JULY/AUGUST 2024
Vol. 37, No. 4

CRB
CONCRETE REPAIR BULLETIN

SPECIFICATIONS FOR CONCRETE REPAIR

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CONCRETE REPAIR
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ON THE COVER: Check out the project profile in our featured article on page 23.

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FEATURE ARTICLES

DEPARTMENTS

The International Concrete Repair Institute is the leading resource for education and information to improve the quality of repair, restoration, and protection of concrete. Visit www.icri.org.

PRESIDENT'SMESSAGE

BRIAN MACNEIL

SPECIFICATIONS FOR CONCRETE REPAIR

I remember working for my uncle on weekends during high school washing trucks. We had a big 5-ton truck with a pressure washer, tanks, hoses, and brushes in the back and rolled around the lower mainland of British Columbia washing trucks at their company yards. Some companies had hundreds of vehicles in their fleets of all shapes and sizes. Cars, trucks, vans, tractors, trailers, tankers… anything you could think of, and we washed them.

One sunny afternoon, we had just started a new yard when my uncle pulled up and told us we needed to go back to the last yard and catch some misses. Looking back, I think we had missed inside the wheel wells of some of the larger vehicles. Something the owners of the vehicles probably would not have even noticed. We made no excuses, and we went back and caught the misses. My uncle wasn't mad. He simply said, ***"If you are going to do something, do it well."***

I think about that from time to time, as it is not a bad piece of advice. But I'll take it even further. If you were going to be graded on how well you did on the last activity you accomplished, what grade would you get? Let's go a step even further. If you were ***only going to be known*** for the last activity you accomplished, would you have done it differently?

For example, let's say you are a contractor, and you were hired to fix a leaking elevator pit. What does "doing it well" look like? Sure, you dried it up, but… Did you clean up the area afterward? Did you have good conversations with other trades? Did you do it safely? Were you polite to the surrounding trades/public? Did you communicate well with the client? Were you on time?

Or let's say you are a specifier and were hired to create a repair specification for a leaking elevator pit. Sure, you created the specification, but… Did you visit the site? Did you create a specification that solves the problem or just the symptoms? Are the materials specified all the same caliber/available? Are the steps thought through and clear? Were you open to feedback/questions? Is the information and standards in the specification up to date?

The difference between just doing something or ensuring you do it well could be the difference between getting more work, getting referrals, or even getting an award for that project!

We only get ***one shot*** at many activities, so it is important to take advantage of these opportunities and do them well. If you are participating on a committee, attending a networking event or conference, preparing for a presentation, having a meeting etc., there is a huge difference in the results that you could manifest if you took the extra time and care to do them well.

For example, when people ask me for advice on how to make the most out of an ICRI conference, I always tell them the same thing: ***"You only have one chance at everything at this convention. One Monday morning networking breakfast, one chance to see each presentation, one chance to attend the social, one chance to…. So, you better make the most of it and attend everything you can while you are here. You might not get another chance to learn something new or meet that person who will have a lasting positive impact on your life and livelihood. The worst part is that you'll never know what you missed. So, get out there!"*** (There is a chance I don't say it quite as poetically as that every time—but for the sake of the article, maybe read it as if someone like Morgan Freeman was narrating it and it will be incredibly impactful. Read it again.)

As this year's ICRI president, I am staying focused on doing what I can well. I am fortunate to be surrounded by so many high achievers in this association who are showing me the way. If I have one piece of advice, it is to live each day and perform each task as if it is the only thing that you will ever be graded on. So do it well.

In closing, if you need an example of someone who "did it well," then I would ask you to look towards a gentleman named ***Jim MacDonald***. Jim was a Fellow of ICRI and ACI. He was a founding member of ICRI, served as President, was named Honorary Member in 2012, received the ICRI Distinguished Service Award in 2016 and the first-ever President's Award in 2019. Along the way, Jim mentored many people and made many close friends. We thank Jim for all his contributions and thank his family for lending him to us. As many of you know, Jim passed away recently so I would like to dedicate this president's message to someone who not only "did it well," he did it ***AMAZINGLY well***! Hearts and thoughts to Jim's family and loved ones. Thank you, Jim.

Sincerely,

Brian MacNeil
Brian MacNeil
President, International Concrete Repair Institute

DIRECTOR'SMESSAGE

ERIC HAUTH

Greetings! I write this from our sunroom porch on a spectacular June morning in Minnesota. “Weather” usually ranks in the top 3 conversation topics in this part of the country, so picture-perfect days like this are hard to come by and even harder to beat!

With repair and construction in full swing, summer is truly go-time for ICRI members. Yet, even during this busy season, I’m amazed by the time and dedication put in by ICRI volunteers!

Technical committees continue to push their work forward. One example, Committee 120-Health and Safety, chaired by Steven Walker, Baker Restoration & Waterproofing, has been regularly meeting virtually to complete and publish a major update to ICRI’s safety guidelines, 120.1-2009, *Guidelines and Recommendations for Safety in the Concrete Repair Industry*. They are also championing a crucial upgrade in personal protective equipment with the Hardhats to Helmets campaign and reviving the “Safety Corner” for regular safety messages in the CRB.

It’s hard to imagine work that better reflects ICRI’s core mission: *Making the built world safer and last longer*.

The work also never stops on the administrative committee side. This is exemplified by the Marketing Committee, chaired by Ed Kluckowski, Freyssinet, LLC. The committee has been working closely with ICRI staff to develop a comprehensive product launch campaign this summer for ICRI’s new Rebar Cleanliness App, available now on both Apple and Google Play stores.

Leveraging the new 210.5R-2023 *Guide for Selecting and Specifying Reinforcing Bar Cleaning Levels*, published under the leadership of Committee 210 Chair Charles Mitchell, this new app (the first such product of ICRI) represents an exciting step forward in delivering ICRI’s highly relevant technical tools on the job site.

Keep an eye out for ICRI marketing efforts on this new app and, if you’re in need of guidance and documentation on rebar cleanliness on the job site, go to either the Apple or Google Play store and give it a try! You’ll be on the leading edge of efforts to raise the bar on this facet of concrete repair.

This summer, I am also very excited to host ICRI’s Executive Committee (EC), led by ICRI 2024 President Brian MacNeil at our summer EC planning retreat here in Minneapolis. At this annual retreat, ICRI leadership will focus on innovation and strategies to grow the value of this association for our current and future members and the industry as a whole. In many ways, ICRI stands at an important inflection point, with a well-established brand, reputation, and content. Focusing on these strengths, the future looks as bright as the Minnesota morning shown above.

None of these activities would be possible without the incredible contributions of our many volunteers who work closely with our small but mighty staff team at ICRI headquarters. We thank every one of you for taking the time out of your busy lives to make an impact on ICRI and this industry.

I look forward to seeing you at a future ICRI chapter or national event. For now, I wish you a safe, successful, and enjoyable summer.

Sincerely,

Eric Hauth

Eric Hauth
ICRI Executive Director

ICRI CONCRETE REPAIR
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COMMITTEE 110: GUIDE SPECIFICATIONS

MISSION STATEMENT

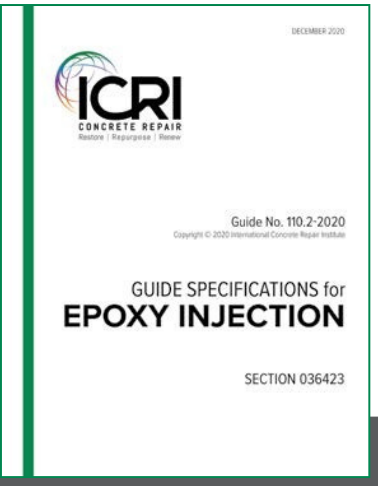
To be a leading resource for education and information to improve the quality of repair, restoration, and protection of concrete and other structures in accordance with consensus criteria.

BENEFITS OF COMMITTEE MEMBERSHIP:

- Network with repair experts within the concrete repair industry, including repair engineers, leading manufacturer representatives, experienced repair contractors, and educators.
- Expand knowledge on best practices used in the concrete repair industry that are essential to an effective and durable repair program.
- Support design professionals to improve their technical specifications for various repair projects.

WHAT WE DO:

- Develop guide specifications for various types of repairs, including concrete, masonry, coating, etc.
- Provide individual guide specifications that can be directly used as a technical specification section in a complete and coordinated project manual.
- Transfer "state-of-the the-art practice" to all repair professionals via webinars, technical presentations, and other effective methods.


DECEMBER 2020
ICRI CONCRETE REPAIR
Restore | Repurpose | Renew
Guide No. 110.2-2020
GUIDE SPECIFICATIONS for
EPOXY INJECTION
SECTION 036423

GOALS/DELIVERABLES

To develop guide specifications to aid the Licensed Design Professional in the preparation of technical specifications, for inclusion directly into a contract for the repair in structural concrete and related items using materials and methods that are in line with the state-of-the-art practices materials and methods used in the concrete repair industry

