the following links:

- English flipbook: cfaconcretepros.aflip.in/4ef10d3f36.html
- Spanish flipbook: cfaconcretepros.aflip.in/8d972e80a3.html

The summer issue includes:

- A Q&A with John Smoll on 3D-printed houses
- An article on blended cements and concrete foundations
- An article about post-tensioned slabs-on-ground



INDUSTRY NEWS

- A technical article about low cylinder breaks in concrete testing
- And more

For questions regarding the publication or membership resources, please contact the CFA directly at info@cfaconcretepros.org.

About the Concrete Foundations Association

The Concrete Foundations Association (CFA) aims to support the cast-in-place contractor as the voice and recognized authority

for the residential concrete industry. As an international nonprofit trade association with a diverse membership spread throughout the United States and Canada, CFA maintains a network that helps those with needs or questions seek advice and professional experience.



CONSTRUCTION MENTAL HEALTH ALLIANCE LAUNCHES INDUSTRY PLEDGE ON WEBSITE

The Construction Mental Health Alliance (CMHA), a newly formed 501(c)(3) nonprofit, announced the official launch of its Industry Pledge, now available on the organization's website.

The pledge includes measurable goals and invites construction leaders across North America to protect the physical and mental health of their workforce by committing to:

- Preventing traumatic brain injuries (TBIs) and head injuries
- Improving mental health and reducing suicide in construction
- Managing fatigue and reducing mental and physical stress
- Improving health, wellness and fitness

"For too long, our industry has asked workers to power through pain, both physical and mental, without the support they deserve," said Scott Greenhaus, president of the CMHA. "The Industry Pledge gives every company a way to lead with intention. When we make psychological safety a shared standard rather than an individual choice, we change the trajectory of an entire profession. This is about accountability, and it only works when we move forward together."

Many organizations and individuals have already made the pledge, and CMHA is hoping the pledge will serve as a cornerstone of building awareness about mental health in the industry. Those who take the pledge are invited to spread the word further by letting their team, clients and subcontractors know about their commitment by using the digital media tool kit on the CMHA website. Other recommendations include downloading resources for toolbox talk or safety meetings

covering mental health, opioid misuse, head injury prevention, fatigue management and wellness strategies. Most important is reminding field teams that confidential crisis support is always available by calling or texting the **988 Suicide & Crisis Lifeline**.

Construction leaders and organizations are invited to take the pledge and learn more at www.constructionwellness.org.

View the CMHA Pledge



About CMHA

The Construction Mental Health Alliance is a new 501(c)(3) organization that is working to address the challenges of mental health support in the construction industry head-on. Its mission is to drive systemic change in the construction industry by embedding mental health, emotional well-being and psychological safety into every level of the workforce — from company leadership to the jobsite.

NEU, RAF SIGN MOU TO DRIVE RESILIENCY, SUSTAINABILITY THROUGHOUT THE GLOBAL BUILT ENVIRONMENT

NEU: An ACI Center of Excellence for Carbon Neutral Concrete (NEU) and the Resilience Action Fund (RAF) on June 17 announced the two organizations have signed a memorandum of understanding (MOU) documenting a shared commitment to advancing the adoption of resilient construction practices that will enhance the service life of structures that include concrete or potentially increase the use of concrete in the new and/or existing built environment.

NEU and RAF staff will work together to develop and implement mutually acceptable procedures and guidelines to ensure compliance with the intent of this MOU in establishing any joint activities. Specifically, NEU and RAF will identify opportunities for the construction industry on the principles and economics of resilient practices followed by organizations such as the International Finance Corporation (IFC) and others. Both organizations will also expand national and international messaging to increase engagement on the resilience and sustainability of concrete structures.

“NEU is excited to enter this agreement with the Resilience Action Fund, as NEU and its staff have been charged with helping deliver the American Concrete Institute’s strategic goal of advancing resiliency and sustainability,” said Kerry Sutton, executive director, NEU. “By working with RAF, we will support our stakeholders in achieving resiliency and sustainability while continuing to be responsible stewards of our world to benefit future generations.”

To learn more about NEU, its members and its allied organizations, visit www.neuconcrete.org.

About the American Concrete Institute

The American Concrete Institute (ACI), a 501(c)(3) nonprofit organization, is the leading global authority for the development, dissemination and adoption of its consensus-based standards, technical resources, and educational, training and certification programs. Founded in 1904, ACI is headquartered in Farmington Hills, Michigan, USA, with a regional office in Dubai, UAE, and Resource Centers located in Southern California, the Midwest (Chicago, Illinois, area) and the Mid-Atlantic (Baltimore, Maryland, area). ACI has more than 90 chapters, 350 student chapters and approximately 40,000 members spanning more than 120 countries. The American Concrete Institute – Always advancing®. Visit www.concrete.org for additional information.

About NEU: An ACI Center of Excellence for Carbon Neutral Concrete

NEU: An ACI Center of Excellence for Carbon Neutral Concrete, was established in 2022 by the American Concrete Institute. The Center, based at ACI World Headquarters in Farmington Hills, Michigan, USA, leads the global concrete industry in advancing low-carbon and sustainable concrete

technologies, empowering all stakeholders to create a resilient built environment, and leverages ACI’s role as a world-leading authority and resource for the development, dissemination and adoption of consensus-based standards for concrete design, construction and materials. The Center’s membership is open to government agencies, industries, technical societies, standard bodies, manufacturers, contractors and professionals. To learn more, visit www.neuconcrete.org.

About Resilience Action Fund

Resilience Action Fund (RAF) is a 501(c)(3) nonprofit organization founded in 2015 whose mission is to empower people with the knowledge and tools for long-lasting homes and communities. This aligns with the UN Sendai Framework for Disaster Reduction: 2015-2030, signed by 187 countries in 2015. RAF believes that resilient development practices are a critical and often missing piece of green and sustainable building programs. It has created a library of materials and tools around resilient construction practices and development policies, including the books *Resilience – The Ultimate Sustainability and Resilience* and *Nomics*. RAF has been the lead technical adviser to IFC’s Building Resilience Index. It coordinates with international institutions, universities, public-interest entities, insurance organizations, corporations and grassroots groups to promote more resilient building policies and practices through public awareness, research and education. For more information, visit www.buildingresilient.com.



ICRI COMMITTEE 110: UPDATES TO 110.1R-2026, *Guide Specifications for Structural Concrete Repair*

BY CHARLES HANSKAT, COMMITTEE VICE CHAIR

ICRI Technical Committee 110 developed the first edition of the 110.1 Guide Specification in 2016. The committee monitors updated materials, testing and performance in the concrete repair industry that may impact revisions of the document.

From ICRI's website, "The guide specification offers a methodology for standardizing the essential requirements for structural concrete repairs by providing specification text, optional requirements, and commentary to allow the user to tailor the document to a specific concrete repair project and use as a technical specification section in a complete project manual. Both the printed and PDF copies include a Word document with hidden text for easy modification of text to meet specific repair project requirements." Essentially, the guide provides guidance for specification provisions with commentary within the text of the document. For more detailed guidance on use of the guide specification, check out this article by John Weisbarth in the *Concrete Repair Bulletin* (January/February 2016) at www.icri.org/wp-content/uploads/2024/04/NewGuide-Weisbarth.pdf.

So, what's changed in the new version recently approved by ICRI?

Shotcrete Placement: Though shotcrete has been used in repair for decades, it was not fully covered as a placement method for concrete repairs.

- The shotcrete provisions include referencing ACI SPEC 506.2 when using structural and fiber-reinforced shotcrete placement.
- Though shotcrete is a placement method for concrete, using ready-mix and prepackaged concrete materials, text was added in many sections addressing the specifics of shotcreted materials, including compressive strength, w/cm, admixtures, and aggregate sizes and gradations. Guidance is given on appropriate shotcreted concrete mixture designs.
- In qualifications, requiring verification of ACI-Certified Shotcreter was added. Note that ACI changed the terminology from "nozzleman" to "shotcreter" a few years ago.
- Preconstruction testing for shotcreted materials, both conventional concrete and fiber-reinforced, was added.
- Guidance was included that bonding agents are not required

for shotcrete placement, and latex-modified admixtures are not recommended.

- A provision was added that if a shotcrete placement is "not exposed to view," an as-shot finish may be preferable as it requires in finishing actions.
- Shotcrete testing by the relevant ASTM standards C1140 and C1604 is included.

Qualification of Repair Contractor and Foreman: The final quality of any repair is dependent on many factors, and the documented experience of the contractor is an important factor. The guide specification has required documenting company projects and the foreman's experience with jobs of similar size and complexity. Added in this version is that the foreman should also have "successful completion of the International Concrete Repair Institute's Concrete Surface Repair Technician (CSRT) educational program (Level 1)."