www.icri.org/icri-committees

matthewc@icri.org

+1 651.366.6095

www.icri.org/volunteer-job-board

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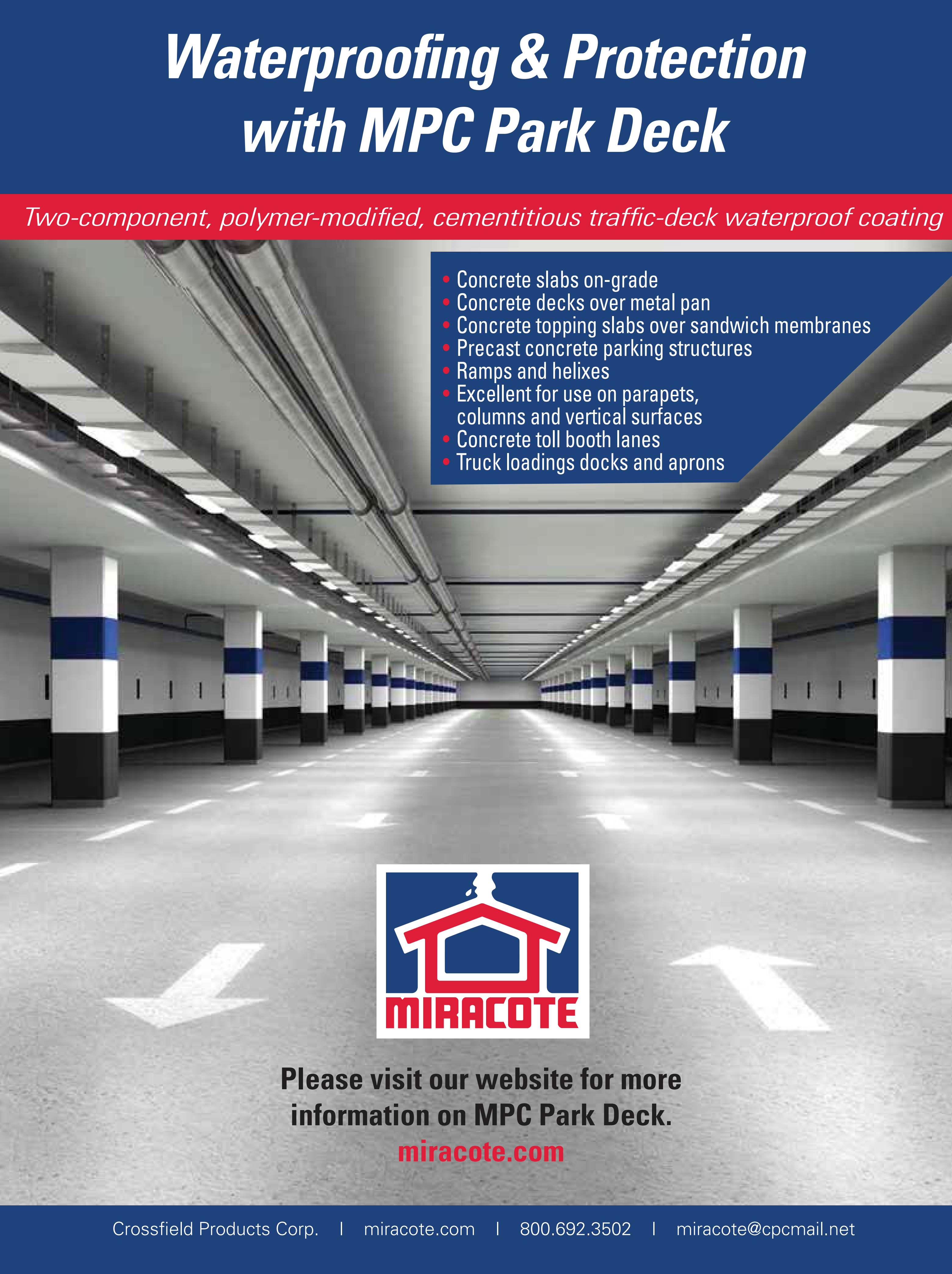
Waterproofing & Protection with MPC Park Deck
Two-component, polymer-modified, cementitious traffic-deck waterproof coating
• Concrete slabs on-grade
• Concrete decks over metal pan
• Concrete topping slabs over sandwich membranes
• Precast concrete parking structures
• Ramps and helixes
• Excellent for use on parapets, columns and vertical surfaces
• Concrete toll booth lanes
• Truck loadings docks and aprons
MIRACOTE
Please visit our website for more information on MPC Park Deck.
miracote.com
Crossfield Products Corp. | miracote.com | 800.692.3502 | miracote@cpcmail.net

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Cortec Corporation – Environmentally Safe VpCI™/MCI® Technologies

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CTS Rapid Set

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Hammer Construction

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SUPPORTING MEMBERS

...your continued support greatly enhances programs both within ICRI and the concrete repair industry as a whole.

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SHERWIN-WILLIAMS.

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USCP US CONCRETE PRODUCTS

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CERTIFICATIONUPDATE

CSMT PROGRAM AT IUPAT

ICRI hosted two Concrete Slab Moisture Testing (CSMT) programs in May of 2024. Both were private programs for some of our most dedicated flooring companies. First, we held a program in Greenville, South Carolina for Bonitz, Inc. where we certified eleven and re-certified seven moisture testing technicians. Following the Carolinas, we travelled to the Dallas/Ft. Worth area to host a program for Spectra Contract Flooring. There we certified nine and re-certified six current technicians.

If your company or your Chapter wishes to schedule a CSMT Program, please contact Dale Regnier (daler@icri.org) and provide him with contact information for the point person who will be in charge of coordinating the event, the proposed exam location, and potential date(s).

Top of the class for Bonitz were these three in the drilling demonstration and contest. Left to right we have Lance Campbell, Tim Sheperd, and Tyler Tirpak with lead instructor and moisture testing expert, Peter Craig.

The top three drillers at the Spectra class in Texas were (left to right) Jose Dorado, Ron DePolo, and Beau Gajdica, each drilling at least a two-inch-deep hole going past two inches by the smallest margin.

NORTHFORD STRUCTURAL CONNECTIONS

Introducing the

DTFC

DOUBLE-TEE FLEXIBLE CONNECTION

By Northford Structural Connectors
(U.S. PATENT NO. US8800232)

Finally, a solution to failed double-tee shear connections.

A post-installed flexible connection for seismic and vehicular loading.

TESTED | PROVEN RESULTS | FATIGUE RESISTANT | CORROSION RESISTANT

TYPICAL FAILURES

Traditional double-tee connections can fail for many reasons, including corrosion of attached reinforcement, restrained tension in colder months, and fatigue from vehicular loading. The immediate and tangible result is in moving and leaking joints. More importantly, it also leaves the cantilevered double-tee flange unsupported and diminishes the seismic resistance of the deck diaphragm.

OLD METHODS FALL SHORT

Spall repairs at connections fail because the concrete patch is adhered to a stressed connection; it is a fight the patch cannot win. And weld repairs at fatigue fractures do not change the underlying problem; they just restart the clock.

OUR SOLUTION

Our DTFC is designed to both repair and avoid the common pitfalls of the traditional connection. It is corrosion resistant, allows movement across the joint to dissipate tensile loads, and is not affected by vehicular fatigue loading.

A GAME CHANGER

The DTFC was designed by industry experts seeking to provide a simple and resilient solution to the familiar precast double-tee garage connection weaknesses and failures. It succeeds where tradition has failed.

The DTFC is a product of Northford Structural Connectors, a privately held company.

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Designing for Durability: Galvanic Anode Systems to Assure Long-Term Performance

by David Whitmore and David Simpson with Aimee Pergalsky

HISTORY AND USE OF EMBEDDED GALVANIC ANODES FOR CONCRETE

Galvanic anodes were first proposed and used by Sir Humphry Davy in the 1820s when he proposed to use small quantities of zinc or iron to prevent oxidation of copper plating from corroding, thereby expanding the lifespan of British Navy ships.[1] Since then, galvanic anodes have also been used to protect underground steel structures such as pipelines and tanks.

Galvanic protection systems were first used on reinforced concrete structures around 1960,[2] and the first galvanic anodes for embedment in concrete were developed in Britain in the early 1990s as a cost-effective means of protecting concrete structures from corrosion due to chloride exposure.[3]

Galvanic anodes are a proven method of corrosion protection for steel reinforcement in concrete. This straightforward yet powerful technique involves connecting the reinforcement steel to a more active metal that corrodes preferentially, thereby shielding the reinforcing steel from corrosion.

The initial use of embedded galvanic anodes was in concrete repairs to protect concrete adjacent to the repair from accelerated breakdown due to the "halo effect" (incipient anode formation), which results from an imbalance of chloride concentration between the substrate concrete and the repair material.[4] Reinforcing steel in the substrate concrete adjacent to the repair corrodes at an accelerated rate relative to the repaired area. Galvanic anodes attached to the steel in the repair area provide an alternate preferential electrical path, diverting corrosion to the embedded anodes instead of the reinforcement.

The most commonly used galvanic anodes are crafted from high-purity zinc, which is cast around a tie wire to provide a durable zinc-to-steel connection (Fig. 1). These Type 1A anodes are encased in an alkaline cementitious mortar shell, which keeps the zinc active over their design life, ensuring their longevity.[5] The zinc, designed to corrode at a faster rate than the steel it's attached to, remains active over the anode's lifespan thanks to the enhanced formulated alkaline mortar shell. The tie wire secures the anode to the reinforcement and serves as the electrical connection between the reinforcement and the zinc anode, making it a crucial component of the system (Fig. 2).

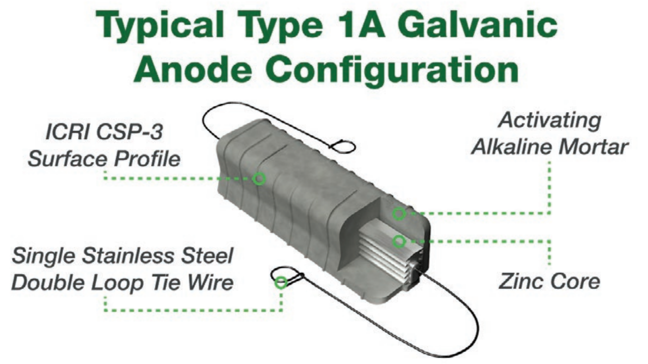

Fig. 1: Illustration of a typical galvanic anode used for concrete repair

Fig. 2: Galvanic anodes attached to reinforcing steel in bridge deck repair

APPLICATIONS OF EMBEDDED GALVANIC ANODE SYSTEMS FOR CONCRETE

Galvanic protection systems are used to prevent corrosion in various applications. These systems provide localized corrosion protection in concrete repairs, joints between new and existing concrete, and targeted areas with high corrosion risk. They also offer blanket corrosion protection to entire structures that are severely corroded or exposed to corrosive environments. Galvanic protection systems are installed in structural encasements and overlays, jackets using stay-in-place forms, and proactively in new construction to mitigate corrosion in sound concrete before damage becomes visible. (Fig. 3)

Fig. 3: Galvanic jacketing to protect bridge columns in a marine environment. The jacketing system includes alkali-activated distributed anodes inside stay-in-place FRP formwork

LONG-TERM PERFORMANCE OF GALVANIC ANODE SYSTEMS: LESSONS LEARNED FROM EARLY PROJECTS

Galvanic anodes are increasingly being utilized to protect reinforcing steel in concrete structures, showcasing the widespread acceptance of this technology globally. The volume of galvanic anode performance data collected has aided in the fundamental understanding and development of the technology and refinement of system design and application. While the technology behind galvanic anode performance is more complex than once believed, long-term monitoring of in-place systems has led to better comprehension of factors affecting anode performance and the development of a customizable design process.

Over the past 25 years, embedded galvanic anodes have been used extensively, and various sites have been closely monitored and investigated to validate performance over time. This has enabled detailed analysis and long-term predictability of anode behavior to be determined. While analyzing the data, a significant finding was made that the current output of a particular anode reduces over time and can be predicted such that a long-term predictive model could be developed. Understanding the current output performance of an embedded galvanic anode system is crucial for maintenance planning and ensuring corrosion protection is provided for the desired service life.

Anodes installed in the 1990s have been monitored for over 25 years, and these data have provided invaluable information on how galvanic anodes work and how they behave over time.[6] These studies have provided an understanding of the impact of anode spacing steel density, current density, and the formation and movement of zinc corrosion products within the anodes. Most importantly, the knowledge of the aging factor associated with galvanic anodes was established. This aging factor allows designers and specifiers to predict the level of corrosion protection over the entire life of the galvanic anode. When choosing an anode type for an application, it is important to consider these design factors, as they can vary significantly depending on the anode used.

DESIGN CONSIDERATIONS FOR EMBEDDED GALVANIC ANODES: A COMPREHENSIVE APPROACH

Reinforcement corrosion is not generally uniform throughout a structure. The rate and amount of corrosion vary based on several factors, including concrete cover and its variability, localized water and chloride exposure, degree of carbonation, and variability of the concrete itself within a given structure or member.