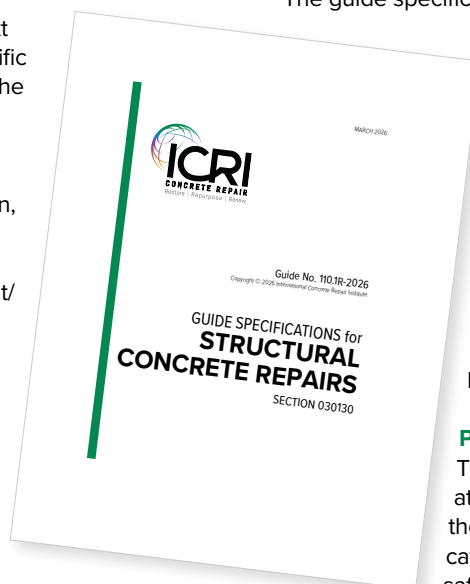
Further, in the Execution section, text was added to note that "All concrete repair work shall be performed under the direct supervision of the designated Concrete Repair Foreman."

Preconstruction Meeting

The new version now includes attendance at the project's preconstruction meeting by the anode manufacturer responsible for the cathodic protection on the job. Similarly, the safety supervisor was added to the list of preconstruction meeting attendees.

Summary

Overall, shotcrete placement was added throughout the guide specification. Also, qualifications for the repair crew, the concrete repair foreman and the shotcreter were specifically covered. As with most technical document revisions, there were also many small tweaks to refine, clarify or update the original provisions to meet current repair practices. The ICRI Committee 110 members worked diligently in reviewing and revising all the text in the document. This led to much discussion at committee meetings and on ballots, but that is part of the consensus process of document development and approval. The final document provides a valuable tool for designers and specifiers to use in developing their project specifications.



ICRI COMMITTEE 210: UPDATES TO 210.5R-2026, *Guide for Selecting and Specifying Reinforcing Bar Cleaning Levels*

BY CHARLES MITCHELL, COMMITTEE CHAIR

ICRI Technical Guideline 210.5-2023, *Guide for Selecting and Specifying Reinforcing Bar Cleaning Levels*, was developed to provide a consistent, objective method for specifying, evaluating and approving the cleanliness of exposed steel reinforcement during concrete repair projects. The guideline establishes standardized cleaning levels for steel reinforcement that has been cleaned using abrasive blasting or mechanical hand-tool methods, helping owners, engineers, contractors and inspectors communicate expectations using a common set of criteria. Rather than relying on subjective descriptions of steel reinforcement condition, the document employs visual references and standards-based comparisons to define the degree of surface preparation required before repair work proceeds.

A major emphasis of the 2023 guideline is reducing ambiguity in the assessment of corrosion products, mill scale, coatings and other contaminants remaining on steel reinforcement after cleaning. By providing clearly defined cleaning levels and corresponding visual examples, the document helps ensure that repair specifications can be written more precisely and that completed work can be evaluated consistently in the field. This approach improves quality control, reduces disputes between project participants and supports better long-term performance of concrete repairs involving corroded reinforcement.

The guideline was also designed to integrate with ICRI's Rebar Cleanliness App, which includes digital versions of the cleaning-level references, photo-matching tools, steel reinforcement renderings, reporting capabilities and project documentation features. Through this integration, users can compare field conditions directly with guideline references, can document compliance and can communicate results more effectively among contractors, inspectors and design professionals. The result is a more uniform and repeatable process for determining

whether steel reinforcement has been cleaned to the specified level before repair materials are installed.

The revisions in Guideline 210.5-2026 intend to pair tactile precision with digital assessments more accurately by using the ICRI Rebar Cleanliness App along with physical rebar samples (similar to ICRI CSP Chips) to objectively discern the level of cleanliness of existing steel reinforcement during concrete repair projects. The guideline was updated to clarify language to be consistent with ICRI Concrete Repair Terminology, so that it was not only consistent within the document but also in reference to other ICRI documents.

The major revision in the document is the concise identification of the cleanliness levels with respect to the method of removing cement paste and concrete residues from the exposed steel reinforcement. In the previous edition, there were 14 cleanliness levels, including uniformly and pitted corrosion without preparation. These levels have now been grouped into four distinct categories, RCL0, RCL1, RCL2 and RCL3. RCL0 is described as uncleaned, RCL1 is the lowest level of cleanliness and RCL3 is the highest level.

Examples of the physical samples with 12 levels of cleanliness shown, not including those that are unprepared, can now be grouped into the aforementioned four RCL categories. (Flash rust on steel reinforcement examples are also described.) The guideline still highlights the method of cleaning, either abrasive media blast (AMB) or mechanical cleaning, and identifies the corrosion as either pitting-type or uniform under the banner of the four Rebar Cleanliness Levels. The recent update to the document is intended to enable the owner, engineer, contractor and inspector to better communicate expectations of the degree of cleanliness of exposed steel reinforcement in concrete repair projects.



CHAPTER NEWS

SEPTEMBER/OCTOBER 2026

Chair's Message



Take an Active Role in Your Local Chapter

As another year begins to wind down, it's a great time to recognize the momentum our chapters have built throughout 2026. Across North America, ICRI chapters continue to strengthen our industry through technical education, networking opportunities and the exchange of practical repair knowledge. The final months of the year often bring renewed energy as chapters wrap up educational programming, plan member appreciation events and prepare for a successful start to the coming year.

One of the most valuable ways chapters can increase engagement is by promoting events early and often. Whether you're hosting a technical presentation on concrete durability, corrosion mitigation, façade assessment techniques, waterproofing systems or repair material advancements, make sure those events are posted on both your chapter website and the ICRI website. Timely promotion allows traveling members and industry partners to discover opportunities to connect with your chapter and participate in local activities.

The technical side of our industry continues to evolve rapidly. New developments in structural assessment technologies, drone-assisted inspections, nondestructive testing methods, service life modeling and sustainable repair strategies are providing owners and practitioners with more tools than ever before to preserve existing infrastructure. Chapters play a critical role in bringing these emerging technologies and best practices to our membership through high-quality educational programming and discussions.

Looking ahead, I encourage every chapter to begin identifying opportunities for 2027. Consider developing programs that emphasize hands-on learning, project case studies, field demonstrations and collaboration with local engineering firms, contractors, manufacturers and building owners. Strong partnerships and diverse educational offerings help chapters

attract new members while delivering value to longtime participants.

I encourage every member to take an active role in strengthening their local chapter. Attend a meeting, bring a colleague to an event, volunteer for a committee, submit a project presentation or consider stepping into a leadership position. The success of ICRI has always been driven by members who are willing to share their knowledge, invest in relationships and contribute to the growth of our industry.

Every chapter benefits from fresh ideas, new perspectives and engaged volunteers. Whether you are a longtime member or new to ICRI, your participation can help expand educational opportunities, support future industry leaders, and advance the repair and restoration profession. Don't wait for an invitation. Reach out to your chapter leadership team and find a way to get involved today.

As we continue to grow as an organization, chapter delegates remain a key connection between local chapters and ICRI leadership. The Delegate Program provides chapters with a direct voice in the future direction of the Institute while allowing representatives to bring valuable information, ideas and best practices back to their local membership. If your chapter has not participated recently, I strongly encourage you to take advantage of this opportunity at future conventions and meetings.

I hope to see many of you at upcoming chapter events and national programs in the months ahead. As always, if I can assist your chapter in any way, please do not hesitate to reach out.

Best regards,

David Grandbois,
ICRI Chapters Committee Chair
Western Specialty Contractors –
Minneapolis, MN



Current PNW President Audrey Wykes getting ready to start the program



Introducing everyone to ICRI Guideline 310.2R-2013 and the Concrete Surface Profile Chips



Demo participant MAPEI

PACIFIC NORTHWEST (PNW) HOSTS FIRST DEMO DAY

ICRI's Pacific Northwest Chapter hosted their first Demo Day, focused on Concrete Surface Preparation & Structural Repairs, on Thursday, June 25, 2026. This hands-on event featured a technical presentation on ICRI 310.2R, the surface preparation guideline, followed by live demonstrations of products, tools and repair techniques from leading industry manufacturers.

The chapter wishes to thank everyone who joined them for this experience. It was awesome to see so many industry professionals come together to learn, connect and share best practices in concrete surface preparation and structural repair.