Galvanic repair protection requires several steps to ensure a successful design strategy.

I. Identifying & Analyzing the Cause of Corrosion: Structure Evaluation and Testing

The first step is to assess the cause of reinforcement corrosion and perform relevant testing to determine the degree and extent of corrosion. Once the testing is completed, priorities are determined based on corrosion risk classification, client needs and expectations, structure use, the life expectancy of the repaired structure, the anode system, and cost/benefit analysis.

Typical testing and evaluation protocols include visual and delamination surveys, concrete cover depth evaluation, chloride content testing and profiling, corrosion potential mapping, carbonation testing, and reinforcement continuity. Although there are others, these are the most common tests conducted in a corrosion condition assessment (Fig. 4).

Fig. 4: Corrosion potential testing of prestressed concrete pile

Design Current Density used in Tables

Design Criteria

Corrosion Risk Category	Chloride Level*	Minimum Design Current Density**
Low to Moderate	<0.8%	0.4mA/m2 (0.04mA/ft2)
High	0.8%-1.5%	0.8mA/m2 (0.07mA/ft2)
Extremely High	1.5%	1.6mA/m2 (0.15mA/ft2)

** Chloride content is based on percent by weight of cement.*
***Minimum design current densities at end of anode design life. Current densities for the XPX and/or environments with average annual temperatures above 20°C (68°F) are double the standard current densities.*

ISO Standard

0.2-2.0mA/m2

0.2-2.0mA/m2 Only New Construction

Environment may override this e.g. Marine, Artificial Environments etc.

All based upon 10°C Average Annual Temperature

Fig. 6: Corrosion risk categorization and recommended minimum current density[7]

II. Risk Classification & Zoning

After testing is completed, corrosion risk is determined and assigned to each structure or element. Variables are addressed by separating a structure into zones based on exposure, steel distribution, structural member geometry, and chloride level. It's important to note that the ambient environment often plays a critical role, potentially overriding the general guidelines. Environmental conditions such as proximity to marine settings, exposure to frequent or continuous water contact, and locations of structural joints demand particular attention. (Fig. 5) These conditions can significantly elevate the corrosion risk, necessitating experience-based judgments and protective measures beyond what chloride levels alone may suggest.

Structures or elements can be divided into three zones or risk categories based on the results of a comprehensive testing program (Fig. 6).

Fig. 5: Concrete deterioration in marine environment due to corrosion

Zone 1 (low to moderate risk): areas with low to moderate risk of corrosion

Concrete deterioration may or may not be present yet, but testing has determined that the risk of corrosion activity may be sufficient to warrant protection. These areas typically have a chloride level of <0.8% by weight of cement.

Zone 2 (high risk): areas with high risk of deterioration due to corrosion

Without protection, corrosion will be likely and will continue resulting in concrete damage and the need for repair. These areas typically have a chloride level of 0.8- 1.5% by weight of cement.

Zone 3 (extremely high risk): areas with severe risk of deterioration due to corrosion

Corrosion risk is very high and immediate action is required to maintain concrete integrity and mitigate progressive deterioration. These areas may have chloride levels of 1.5% by weight of cement or more.

Once the risk profile is understood, spacing charts can be used to provide recommendations for the placement of anodes in most applications.

III. Current Density

Current density is the amount of electric current flowing through a unit of surface area of the steel. It is measured as milliamperes per unit area (mA/m^2). It is vital to understand that the protection afforded by galvanic anodes is directly linked to maintaining this current density throughout the entire life of the system.

When dealing with concrete repairs, only the boundary of the repair area is at risk of the Halo Effect (incipient anode

Current Density Requirements

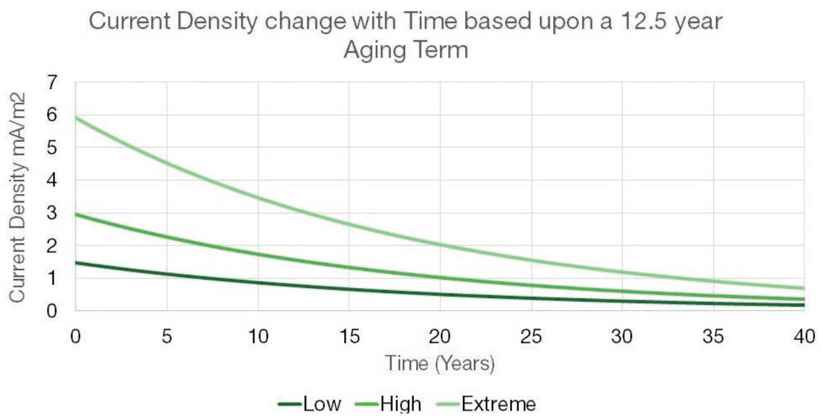

Fig. 7: Modeled current density change over time

formation) if repairs are completed as per ICRI Guidelines.[8] To be conservative, the current density is calculated to a position halfway between two anodes, four inches (or 100 mm) beyond the outer edge of the repair. However, an increased current density may be desired depending on the external environmental temperature and customer requirements.

IV. Current Density Prediction

All galvanic anodes age. When anodes are first installed, the electrical current output is at its best and strongest. Over time, the current output diminishes (Fig. 7) due to the reduction in the surface area of the anode and the buildup of corrosion products around the zinc anode. (Fig. 8)

Long-term monitoring of in-place systems and laboratory tests has defined the current output of these systems over time. The galvanic anode system should be selected and designed based on its ability to deliver the desired current density for the entire design service life, as opposed to just when the system is installed.

Fig. 8: Zinc corrosion byproduct surrounding core from galvanic anode removed after 20 years in service

V. Steel Reinforcement Density Calculation

Calculating steel density is important to ensure that the anode system can provide enough current to all the steel to be protected. The steel density is the ratio of the reinforcing steel surface area to concrete surface area.

Simplified: Steel Area = bar diameter x length x number of bars per unit area x π

Examples:

Commonly, 10% additional steel is added to account for lap splices and other steel found in most structures. For more precision, ground penetrating radar (GPR) can be used to confirm the number and position of steel bars rather than depending on as built and shop drawings.

Imperial	Metric
#5 bars @ 8" on center each way (2 mats)	**15M bars @ 200mm on center each way (2 mats)**
Top mat longitudinal bars π x D x L x n = π x 5/8" x 12" x 12/8" = 35.3 in^2	Top mat longitudinal bars π x 15 mm x 1,000 mm x 1,000 mm/200 mm = 235,612 mm^2
Top mat transverse bars π x D x L x n = π x 5/8" x 12" x 12/8" = 35.3 in^2	Top mat transverse bars π x 15 mm x 1000 mm x 1000 mm/200 mm = 235,612 mm^2
Bottom mat longitudinal bars π x D x L x n = π x 5/8" x 12" x 12/8" = 35.3 in^2	Bottom mat longitudinal bars π x 15 mm x 1000 mm x 1000 mm/200 mm = 235,612 mm^2
Bottom mat transverse bars π x D x L x n = π x 5/8" x 12" x 12/8" = 35.3 in^2	Bottom mat transverse bars π x 15 mm x 1000 mm x 1000 mm/200 mm = 235,612 mm^2
Total bar surface area = 141.2 in^2	Total bar surface area: 942,488 mm^2
Concrete surface area = 12" x 12" = 144 in^2 141.2 in^2 ÷ 144 in^2 = 0.98	Concrete surface area: 1,000 mm x 1,000 mm = 1,000,000 mm^2 942,488 mm^2 ÷ 1,000,000 mm^2 = 0.94
Total steel density: = 0.98	Total steel density: 0.94

VI. Climate Consideration

Temperature impacts the long-term performance of galvanic anodes. In addition to the risk category, current density, and steel density, the temperature of the structure must also be taken into consideration (Fig. 9). Annual average temperatures higher than 59-68°F (15-20°C) require higher current densities and different anode designs to achieve the same anode life as lower temperatures.

VII. Zinc Mass

The level of protection provided by a galvanic anode is not determined solely by the mass of zinc in the anode. Instead, protection is a combination of factors, including the activator, surface area, zinc mass, anode structure, efficiency, and utilization. Most anodes contain excess zinc mass to perform over the expected service life (Fig. 10). Understanding how an anode produces current as a function of time is critical.

Over time, the anode's capacity to generate current decreases (refer to Fig. 7). Factors, such as the reduction of zinc surface area and the generation of zinc corrosion products, cause the current output to decrease over time. This process is called "anode aging" and can be described by an "anode aging term."[6] The anode aging term is the time it takes for the anode's current output to decrease by 50%.

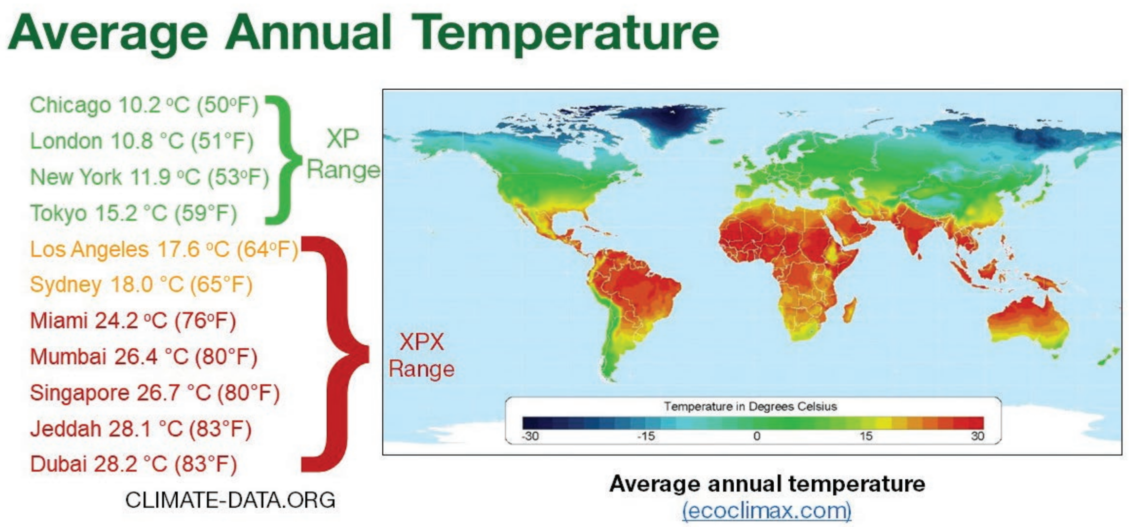

Fig. 9: Average annual temperature in global locations[9]

Data collected through monitoring have provided valuable information regarding anode aging terms. Predictive models for various anodes and service conditions are being developed. When choosing a galvanic anode system, it is important to consider the anode's aging term, as it varies depending on the anode type.

THE USE OF TECHNICAL DATA SHEETS AND THE CUSTOM DESIGN PROCESS

Once the risk profile and other criteria are understood, spacing charts can provide anode spacing for most applications.