A special thank-you goes out to the chapter's participating manufacturers — Euclid Chemical Company, W.R. Meadows Inc., MAPEI, Sika, Hilti Group, Simpson Strong-Tie and Husqvarna Construction — for making each of the hands-on demonstrations possible. Each participating company brought the expertise and support that made this event a tremendous success. Thank you as well to Pullman Seattle for sponsoring breakfast, Georgetown Campus/South Seattle College for hosting the event and Cement Masons & Plasterers Local 528 for their continued support and partnership. The chapter volunteers who organized this activity couldn't have asked for a better first Demo Day and look forward to making this an annual tradition!



The promotional flyer for the PNW Chapter's First Mega Demo



Tool demo from Hilti



Education by Euclid Chemical Company



Equipment demo from Hilti



Demo participant W.R. Meadows



Demonstration by Sika Corporation



Demo from Simpson Strong-Tie

VOLUNTEER CORNER

Impact of Volunteering at the Chapter Level

ICRI relies a great deal on the role of volunteers, especially at the chapter level. Chapters are the lifeblood of ICRI and integral to all that the association does. And those who volunteer to lead chapters show a commitment to ICRI at the local level as well as at the national level. What it takes to be a chapter leader is one thing, but what do volunteers get for all their time, energy and trouble as a volunteer for an ICRI chapter? We asked a few of them, and this is what they told us.

First up is Caitlin J. Maggiano, PE, associate principal and branch manager for Klein & Hoffman in Philadelphia, Pennsylvania. She is currently serving as the Delaware Valley Chapter president. We asked Caitlin what led her to volunteer as a chapter leader and what experience with ICRI colleagues has had the biggest impact on her personally.

Caitlin J. Maggiano, PE *ICRI Delaware Valley Chapter President*



Caitlin said, “I was initially drawn to becoming a chapter leader because a co-worker who was leaving the Board mentioned that they

were hoping to bring more women and more engineers into leadership roles. I happened to fit both criteria, so it seemed like a natural opportunity to get involved. I started as a director and have since served as secretary, vice president and now president. Being active in professional organizations has always been important to me. That interest began in college at Temple University, where I was heavily involved in the ASCE Student Chapter. I eventually served as president and helped lead our chapter back to the Concrete Canoe

Competition after several years of nonparticipation.

“The greatest impact of my involvement with ICRI has been the relationships I’ve built. The networking opportunities and connections formed through working alongside contractors, manufacturers and fellow engineers have been invaluable. Through ICRI, I have been able to establish myself in the restoration industry not only locally but nationally. I’ve developed trusted professional relationships with people I can turn to for guidance on projects, career decisions and even personal challenges.

“One of the most rewarding aspects of serving as a chapter leader is knowing that I am helping keep our chapter strong and active for current and future members. Seeing people make connections, grow professionally and become more engaged in the industry is incredibly fulfilling. The relationships I’ve built and the sense of community I’ve found through ICRI have had the most lasting impact on me, and I am grateful for the opportunities and friendships that have come from my involvement.”

Then we have Brian MacNeil. Brian has been involved with the British Columbia Chapter since its beginnings, being one of the local professionals

who started the chapter. And Brian has even served on the ICRI National Board of Directors, moving up through the ranks from director all the way to ICRI national president in 2024. Brian is a managing partner at TMG, Inc., out of Vancouver, Canada.

Brian MacNeil *ICRI British Columbia Chapter Director*



Brian originally started volunteering for ICRI committees and local leadership so that he could sit next to people he wanted to meet and partner with in some

commercial capacity. After about three conventions, his motivations changed to wanting to learn how the industry worked from various angles (engineering, contractors, manufacturers, etc.), get better at different aspects of his job through learning from his ICRI peers and improve engagement throughout this industry. The commercial aspect of participating in ICRI didn’t go away; it changed from being the main motivator to an amazing by-product of learning and getting better at his job in this industry.

Brian said, “Getting elected and being president was a pretty cool

experience that can't be matched. That being said, the organization trusting me (and bringing me back again and again) to host the Awards Luncheon is one of my favorite things to do." For Brian, celebrating the amazing people, the projects and the results of the incredible collaborations of those amazing members, while making his ICRI friends smile, just does not get old. At one point, he plans to pass that gavel too — but not quite yet.

Finally, there is Trevor Bestwick. Trevor is currently serving as the secretary for the Houston Chapter. Trevor is a project manager at Walter P Moore in Houston, Texas. Here is what Trevor had to say about why he got involved as a volunteer and how volunteering at ICRI has been helpful with his career.

Trevor Bestwick *ICRI Houston Chapter Secretary*



Trevor said, "Over the past decade as a restoration engineer, my work has spanned multiple markets and countries, with ICRI serving as a consistent

presence throughout. While working in Calgary and Vancouver, I became involved with ICRI because I wanted to deepen my knowledge of concrete restoration and build meaningful relationships with other industry professionals.

"When I decided to relocate to the United States and ultimately to Houston, Texas, I was able to use the ICRI network to connect with the local firms and continue my career in restoration. This led to my desire to give back to ICRI by becoming an officer for the ICRI Houston Chapter. As an officer, I have been able to accelerate the growth of my network in Houston by meeting contractors, suppliers and other design professionals through ICRI Houston Chapter events and ICRI conferences."

Do you have a volunteer story to tell? Would you like to be featured here in the Volunteer Corner of the next issue of *Concrete Repair Bulletin*? If so, please send an email to Dale Regnier at daler@icri.org with your answer to the following question and include either your headshot or a photo that helps tell your volunteer story.

People volunteer their time for a variety of reasons: to help others, to develop a new skill, to make connections or friends, to build their résumé or to be a part of something bigger. Tell the story about what led you to volunteer as a chapter leader and what you feel has had the biggest impact on you personally.



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CHAPTER CALENDAR

ICRI chapters are hosting events in 2026. Be sure to check with individual chapters by visiting their chapter pages to determine if they have made any plans after this publication went to print. You can also contact a chapter leader from any chapter to ask if they have added an event.

BALTIMORE-WASHINGTON

October 1, 2026
ANNUAL GOLF
TOURNAMENT
Blue Mash Golf Course
Laytonsville, MD

November 12, 2026
FALL TECHNICAL SEMINAR
CP&R's Main Office
Baltimore, MD

CAROLINAS

October 15-16, 2026
2026 FALL CONFERENCE
Embassy Suites
Conference Center
Greenville, SC

CENTRAL OHIO

October 9, 2026
CHAPTER CLAY SHOOT
Eagles's Nest
Sporting Grounds
Mount Gilead, OH

CHICAGO

September 16, 2026
EMERGING PROFESSIONALS
NETWORKING
Offices of SG&H
Chicago, IL

November 3, 2026
SEMINAR – CONCRETE 360
Drury Lane
Oakbrook Terrace, IL

CINCINNATI

September 16, 2026
CHAPTER GOLF OUTING
Aston Oaks
North Bend, OH

November 18, 2026
TECHNICAL SEMINAR
Rhinegeist Façade
Restoration
Location: TBD

December 16, 2026

WINTER MEETING
TPC River's Bend
Maineville, OH

DELAWARE VALLEY

September 14, 2026
ANNUAL GOLF OUTING
Radley Run Country Club
West Chester, PA

FLORIDA FIRST COAST

September 16, 2026
TECHNICAL LUNCH
& LEARN
Topic: Berkman
Garage Collapse
Speaker: Bryan Busse
University of North Florida
Jacksonville, FL

November 10, 2026
FIFTH ANNUAL SPORTING
CLAY TOURNAMENT
Jacksonville Clay
Target Sports
Jacksonville, FL

FLORIDA WEST COAST

September 16, 2026
TECHNICAL
PRESENTATION
Topic: What Is Safety?
Presenter: Rob Sullivan
Webb City Cellar at
Green Bench Brewing
Tampa, FL

GEORGIA

November 12, 2026
DEMO DAY: REPAIR
MATERIALS & METHODS
Southern Wall Systems
Suwanee, GA

GREAT PLAINS

October 15, 2026
20TH ANNUAL CHAPTER
GOLF OUTING
Winter Stone Golf Course
Independence, MO

INDIANA

September 3, 2026
CHAPTER GOLF OUTING
Plum Creek Golf Club
Carmel, IN

METRO NEW YORK

September 17, 2026
ANNUAL GOLF OUTING
Cedar Hill Country Club
Livingston, NJ

October 1, 2026
DEMO DAY:
TERRA COTTA
Skyline Restoration
Long Island City, NY

November 2026
TECHNICAL
PRESENTATION
Topic: TBD
Club 101
New York, NY

MINNESOTA

September 25, 2026
FALL TECHNICAL
SESSION
Topic: Shore Thing:
Best Practices for
Temporary Support
Speaker: Tom Oberding
Advance Shoring
Saint Paul, MN

NEW ENGLAND

September 22, 2026
CHAPTER
DINNER MEETING
Topic: GFRP Bars for
Concrete Repairs
Simpson, Gumpertz &
Heger Offices
Waltham, MA