Technical data sheets use default values for several factors, such as the design service life, current density, average annual temperature, and anode aging term.

In addition to standard design assumptions in technical data sheets, anode designs can be customized by using different assumptions, such as changing the design service life, using different average mean temperatures, changing the current density, etc.

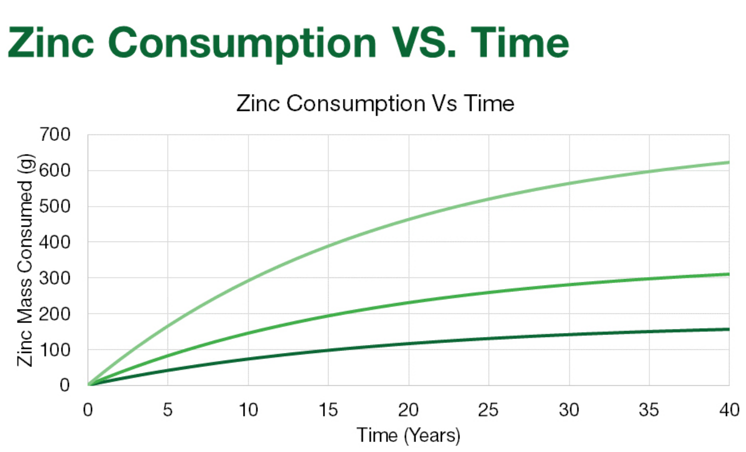

Fig. 10: Zinc mass consumption over time for one specific anode type

This graph was developed based on data from a specific anode system. The aging factor will vary for different anode types and configurations.

PERFORMANCE SPECIFICATIONS BASED ON LONG-TERM PERFORMANCE MODELING

Many specifications rely on zinc mass alone, which is a prescriptive approach. However, research and monitoring have revealed that zinc mass is not an accurate predictor of performance. Performance is a function of the current output of the specific anode over the design service life, which can vary due to differences in anode construction. Anodes may use different activators, zinc mass, zinc surface area, and construction methods, all of which impact the initial current output and how it diminishes over time. Therefore, knowing the initial current output and the aging factor for each anode is crucial to achieve the desired level of performance.

To ensure performance, it is necessary to specify the desired performance, such as the current density to be provided to the steel in proximity to the repair. This level of performance should be specified for the desired design service life and should consider factors such as anode aging, as shown by field performance data, in the service environment.

The specified current density should be chosen based on the corrosion risk factor, which may vary for different areas of the structure. Specifying field performance data to support the design is essential. ACI CODE 562-21: Assessment, Repair, and Rehabilitation of Existing Structures—Code and Commentary requires the specifier to define the service life and to design the repairs to achieve that service life.[10]

SUMMARY

Understanding the long-term performance of galvanic anodes over time is essential. This knowledge can be used to design effective and efficient galvanic anode systems to provide long-term corrosion protection and durable, sustainable reinforced concrete structures.

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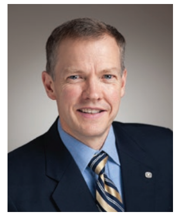

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Assessment and Repair of Fire Damaged Power Plant Turbine Pedestal

by Kurt Tyler, PE and Daniel Pearson, PE, SE

BACKGROUND

A fire broke out at the power plant due to a mechanical failure in the electrical generator at a power plant on the Gulf Coast. The fire spread from the electrical generator to various support equipment and piping below the upper deck. Based on discussions with the owner, the fire burned for approximately 5 to 6 hours before it was extinguished. The fire caused extensive damage to the mechanical equipment and support utilities and caused damage to concrete elements of the turbine pedestal (Fig. 1).

Fig. 1: Fire damage to turbine pedestal and piping, photo taken a few days after fire

The subject turbine pedestal is a conventionally reinforced cast-in-place concrete tabletop structure that supports a turbine, generator, and various support equipment, piping, instrumentation, and electrical utilities. The turbine pedestal is comprised of an upper deck that is 9 feet (2.7 m) thick supported by twelve rectangular columns which vary in size from 7 feet 6 inches by 7 feet (2.3 by 2.1 m) to 9 feet 6 inches by 7 feet (2.9 by 2.1 m) (Fig. 2). There are several large penetrations in the upper deck at the locations of major pieces of equipment. The turbine pedestal is rectangular in plan with overall dimensions of 142 feet 6 inches (43.4 m) in the north-south direction by 49 feet (14.9 m) in the east-west direction and an overall height of 40 feet (12.2 m) from the top of the mat foundation to the top surface of the tabletop.

The engineer was retained to perform a fire damage assessment of the concrete element of the turbine pedestal and to develop repairs. Recovery time was critical, as the damaged unit represented a large loss of electrical generation for the grid and the owner was facing heavy financial losses due to the loss in revenue. The fire damage assessment consisted of a field assessment and laboratory evaluation of concrete samples extracted from the turbine pedestal.

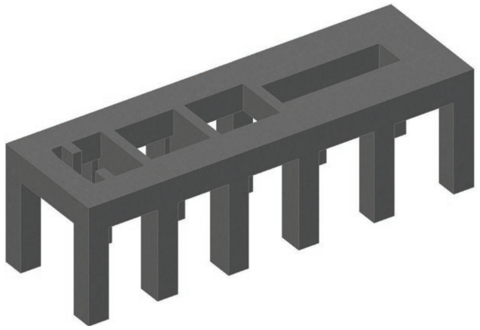

Fig. 2: 3D model of turbine pedestal with major components labeled

Effects of Fire on Reinforced Concrete

In reinforced concrete, both the concrete itself and the reinforcing steel can be damaged when subjected to fire exposure.

As the surface temperature of the concrete element increases from fire exposure, surface crazing will occur, followed by cracking and spalling as the heat transfers to the interior of the concrete. Cracking is typically a result of restraint from thermal expansion due to differential temperatures between the exterior surfaces of a concrete element relative to the cooler interior concrete; this is often seen most clearly at the corners/along edges of concrete elements. Depending on the type of aggregate present, cracking can also be attributed to expansion of aggregates which leads to internal microcracking, popouts, or crazing.

Spalling can occur in the temperature range of 302°F to 572°F (150°C to 300°C).[1] Thermal stress-induced spalling is the result of near surface compressive stress (due to restrained thermal expansion) creating a fracture plane between the heated surface and cooler interior region. Spalling is also possible during fire extinguishing efforts where the opposite occurs, as the water rapidly cools the surface of the concrete allowing for differential shrinkage at the surface from the hotter interior.

The color of concrete aggregates and paste may change during heating, depending on the concrete constituents, and can provide an indication of the maximum exposure temperature. At 482°F to 572°F (250°C to 300°C), there is usually a color change to pink/red and at 932°F to 1112°F (500°C to 600°C) there can be a color change to purple/grey.[2] The intensity of the color change is mostly dependent on aggregate type (i.e., presence of certain minerals). These color changes can provide a visual indication of the depths of general heat exposure within a concrete member, and also an indication of the temperatures of the underlying steel reinforcement.

The reinforcing steel within concrete elements may also be affected by elevated temperatures. Strength reduction in reinforcing steel may occur while the steel is at high temperatures; however, yield strength may recover after cooling. For hot-rolled steel reinforcement bars, the yield strength is typically recovered for temperatures less than approximately 1112°F (600°C).[3] As such, for exposure temperatures greater than 1112°F, yield strength and/or ductility of the steel reinforcement may be reduced. While for concrete temperatures above 930°F (500°C), there may be significant compressive strength loss due to irreversible microcracking and volume change of the matrix.[2]

FIELD ASSESSMENT

The field assessment was performed over the course of several weeks and mobilizations. Several visits were performed shortly after the fire, and several additional visits were performed in the following weeks as mechanical equipment and support utilities were removed, providing additional access. The field assessment consisted of a visual assessment, mechanical sounding, and material sampling.

Fig. 3: Fire damage to soffit of upper deck. Extensive spalling is visible

Fig. 4: Deep spalling with exposed reinforcing along edge of equipment penetration (marked with red arrow)

Visual Assessment

The visual assessment identified widespread damage to the upper deck. Mechanical (hammer) sounding was used to identify the extents of delaminations. Widespread spalling and delaminations were noted on the soffit (Fig. 3), vertical surfaces of the various equipment penetrations, and vertical surfaces around the perimeter of the upper deck. The spalled depth on the soffit and vertical surfaces of the upper deck ranged from 1 to 1-1/2 inches (25 to 38 mm). More severe spalling occurred along the edges of the upper deck soffit, with some of the spalls featuring exposed reinforcing (Fig. 4). Several of the columns also exhibited concrete spalling and delaminations on the sides (Fig. 5).

The upper deck and columns featured numerous embedded steel channels that acted as connection points for piping, instrumentation, and electrical supports. Many of the embedded steel channels locally pulled away from the concrete surface and exhibited concrete spalling near them (Fig. 6). The damage was the most prevalent near the ends of the embedded channels.

Material Sampling

Eleven 4-inch (10.16 cm) diameter concrete core samples from the turbine pedestal were extracted. The concrete core locations were chosen to capture a range of fire damage exposure conditions on the various structural elements. Several core samples were extracted from areas with no fire damage for use in heat soak studies, in which samples are exposed to specific temperatures to observe color changes within the concrete, and to provide a point of comparison during petrographic studies of the damaged samples. The material sampling was done near the beginning of the field assessment, so the laboratory evaluation could be completed

Fig. 5: Spalling on side of column

Fig. 6: Typical damage to embedded channels. Channel is pulled away from the surface of the concrete by approximately one inch

as soon as possible. This reduced the time required for the fire damage assessment and expedited the overall time to begin repairs.

LABORATORY EVALUATION

Petrographic Examination

A petrographic examination was performed on the cores in accordance with ASTM C856 to determine the effects of exposure to elevated temperatures on the concrete.[4]

A high volume of meso- and microcracking was observed to a maximum depth of approximately 1/2-inch (13 mm) in the concrete core samples from the areas exhibiting fire damage (Fig. 7). The cracks propagated through and around fine aggregate and were oriented predominantly sub-parallel to

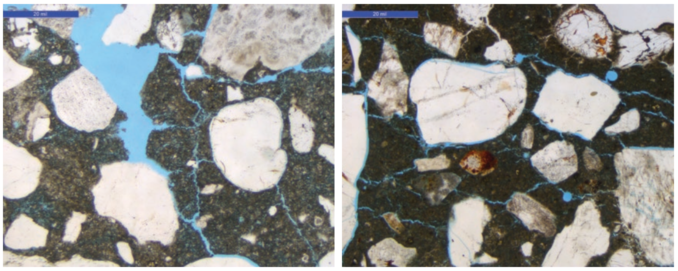

Fig. 7: Photomicrographs of the exterior surface regions of the cores, showing a high volume of microcracking within the paste and some aggregate (red arrows). Also note the red appearance within a few fine aggregate particles in Core 2 (yellow arrows). Both images were taken in plane-polarized light.

the surface. The paste in these cores was softer and more absorptive than undamaged concrete. Discolored aggregate particles which appeared redder and darker in color than aggregate in unaltered areas were also observed.

Heat Soak Studies

A heat soak study was performed on a concrete core sample in an area that did not experience fire damage. In these studies, the concrete was heated in the laboratory to known temperatures for a set period of time. The purpose of the studies was to identify any key color and microstructure features of the concrete when exposed to known temperatures that could be used to compare with concrete in the fire-exposed area.

Based on comparisons between the concrete core samples exposed to the fire event and the heat soak study samples, it is believed that the maximum temperature the concrete was exposed to was approximately 550°F (287°C) (Fig. 8 & Fig. 9).

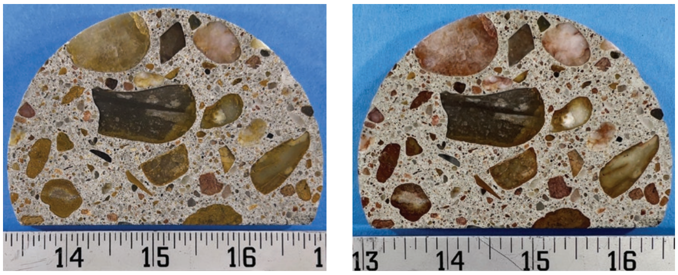

Fig. 8: Images of lapped concrete core sample, before (left) and after (right) being placed in a muffle furnace at 550°F for 4 hours. Note the lighter, yellower color in paste after heating, and general darker/redder color of many aggregate particles.

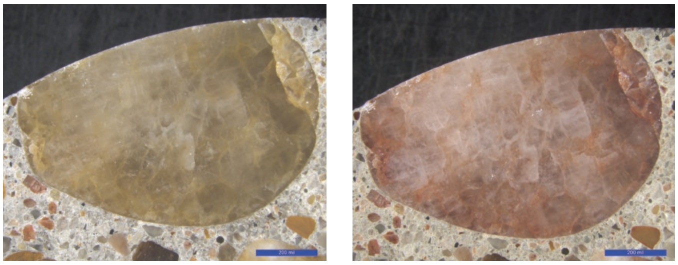

Fig. 9: Close-up images of a coarse aggregate particle before (left) and after (right) being placed in a muffle furnace at 550°F for 4 hours.. Note the visible darkening and pink/red discoloration of the particle, induced during heating, as well as a yellower paste color and similar color change to that of the coarse aggregate particle in surrounding fine aggregate particles.

Estimated Damage Depth and Maximum Temperature of Examined Samples

Based on comparisons between the cores damaged due to the fire and those altered in the lab, it was believed that the fire-damaged concrete was exposed to a maximum temperature of 550°F (287°C) and that fire damage in the concrete occurred to a maximum depth of approximately 1/2-inch (13 mm) from the top surface of the cores; however, the surface of the concrete had already spalled off in these locations.

REPAIR DESIGN

The goal of the repairs was to remove fire-damaged concrete and restore the original section and cover for durability. Based on the estimated maximum temperature from the laboratory studies, strength loss in the reinforcement steel was deemed unlikely. As such, the focus on the repairs was only on removal and replacement of the fire damaged concrete.

As discussed previously, the soffit and vertical surfaces of the upper deck exhibited spalling of up to 1-1/2 inches (38 mm) deep and fire damage up to a maximum of 1/2-inch (13 mm) from the remaining surface. For most areas of the upper deck soffit, the concrete clear cover was 4 inches (100 mm), which meant a shallow depth concrete repair was an option. However, due to the extent of fire damage, a typical unreinforced shallow-depth repair would likely be at an increased risk of spalling if/when shrinkage cracking occurs, due to the lack of reinforcing and mechanical anchorage. As such, a modified shallow-depth repair approach was selected, with input from the repair contractor and owner. In these areas, the repairs detailed a concrete removal to a depth of approximately 3-1/2 inches (90 mm) and concrete surfaces prepared to a Concrete Surface Profile (CSP) 7.[5] A new mat of temperature and shrinkage steel was detailed at the mid-depth of the repair area to mitigate against future temperature and shrinking cracking (Fig. 10). New bent bar dowels were detailed to provide mechanical anchorage for the new shallow-depth repair material.

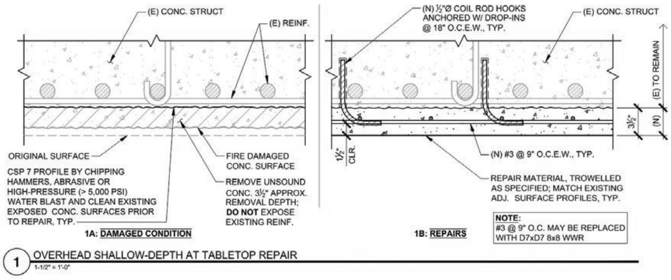

Fig. 10: Concrete repair detail for soffit of turbine pedestal upper deck.

At locations on the pedestal with shallower clear cover, or along edges with deep spalling and exposed reinforcement, a typical partial-depth concrete repair was utilized. This consisted of concrete removal to a depth which allowed for a ¾-inch (1.91 cm) annular space around the main reinforcing bars.

Fig. 11: Overhead concrete repairs on soffit of upper deck during demo.

CONSTRUCTION

The overhead concrete repairs were formed and pumped (Fig. 11 & Fig. 12). Some repair areas were large, which required significant amounts of concrete formwork. At some of the overhead repair areas, the mezzanine level was not present directly below. Instead of having the formwork posts span over 30 feet down to the top of the mat foundation, aluminum stringers were designed to support the formwork and span over some of the gaps in the mezzanine level. This significantly sped up the construction of the formwork and the overall project schedule. The vertical concrete repairs were formed and poured with concrete placed using a bird's mouth (Fig. 13).

Fig. 12: Overhead concrete during forming (left) and after being completed (right).

Fig. 13: Vertical concrete repairs on face of equipment penetration during demo (left) and during formwork removal (right).

CONCLUSIONS

Despite significant challenges in the form of tight timeline, access constraints, and amount of fire damage, the project was completed on time. In total, over 1,500 square feet (139.4 m^2) of overhead concrete repairs and 750 square feet (69.7 m^2) of vertical concrete repairs were completed. Open and constant communication between WJE, the repair contractor, and owner was a major part of the success of the project. The concrete repairs to the turbine pedestal helped contribute to returning a major power plant back into service.

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Project Profile: Lower St. Anthony Falls, Dam Sill Joint Repair

by Jacob L. Fall, PE

BACKGROUND

Located within downtown Minneapolis, Minnesota, and constructed in 1956, Lower St. Anthony Falls (LSAF) Lock and Dam is supported on a St. Peter Sandstone and Platteville Limestone foundation. The sandstone is friable and poorly to non-cemented and must be fully protected from erosion and excessive seepage forces. The failure of an electric utility powerhouse adjacent to LSAF in the 1980s from the internal erosion of its foundation is a good example of the seepage susceptibility and erodability of the sandstone and overlying alluvial deposits. According to the 1991 and 2005 dive inspection reports, significant concrete scour was detected in the downstream aprons of each gated dam bay. The monolith joint nearest to pier 4, the river wall, was reported to have experienced severe scour, 18–21 inches (457–533 mm), potentially compromising the copper waterstop. Therefore in 2012, with near historical low water flow conditions, a concrete repair plan was developed and implemented. To perform a complete inspection and proper repair of each monolith construction joint, each downstream gate bay sill was required to be dewatered. For each gate bay to be properly and safely dewatered, several key factors had to be considered including waiting for low flow conditions, maintaining the pool elevation, designing and constructing a dewatering box, and coordinating between Locks and Dams, Maintenance and Repair and Engineering (Fig. 1).

Fig. 1: Lower St. Anthony Falls (LSAF) Lock and Dam

PREPARATION PRIOR TO REPAIRS

To successfully complete the project, water flow conditions needed to be maintained near 2000 cubic feet per second (56.6 M^3/s) and to sustain a reasonable flow capacity only one gate bay at a time was dewatered. During the time of construction, drought-like conditions during the past winter, spring, and summer months aided in water flow conditions. The bulkheads stored onsite were employed upstream of each gate bay under construction. There are no such bulkheads or reaction slots in the piers accommodating a downstream closure at each gate; therefore, aluminum needles once used as the St. Paul District's main dewatering system were implemented as the dewatering surface skin plate and were supported by a custom fabricated steel frame support system. They installed by crane into each gate bay (Fig. 2).

Fig. 2: Downstream dewatering using surface skin plate, supported by custom steel frame support system

REPAIR STRATEGY

Each eroded area was repaired with conventional concrete and involved preparing the eroded concrete surface and properly placing and curing the concrete. Before each repair was conducted, the repaired areas were mapped. At the perimeter of the repair area, a 4" wide by 2" (102 by 51 mm) deep trench was cut into the concrete. The purpose is to provide a retaining boundary against which the repair material can be compacted and consolidated. Wood 2" by 10" (38 by 235 mm) was used as formwork enclosing each repair area. Next, within each heavily eroded area, equivalent size reinforcement was installed to replace any missing reinforcement. In the repair areas with less than 6" (152 mm) of erosion, half half-inch anchor bolts were installed 12" (305 mm) on center both ways and had a minimum of 2 inches of concrete clear cover above the prepared concrete surface. The installed anchor bolts provided a mechanical anchorage to supplement bonding for the newly placed concrete. Meanwhile the installed reinforcement will restore the original design capacity of the concrete structure. After the reinforcement and anchor bolts were installed, the repaired areas were cleaned using shop vacuums, ensuring that the concrete surface was clean of sand, dust, and any debris that would hinder the bond. During the surface preparation and cleaning stages, most of the water could be pumped out. However, any water left within the repair areas was properly displaced during the concrete placement (Fig. 3 & 4).

Fig. 3: De-watering of the repair area

Fig. 4: De-watering of the repair area

REPAIR MATERIAL SELECTION AND CURING

According to EM 1110-2-2002 Evaluation and Repair of Concrete Structures, pages 8-34, "The use of conventional concrete with the lowest practical water to cement ratio and hard, abrasion-resistant coarse aggregate is recommended for repair of structures subjected to abrasion-erosion damage. Also, silica fume concrete appears to be an economical solution to abrasion-erosion problems."[1] The concrete mixture used contained 670 lbs (304.0 kg) of cement, 54 lbs (24.5 kg) of silica fume, and a ¾ inch (19 mm) granite coarse aggregate. The water-to-cement ratio was lowered to 0.38, with a maximum slump of 6 inches (152 mm). This mixture also contained a viscosity-modifying admixture (VMA) and a workability-retaining admixture (WRA). These two admixtures were used for increased resistance to segregation and workability, also contributing to properties of Self Consolidating Concrete (SCC) (Fig. 5 & 6).