November 10, 2026
CHAPTER
DINNER MEETING
Granite Links
Quincy, MA

December 8, 2026

ANNUAL HOLIDAY
SOCIAL &
CASINO NIGHT
Granite Links
Quincy, MA

NORTH TEXAS

October 2, 2026
ANNUAL JESSE
POINTS MEMORIAL
GOLF CLASSIC
Waterchase Golf Club
Fort Worth, TX

NORTHERN CALIFORNIA

October 15, 2026
TECHNICAL
SYMPOSIUM
Topic: Rehabilitation
in Marine Environments
Bay Area Roofing
and Waterproofing
Union Training Center
Livermore, CA

OKLAHOMA

September 24, 2026
CHAPTER MEETING
Topic: ACI 562
Requirements
Speaker: Aaron
LaRoche
AGC Tulsa Office
Tulsa, OK

PITTSBURGH

September 11, 2026
TECHNICAL LUNCH
MEETING #3
Topic: Concrete
Plant Tour
Castle Builders
Supply, Inc.
Pittsburgh, PA

October 2026
TECHNICAL LUNCH
MEETING #4
Topic: Critical
Material Testing
Ground Floor
Training Center
Pittsburgh, PA

November 13, 2026
DEMO DAY
Topic: Cleaning
and Restoring
BAC Local 9
Training Center
Pittsburgh, PA

SOUTH CENTRAL TEXAS

September 17, 2026
CHAPTER
EDUCATION EVENT
Topic: Post Tensioning
Haywire
Austin, TX

October 15, 2026
CHAPTER GOLF
TOURNAMENT
The Bandit Golf Course
New Braunfels, TX

November 12, 2026
ACI/ICRI JOINT
EDUCATION EVENT
Topic: Concrete Repair
Casa Chapala
Austin, TX

SOUTHWEST FLORIDA

October 23, 2026
SUNSET OCEAN CRUISE
Salty Sam's Marina
Fort Myers Beach, FL

VIRGINIA

October 29, 2026
CHAPTER DEMO DAY
Richmond Primoid
Warehouse
Richmond, VA

INTERESTED IN SEEING YOUR CHAPTER
NEWS & EVENTS LISTED HERE?

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PEOPLE ON THE MOVE

Hoffmann Promotes Robert Delagrange to Director of Business Development

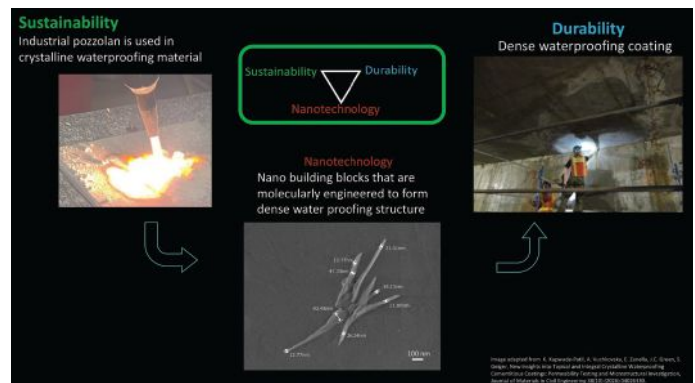
ICRI Company Member Hoffmann Architects + Engineers is pleased to announce the promotion of Robert G. Delagrange to director of business development. Previously senior business development manager for the firm's Connecticut office, Bob focused on Southern New England opportunities in higher education and healthcare. In his new role, he will oversee strategic growth across Hoffmann's three locations, expanding the firm's presence across the Northeast and Mid-Atlantic. Bob joined Hoffmann in 2016, was promoted to senior business development manager in 2021 and became a shareholder in 2024. He is active across the Southern New England design and construction industry, serving as Programs Committee co-chair at the Connecticut Building Congress and began his term as secretary this July. He also holds leadership roles with several local community and industry organizations.

PRODUCT INNOVATIONS

Nano-Scale Building Blocks Developed from Sustainable Materials Could Play a Major Role in Waterproofing Concrete

The research and development center at W.R. Meadows, Hampshire, recently published a journal paper titled "New Insights into Topical and Integral Crystalline Waterproofing Cementitious Coatings: Permeability Testing and Microstructural Investigation" in the American Society of Civil Engineers (ASCE) *Journal of Materials in Civil Engineering* led by Kunal Kupwade-Patil, principal scientist; Anita Vuchkovska, product manager, construction liquids and industrial coatings; Edoardo Zanella, quality specialist; Jacob C. Green, tech service chemist; and Steven Geiger, director of technical services.

This research details how integral crystalline admixtures and topical coatings lower concrete permeability and porosity. By leveraging sustainable materials, these admixtures generate nano-scale building blocks that fill microscopic pores, strengthen the cement matrix and block water. Kupwade-Patil, lead author at W.R. Meadows Inc., notes this is the first integration of sustainability, nanotechnology and durability in the waterproofing sector.



Advanced instrumentation analysis such as magic angle spinning nuclear magnetic resonance (MAS NMR) spectroscopy revealed the formation of calcium-silicate-hydrate (C-S-H) and calcium-aluminum-silicate-hydrate (C-A-S-H) phases. Additionally, the admixtures produced various carbonate polymorphs (calcite/aragonite) that further compact the matrix and prevent water intrusion. Senior co-author and Director of Technical Services Geiger highlights a historical connection: Because these exact phases healed micro-cracks in ancient Roman concrete, the team has successfully adapted ancient Roman technology for modern waterproofing applications.

View the paper here: www.ascelibrary.org/doi/10.1061/jmcee7.mteng-22888.



WOMEN IN ICRI SPOTLIGHT: MARLA FRANCO

BY MICHELLE NOBEL,
CONSPEC ASSOCIATES INC.

Marla Franco earned her bachelor's degree in civil engineering from the Corporation University of the Costa (CUC) in Barranquilla, Colombia. Encouraged by her father, an architect, she chose civil engineering because it aligned with her strengths in organization, planning and strategic thinking. The field also allows her to serve as a bridge between cultures by supporting clear communication and collaboration, skills she continues to apply in her work today.

During her studies, Marla contributed to an urban bus route project that helped bring bus stops to a city that previously had none. She also gained hands-on experience as a resident engineer on a canal project and worked on road-marking projects in her community.

One of the most meaningful experiences in her professional journey has been building her career in the United States, where each opportunity has continued to challenge and shape her growth. To strengthen her technical foundation, she completed a General Contractor course at Miami Dade College, earned her Level 1 Concrete Technology certification from ICRI and became a Bluebeam Certified Professional (BCP).

Marla began her U.S. career in the gas sector as an inspector for contractors supporting Chicago's gas utility. In that role, she demonstrated leadership, promoted a safe work environment

and maintained quality control over project materials. Her performance led to an opportunity to advance into an engineering position.

In her current work, Marla performs routine and entry-level engineering tasks, supports minor design preparation, develops sketches, reviews project plans, maintains equipment and ensures compliance with specifications and procedures.

Marla's professional interests center on combining fieldwork with engineering analysis to support safe, efficient and well-documented projects. She is proud to have built experience in both field and office settings while earning certifications that strengthen her skills as a civil engineer.

She discovered the concrete repair industry through her work inspecting materials such as concrete, mortars, mastics and fireproofing. Her interest grew after a co-worker encouraged her to pursue a concrete technology certification to deepen her understanding of these materials. She later joined the International Concrete Repair Institute to expand her knowledge of concrete repair and restoration, stay aligned with industry standards and connect with other professionals in the field.

At Brindley Engineering, Marla has developed two informative educational guidelines for implementing Bluebeam in client reports and has contributed to other initiatives by providing feedback and revisions. Her passion for engineering stems from a commitment to continuous learning and effective problem-solving, utilizing practical tools to improve project outcomes.

Marla recently joined the Women in ICRI Committee, an experience she finds inspiring because many members bring extensive engineering expertise. Through the committee, she has connected with women engineers from across the country and is currently focused on becoming more involved with ICRI at the local level.

Outside of work, Marla enjoys reading, cooking, assembling furniture, tackling home projects and exploring new places through travel. She also finds that walking helps her clear her mind and disconnect from her daily routine.

One of her favorite pastimes is visiting coastal areas and spending time at the beach. With family in both Colombia and Florida, she values quality time with loved ones and friends, which helps her maintain balance, motivation and perspective.

Marla has a strong technical curiosity, practical field experience and a commitment to continuous growth in the concrete repair and restoration industry. Her dedication to learning, collaboration and professional engagement positions her well to make meaningful contributions to ICRI and the industry for many years to come.



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AD INDEX

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