Fig. 5: Transporting concrete down to the repair area via bucket

This project consisted of a short working schedule with a pool and tailwater elevation that needed to be maintained. This mix design was chosen to achieve high early strengths within the 14-day curing period. After the initial set of each placement, the repair areas were flooded with water to a depth of 6 to 8 inches (152 to 203 mm). At three days into the curing period, the upstream bulkheads were removed, and the dewatering box was flooded to the tailwater elevation and placed into the next gate bay for dewatering. At 7 days into the curing period, the minimum flows were allowed to be restored. Finally, at 14 days maximum flows were allowed to be restored.

Fig. 6: Transporting concrete down to the repair area via pump truck

The concrete was tested for compressive strength in pound per square inch (psi) at the following schedule: 2 at 7 days, 2 at 14 days, and 2 at 28 days. The strength at seven days was 5040 psi (34.7 MPa), the strength at 14 days was 6365 psi (43.9 MPa), and the strength at 28 days was 7540 psi (52.0 MPa). The tests and their results were conducted in general accordance with ASTM C39 Compressive Strength of Cylindrical Concrete Specimens.[2]

CONCLUSION

With a total cost of $350,000.00, this was a unique, challenging, and successful project for the U.S. Army Corps of Engineers – St. Paul District. The success of this project was the result of several key factors—including historically low flow conditions, a unique dewatering box that was designed and constructed specifically for this project, and an effective surface preparation, concrete placement, and curing procedure. However, the most important key factor contributing to the success of this project was the communication between Locks and Dams, Maintenance and Repair, and Engineering.

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New Joint ACI and ICRI Guide for Cementitious Repair Material Data Sheet

by Fred R. Goodwin, Benoit Bissonnette, Dave Fuller, Mark Nelson, and Joshua Lloyd

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Frequently, cementitious repair material test data are inaccurately reported or improperly required in specifications, often referencing unclear test method modifications or in-house test methods. Descriptions of material limitations, packaging, storage, label contents, application instructions, material composition, and material properties can be inconsistent, confusing, missing, or misleading. ACI PRC-364.3-22/ICRI 320.3R-2022: Cementitious Repair Material Data Sheet—Guide[1,2] is a first in the industry to provide this information in a standardized, logical, and consistent format so that repair materials can be appropriately selected and specified.

The concept of producing a protocol for cementitious repair materials first appeared in "Performance Criteria for Concrete Repair Materials Phase II, Field Studies"[3] in 1998 as the result of a detailed comparison of the published information from 12 proprietary repair materials. A draft document was included in the subsequent report.[4] The document was discussed and refined at the 1999 workshop "Predicting the Performance of Concrete Repair Materials" hosted by the National Institute of Standards and Technology (NIST).[5]

One of the outcomes of the workshop was the formation of a task group that comprised representatives from material suppliers, specifiers, and academics to develop a protocol. Over the next several years, the task group refined and identified the appropriate industry organizations for adoption of the document. This work was included as one of the goals of Vision 2020: A Vision for the Concrete Repair Protection and Strengthening Industry, which was an inter-industry development group to support the concrete industry's strategic needs to establish a set of goals to improve the efficiency, safety, and quality of concrete repair and protection activities. This effort led to a series of focused workshops to define the most important industry issues and needs used to establish the goals in Vision 2020.[6] One of the first goals of Vision 2020 was realized when ICRI published a version of this document as ICRI 03740 Inorganic Repair Material Data Sheet Protocol in 2004.[7,8] It was later renumbered as ICRI 320.3R[9,10] and updated by ICRI in 2012. ACI published a nearly identical version of this document, ACI 364.3R-09: Guide for Cementitious Repair Material Data Sheet, in 2009.[11] Unfortunately, at the time of this publication, it was not possible to have a unified version of the document with both organizations because it had not been developed as a joint committee. Reference to the ICRI document was removed at the request of the ACI Technical Activities Committee (TAC). Now, several years later, the document has been harmonized by merging the content of both versions. The combined document has been balloted by the appropriate technical committees of both organizations and reviewed by both organizations' TACs.

The introduction and scope of the combined document states:

"The guidance on testing and reporting verifiable properties of mortar, extended mortar, and concrete is primarily intended for the manufacturer, to make sure the repair material data sheets are prepared in a standard way, with reproducible and comparable information. The manufacturer should use it for developing products based on market needs and technology improvements. The information provided in the document is certainly useful to the specifier in choosing verifiable properties consistent with the requirements of a particular repair situation. It provides the general user education on the range of material characteristics and properties that may impact a repair and on the nuances of the various tests available for that matter."

"The purpose of this document is to provide a guiding protocol for testing and reporting of data for cementitious repair materials in order to allow objective comparison between alternative products. It does not address every issue associated with material selection; for further discussion, refer to ACI 546.3R.[12] The characteristics and properties described in this document do not necessarily need to be reported depending on the nature of the material and its intended use. Certain tests may not be appropriate for some materials. Materials containing lightweight aggregate or heavyweight aggregate are beyond the scope of this document as typically specialized tests are required for these materials."

"The test methods used for the determination of the reported data should be selected from those listed in the Table included at the beginning of the document and further explained within the document. The table covers most of the characteristics and properties generally of interest for cementitious materials, although it does not preclude others to be reported. Test data should be reported in the order and sections as listed, with the test method(s) used explicitly mentioned adjacent to it. Variations in the standardized test methods or substitute test methods prevent direct comparison between alternative materials by the specifier. Any additional test methods, non-standardized methods, or deviations from the test methods in this document shall be reported and documented in sufficient detail to allow the specifier to evaluate the likely impact on test results and to allow other laboratories to repeat the testing within acceptable repeatability and reproducibility."

"Additional information describing the significance and use of the test methods described herein may be found in ACI 546.3R and ICRI 320.2R.[13] In comparison with these documents, ACI 364.3R/ICRI 320.3R serves a very different purpose, that is, guidance on uniformized testing and reporting Material Data Sheet information. While ACI 546.3R lists standardized tests only, without directions, ACI 364.3R/ICRI 320.3R provides guidance on testing and reporting Material Data Sheet information and, where applicable, describes and explains modifications (such as used for drying shrinkage or freezing and thawing of composite specimens). Contrary to ACI 546.3R, no values are suggested in the ACI 364.3R/ICRI 320.3R document as its intent is essentially to provide a basis for testing to allow comparison between materials and to verify compliance with values reported by the supplier or other laboratories."[1,2]

ORGANIZATION OF THE DOCUMENT

The document contains guidelines from both organizations—ICRI and ACI. It is printed in a two-column format, with the test method listed in the left column and commentary in the right. Information from both original versions were combined to create the final document.

The introduction and scope, which were described previously, are presented in the first chapter of the document. The second chapter is devoted to definitions, which is intended to complement what can be found in ACI Concrete Terminology (CT)[14] and ICRI Concrete Repair Terminology (CRT).[15] Chapter 3 contains information suggested to describe the repair material—including material type, recommended use, claimed benefits, and stated limitations. Further explanation is included in examples listed by each characteristic. In quantitative terms including detailed methods for determining the characteristic, Chapter 4 covers packaged dry material content characteristics such as total sulfur trioxide (SO^3), total alkali content, chloride content, pH, and characteristics of the aggregate. Chapter 5 addresses the freshly mixed (plastic state) characteristics and properties of the repair material including the referenced test methods. The hardened state characteristics and properties of repair materials that should be reported in the Material Data Sheet are described in Chapter 6. The packaging information and content that should be reported in the Material Data Sheet are described in Chapter 7. Finally, the instructions on how to use the material that should be provided in the Material Data Sheet are described in Chapter 8.

INFORMATION TO BE REPORTED IN A MATERIAL DATA SHEET

Chapter 4: Packaged dry material characteristics

Due to concern for potential overexpansion or susceptibility to deterioration in some environments, the total SO_3 is to be reported and expressed as a percentage by mass of cementitious materials. Many proprietary materials contain blends of different cements, additives, admixtures, supplementary cementitious materials, and other constituents that contain alkalis or may influence alkali-aggregate reactivity (AAR). Guidance on the risk and mitigation of AAR is provided by referencing ASTM C1778, "Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete." Total water-soluble and acid-soluble chloride contents as a percentage by mass of the mortar or concrete are reported to provide information to avoid exceeding the critical chloride concentration to initiate corrosion of metals in contact with the repair material. Allowable chloride limits are not provided as this threshold depends on the exposure conditions and on the type of structure being considered. The pH of the repair material for both the fresh and hardened states is also to be reported. A test method for determination

Characteristic	Test method(s)
Total sulfur trioxide (SO_3)	ASTM C114
Total alkali content	ASTM C114
Chloride content	ASTM C1152/C1152M, ASTM C1218/C1218M
pH	ACI 364.17R-18[16]
Characteristics of aggregate	ASTM C33/C33M, ASTM C88/C88M, ASTM C117, ASTM C1778

Table 1: Characteristics of packaged dry materials to be reported in the Material Data Sheet and determined using referenced test methods

of these pH values is recommended. The +170 mesh (90 µm) fraction obtained by wet sieving is used to determine the general characteristics, grading, deleterious substances, soundness, and reactivity of aggregates along with the values obtained from specific tests in comparison to the allowable limits for the intended use according to ASTM C33/C33M, "Standard Specification for Concrete Aggregates."

Table 1 lists all characteristics of packaged dry materials to be reported in the Material Data Sheet and applicable test methods.

Chapter 5: Fresh state characteristics and properties

Chapter 5 describes the freshly mixed (plastic state) characteristics and properties of the repair material including methods for determining consistency, material unit weight, time of setting, air content, and yield using the recommended mixing equipment, duration, and sequence, as well as mixing liquid content. If a range of mixing liquid or consistency is recommended, the most fluid/least stiff workable consistency is to be used and the amount of mixing liquid used and consistency reported. Specific test methods are used for mortar and concrete and for self-consolidating and non-self-consolidating materials. A method for calculating yield of a repair material is provided from the unit weight of the mixed material and the total mass of mixed material and mixed package unit.

Table 2 lists all properties of fresh state material to be reported in the Material Data Sheet and applicable test methods.

Chapter 6: Hardened state characteristics and properties

Chapter 6 describes hardened state characteristics and properties of a repair material. These characteristics/properties depend on the curing regimen used for the material with different conditions required if the repair product is normal setting, rapid hardening, or polymer modified. Four regimens are defined and the specific age(s) for testing described for each test. Rapid-hardening materials are either complying with the compressive strength requirements described in ASTM C928/C928M, "Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete," or prepared with a primary binder complying with ASTM C1600/C1600M, "Standard Specification for Rapid Hardening Hydraulic Cement." Polymer modification is left to the claims of the user of the material or determined based on the benefit of polymer modification, if such guidance is not provided by the material manufacturer or specifier. Because the curing regimen and age of the specimens at testing can significantly influence the test results, that information needs to be provided for the various characteristics and properties reported.

Hardened state characteristics/properties that should be reported in the Material Data Sheet include:

- Density, absorption, and voids—to develop the data required for conversions between mass and volume for mortar and concrete and to show inconsistencies within a mass of mortar or concrete;
- Air content—to estimate the likelihood of damage due to cyclic freezing and thawing;
- Compressive strength—to measure maximum resistance of a concrete or mortar specimen to axial compressive loading;
- Splitting tensile strength—to provide a generally satisfactory estimation of the material's tensile strength;
- Flexural strength—to determine the ability of a material to resist failure in bending and to estimate material's tensile strength;
- Direct tensile strength—to assess material's resistance to cracking and to evaluate tensile bond strength;
- Short-term tensile bond—to determine the adhesive bond between the repair material and the substrate concrete;
- Modulus of elasticity—to measure the stiffness of a material;
- Compressive creep—important if stress is induced in the repair material due to the restraint of shrinkage strains or factors such as thermal movement or the application of live loads;
- Coefficient of thermal expansion—to determine the change in linear dimension per unit length or change in volume per unit volume of a material per degree of temperature change;
- Length change—to determine the length changes that are produced by causes other than externally applied forces and temperature changes;

Property	Test method(s)
Consistency	ASTM C143/C143M, ASTM C1437, ASTM C1611/C1611M
Material unit weight	ASTM C138/C138M, ASTM C185
Time of setting	ASTM C191, ASTM C266, ASTM C403/C403M
Air content	ASTM C231/C231M
Yield	ASTM C138/C138M, ASTM C185

Table 2: Properties of fresh state materials to be determined using referenced test methods and reported in the Material Data Sheet

Property	Test method(s)*
Density, absorption, and voids	ASTM C642
Air content	ASTM C457/C457M
Compressive strength	ASTM C39/C39M, ASTM C109/C109M
Splitting tensile strength	ASTM C496/C496M
Flexural strength	ASTM C78/C78M, ASTM C348
Direct tensile strength	CRD-C 164-92[17]
Short-term tensile bond	ASTM C1583/C1583M, ICRI 210.3R-2022[18]
Modulus of elasticity	ASTM C469/C469M
Compressive creep	ASTM C512/C512M
Coefficient of thermal expansion	CRD-C 39-81[19]
Length change	ASTM C157/C157M
Restrained expansion	ASTM C806, ASTM C878/C878M
Cracking resistance	ASTM C1581/C1581M
Resistance to freezing and thawing	ASTM C666/C666M
Scaling resistance	ASTM C672/C672M (withdrawn), ICRI 320.2R-81
Electrical indication of concrete's ability to resist chloride-ion penetration	ASTM C1202
Chloride ponding	AASHTO T 259-02(2021)[20]
Bulk electrical resistivity or conductivity	ASTM C1876
Sulfate resistance	ASTM C1012/C1012M
Chemical resistance	ASTM D1308

Table 3: Characteristics/properties of hardened state materials to be determined using referenced test methods and reported in the Material Data Sheet

*Some of the referenced test methods are modified in this document, as stated in the corresponding section

- **Restrained expansion**—to determine actual time-dependent volume changes the material, described as shrinkage-compensating, undergoes during and after curing;
- **Cracking resistance**—to evaluate the sensitivity of cement-based materials to cracking when subjected to restrained volume changes;
- **Resistance to freezing and thawing**—to determine susceptibility to deterioration when exposed to cycles of freezing and thawing;
- **Scaling resistance**—to evaluate the surface durability of materials in environments involving cycles of freezing and thawing and the use of deicing chemicals;
- **Electrical indication of concrete's ability to resist chloride ion penetration**—to determine the electrical conductance of concrete and to provide a rapid indication of its resistance to chloride ion penetration;
- **Chloride ponding**—to establish the correlation between the actual chloride ion penetration and indirect measures of the chloride ion penetration;
- **Bulk electrical resistivity or conductivity**—to provide a rapid indication of the material resistance to chloride ion penetration or to penetration of other ions;
- **Sulfate resistance**—to evaluate susceptibility of a material to sulfate attack; and
- **Chemical resistance**—to determine the material resistance to various chemicals

Table 3 lists all characteristics/properties of hardened state materials to be reported in the Material Data Sheet and relevant test methods.

Chapter 7: Packaging information and content

The packaging information and content that should be reported in the Material Data Sheet includes the brand name; ASTM specification designation (if applicable); lot identification number; net weight in each container; date of manufacture; recommended use expiration date (shelf life); required storage conditions, including minimum and maximum temperature, humidity, and other conditions; conditioning requirements of the material prior to use; usable working time for high and low temperatures within which the product will meet the stated performance parameters; material volume yield in each container; and if the product is formulated for use in horizontal, vertical and/or overhead applications. The intent is to provide a consistent format for what information needs to be present on packaging labels.

The mean mass of packages in any shipment, as shown by weighing 50 packages selected randomly, must not be less than the mass printed on the package. In the United States, package mass must comply with the maximum allowable variation requirements specified for packages labeled by weight in the NIST Handbook 133[21] and in Canada, package mass must comply with the tolerance requirements specified in the Consumer Packaging and Labelling Regulations (C.R.C. c. 417)[22] or local requirements if superseded by local regulations. In all locations, the mass of an individual package must not vary by more than ±2% from the mass printed on the package.

Chapter 8: How to use the material

The instructions that should be provided in the Material Data Sheet on how to use the repair material include concrete substrate preparation prior to repair such as the recommended Concrete Surface Profile (CSP)[23] number or range and the recommended moisture condition for the surface at the time of the repair material placement.

When a bonding agent is recommended to bond fresh repair material to the substrate, the type of agent and its open time are to be included. If bonding agents or some types of bonding agents are to be avoided, this also needs to be clearly indicated.

If the product is permitted or required to be aggregate extended, the mass quantity to add per unit of material and, if it depends on the repair thickness or any other parameter, the recommended adjustment criteria, the grading size number per ASTM C33/C33M, the recommended aggregate moisture content, the maximum thickness of repair material beyond which aggregate extension is required, and any other requirement of the aggregate to be used needs to be included in the Material Data Sheet.

The recommended mixing equipment per ICRI 320.5R[24] as well as the amount of mixing water or other designated liquid to be used, or most fluid/least stiff workable consistency or range and the recommended mixing duration or sequence of mixing and resting time periods should also be in the Material Data Sheet. The repair material volume yield for mortar using ASTM C138/C138M, "Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete," with the 13.5 fl. oz. (400 mL) cylindrical measure of ASTM C185, "Standard Test Method for Air Content of Hydraulic Cement Mortar," and for concrete according to ASTM C138/C138M as ft^3/package (m^3/package) at the recommended mixing liquid content or most fluid/least stiff workable consistency needs to be reported on the data guide as well as repeated in the product marking information.

The manufacturer's recommendations for placing, consolidating, and finishing the repair material (including the working time of material at minimum and maximum application temperatures and the minimum and maximum application thickness) should also appear on the Material Data Sheet.

Curing is beneficial for development of desirable properties with cementitious materials. Adequate curing of repairs can be difficult and is sometimes neglected. For overhead and vertical repairs, curing methods such as the use of water spray or fog may not be practical, and the application of certain membrane-forming curing compounds could affect the appearance, the properties, or both, of the completed repair. The manufacturer's recommendations for curing the repair material, including a list of acceptable methods and materials for curing of the applied material and guidance on return-to-service time at maximum and minimum curing temperatures, needs to be provided in the Material Data Sheet.

Finally, the manufacturer's recommendations for cleanup and disposal of material in accordance with local regulations and requirements and the safety precautions necessary in batching, mixing, and application of the repair material referring to the manufacturer's safety data sheet (SDS) are to be included in the Material Data Sheet.

CONCLUSION

ACI PRC-364.3R-22/ICRI 320.3R-2022 is a new type of document for the concrete repair industry that can help overcome several existing obstacles regarding repair specification development. A multifaceted approach is required in the concrete repair industry, where a great number of solutions are needed to solve the unique requirements that arise on repair projects around the world. Using this document, specifiers can select the important material properties and performance characteristics, which can be verified due to the transparency of the test methods used in the reporting of the repair material information.

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Note: Additional information on the ASTM standards discussed in this article can be found at www.astm.org.

Selected for reader interest by the editors.

Fred R. Goodwin, FASTM, FACI, FICRI is retired. He is the former Head of the BASF Construction Chemicals Global Corrosion Competency Center and has worked as a chemist with cement manufacture, research, development, and technical support of grouts, adhesives, coatings, shotcrete, stucco, flooring, and concrete repair materials. He is a former chair of ACI 364 Rehabilitation, ICRI 320 Materials and Methods, and ICRI Technical Activities Committee as well as the inventor of 7 patents. Currently, he is Chair of ACI Committee 321 TG 5, Concrete Maintenance for the Durability Code, and serves on numerous ACI committees and subcommittees. 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.

Benoit Bissonnette, FACI is a professor in the Department of Civil Engineering at Laval University, Québec City, QC, Canada, and a member of the Research Center on Concrete Infrastructure (CRIB). He is Chair of ACI 364 Rehabilitation and member of ACI 223 Shrinkage Compensating Concrete, ACI 546 Repair, and ACI TAC Repair and Rehabilitation. He has authored or coauthored more than 180 scientific and technical publications, notably the book, *Concrete Surface Engineering* (2015). He received his PhD from Laval University and is a licensed professional engineer in the province of Québec.

Dave Fuller is the Director of Technical Training for Coastal Construction Products and has been in the construction materials industry for 30 years. He was previously the Technical Director of ICRI and has held technical positions for PPG, ICI, Degussa, BASF, and Master Builders Solutions. He is a subject matter expert in Coatings and Sealers, Waterproofing, Flooring Systems and Concrete Repair materials. Dave has also designed, developed, and delivered in-person and virtual technical training programs throughout his career and holds a Masters in Adult Education and Training. Dave has delivered technical presentations and hands-on workshops for numerous ICRI local chapters throughout the U.S. and Canada and has also been a technical speaker at ICRI and SWRI National Conventions.

Mark Nelson is currently the President of Nelson Testing Laboratories in Elmhurst, Illinois, where he has held that position since 2004. He has over 30 years of experience in testing and evaluating construction materials related to concrete, masonry, epoxies, joint sealants, coatings, sealers, grouts, concrete repair, and waterproofing. He is a fellow of ICRI and has served as Chair of ICRI TAC as well as the ICRI 710 Coatings and Waterproofing Committee. His involvement in ASTM includes serving on the Executive Committees of both C12 for Masonry Grouts and Mortars and C15 for Manufactured Masonry Units. Mark is also an attorney, graduating with a J.D. from the University of Illinois Chicago (John Marshall Law School) in 1991.

Joshua R. Lloyd, PE is a structural engineering and materials testing consultant with a company he founded in 2022. He has over 12 years of experience in structural condition assessments, structural restoration, construction defect evaluation and repair development, load testing, non-destructive testing, and field inspection and testing during construction projects. Past projects have included the evaluation and repair of concrete, post-tensioned & prestressed concrete, steel, masonry, FRP, aluminum, stainless steel, and cold-formed steel buildings and building components. He worked with SGS TEC Services for 10 years, with a 1-year tenure at Engineered Restorations, Inc. He has been a member of ICRI since 2013, was the Georgia Chapter President in 2017-2018, is the Vice Chair of the ICRI Membership Committee, and is the current chair of ICRI 320 Repair Materials and Methods.

The ICRI 2024 Spring Convention

Scenes from Boston, Massachusetts

by Dale Regnier

The calm waters of Boston Harbor served as the backdrop for ICRI's 2024 Spring Convention in Boston, Massachusetts. Dedicated veteran ICRI members worked alongside many new faces to push forward some significant committee work, participate in some engaging technical sessions, and visit a great mix of exhibitors. The crowd that threatened to surpass the recent Fall 2023 event in St. Pete Beach, Florida saw the convention come together with the Institute's annual recognition luncheon on Tuesday afternoon. This event, April 21-24 at the Westin Copley Place, was more than just another ICRI Convention; it helped prove once again that everyone is welcome at ICRI and if you are willing, there is plenty for you to do.

Each ICRI Convention is built around engaging technical sessions like this one from Tuesday morning with an eager and focused crowd

The convention began late on Sunday afternoon with an "Early Arrivals Mixer" to help welcome those arriving before the first Monday morning sessions with some hospitality and camaraderie. That group of attendees has been steadily growing as they plan to kick things off early on Monday, so the idea of a reception seems to work well. Monday morning at our "Visit the Exhibits" continental breakfast, we staged a special welcome for our First-Time attendees and Chapter Delegates to help introduce them to the crowd and get them primed for the event. As always, our exhibitors (fifty strong again at this convention) showed off their best and brightest for the morning crowd to really get things going for the week. The theme of this convention, "Transportation: Roadways, Bridges, Tunnels," allowed for our Presentation Selection Committee to recruit a variety of industry professionals to address topics and case studies that included utility tunnel and river wall repairs, vibration analysis, and corrosion mitigation. Throughout the convention's four scheduled presentation blocks (Monday morning, Tuesday morning and afternoon,

Attendees flock to the Exhibit Hall where interesting and new products and services are on display

plus Wednesday morning) sixteen different sessions helped bring attendees more information on seismic strengthening and cathodic protection as well as intriguing case studies on an airport runway, viaduct, and just a few bridges. The spring schedule allows attendees to attend technical presentations in the morning of the first day with no other scheduled meetings to compete for their attention.

Scheduled networking events are just one-third of the essential activities that make an ICRI event so unique and special. Add networking to the hard work of committee meetings and the outstanding learning opportunities in the technical sessions, and you begin to see what goes on. The first place to gather outside the exhibit hall is the Women in ICRI reception at the end of the day on Monday. But everyone comes right back to the Exhibit Hall for the crucial Monday evening Welcome Reception where connections are made, friends are welcomed, and everyone gets to mingle.

As is the case with every convention in a city with an ICRI Chapter, the Spring 2024 social events were bolstered by the efforts of the ICRI New England Chapter as they gathered attendees for the Monday afternoon Fenway Park Tour and Tuesday evening Boston Harbor Dinner Cruise! Attendees with those tickets got a unique "backstage" view of the inner workings of Fenway Park—one of the nation's most celebrated baseball parks and home of the Boston Red Sox! Then on Tuesday evening, more than 200 friends and guests boarded The Spirit of Boston with the New England Chapter as hosts for a delightful dinner and cruise around Boston Harbor. The food was amazing, the views spectacular, and the networking was the best of the convention.

Much of what makes ICRI a strong industry association comes from the hard work of our volunteers in our administrative and technical committees. All the ICRI Guidelines and all of our programs come out of the collaboration of our members in these committees. Contractors, engineers, and materials suppliers, experienced and new to the industry, all bring their unique perspectives to the table. If you want to know what is happening at any time with any of our committees, you are encouraged to drop by the ICRI website to learn more about what we're working on right now.

The signature event of the Spring Convention is the Annual Recognition Luncheon. In addition to recognizing ICRI's Supporting Members, Past Presidents, and outgoing Board Members, the institute leadership thanked a number of both administrative and technical committee chairs who have completed their terms. ICRI Past-President Pierre Hebert was able to confer his President's Award to Matthew Sherman from SGH for all he has done for ICRI and the Technical Activities Committee as well as pass his leadership gavel on to 2024 President Brian MacNeil. Brian presented the slate of officers and directors to the crowd while encouraging everyone to participate. After all, it was just a few short years ago that someone from ICRI encouraged Brian to get involved and here he was standing before the crowd as the institute's leading volunteer! Quite the journey.

Speaking of displays, this one was built for the Spring Convention theme: Transportation

The luncheon continued with ICRI Vice President David Karins presenting of the full list of 40 Under 40 recipients for 2024 (showcased in the May/June 2024 issue of the *Concrete Repair Bulletin*) as well as the return of the ICRI Chapter Awards with ICRI Chapter Chair David Grandbois presenting the Chicago Chapter with Chapter of the Year for the activities of 2023. Finally, Fellows Committee Chair Ralph Jones concluded the recognition luncheon with the presentation of Fellows. Ralph began by bringing to the stage the current Fellows in attendance, an impressive gathering of ICRI leaders, to give them each a new Fellows pin. He then honored ICRI's newest Fellows: Marthe Brock, Liying Jiang, Brad Kamin, and John McDougall. More can be seen on each new Fellow on pages 34-35 in this issue of the *Concrete Repair Bulletin*. The rest of the afternoon included more committee meetings and technical sessions.

Every exhibitor appreciates a good conversation on the Exhibit Hall floor

The convention closed Wednesday at noon following one more breakfast, four more technical sessions, and a few more committee meetings. If you are not attending ICRI Conventions, you are missing out on some interesting activities and entertaining networking opportunities.

We hope to see everyone at the ICRI 2024 Fall Convention in Denver, Colorado. We'll be at the Sheraton Denver Downtown from October 22-25, 2024 (YES! We are going back to the Wednesday-Friday schedule for this event, with the Early Arrivals Mixer on Tuesday!). The theme for this event is "Back to Basics" and you don't want to miss the 2024 Project Awards celebration.

Other upcoming dates you can mark on your calendar are:

- Spring 2025 in Austin, Texas, April 13-16, 2025, at the Austin Marriott Downtown
- Fall 2025 in Chicago, Illinois, October 19-22, 2025, at the InterContinental Magnificent Mile

The Exhibit Hall is where ideas are exchanged, and attendees learn about the best of the best

The Recognition Luncheon is the main event for the Spring Convention as we take time to honor and appreciate the efforts of our most active volunteers

Recognize this guy from the Recognition Luncheon? 2024 ICRI President Brian MacNeil always makes a statement wherever he appears

Presidential work sometimes requires a heavy hand (or gavel) as evidenced by Past President Pierre Hebert (left) and current President Brian MacNeil (right) during the Recognition Lunch

After lunch, 40 Under 40 recipient Jeffrey Owad (left) stopped to enjoy the moment with colleague Liying Jiang (right) who had just become an ICRI Fellow

New England Chapter President Dan Clark welcomes ICRI attendees to Boston for the 2024 Convention. The chapter volunteers hosted two unforgettable events

The four newest ICRI Fellows are surrounded by sixteen current ICRI Fellows after the induction ceremony

Chapter of the Year honors went to the Chicago Chapter, which was well represented in Boston with no fewer than sixteen attendees

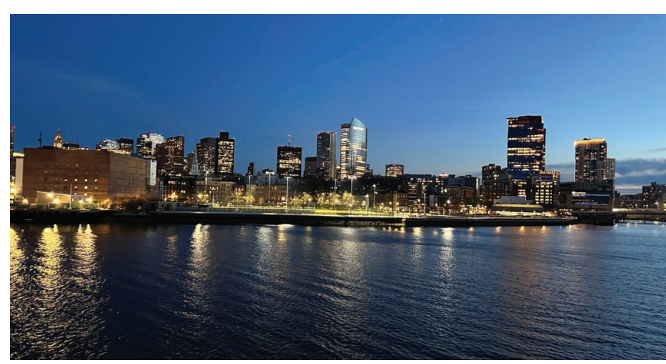
ICRI takes time to thank all Supporting Members during the recognition lunch, but the newest members of that valuable group are highlighted during the presentation

Everyone gets a chance to mix and mingle at the Women in ICRI Reception as we acknowledge the contributions of women in the repair and restoration industry

The Early Arrivals Mixer is the attendees' first chance to network and take in the offerings of the exhibitors

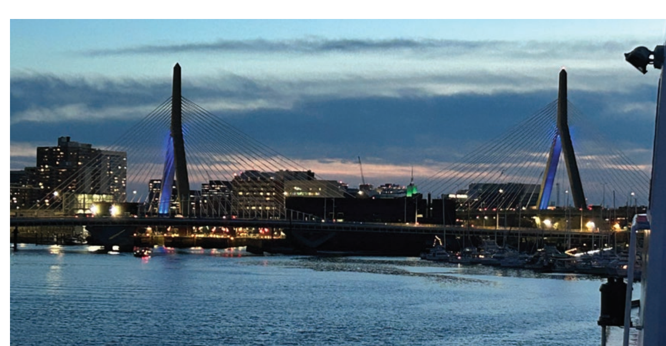
The private tour of Fenway included a rare visit to the infamous Press Box! Yell GROUP SHOT and you get a great photo of one of the tour groups

Joel Garcell (left), Angela Echols (center), and Omari Brown (right) smile for the camera while networking at the ICRI Convention



Everyone enjoyed the food, festivities, and especially the view on the Harbor Cruise hosted by the New England Chapter

Women in this industry are a growing voice and this shot from the Women in ICRI Reception is a testament to the impact they have had and will continue to have in the future



Boston and the iconic Leonard P. Zakim Bunker Hill Bridge are a beautiful sight from the water

ICRI 2024 PERSONAL AWARDS

FELLOWS

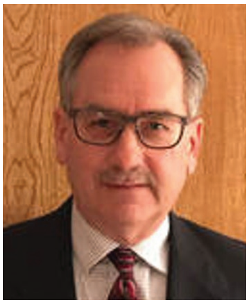
Being named an ICRI Fellow is a recognition of an individual's long-term, devoted, and enthusiastic service to ICRI. An ICRI Fellow is responsible for many noteworthy contributions to ICRI and the concrete repair industry in general. Criteria for nomination is based on: outstanding contributions to the production or use of concrete repair materials, products, or structures; excellence in the areas of education, research, development, design, construction, or management; and ICRI membership for at least five consecutive years. In short, ICRI Fellows are individuals in the organization who have made significant contributions to the organization, have served in leadership roles, and have put the industry's best interests ahead of their own. ICRI is pleased and proud to welcome these Fellows in 2024.

MARTHE BROCK

For more than two decades, Marthe Brock has demonstrated unwavering dedication to ICRI and its mission. She has been a member of ICRI National since 2000 and was a founding member of the ICRI Minnesota Chapter in 2003. Marthe was recognized for her outstanding contributions to the Minnesota Chapter with the 2022 Chapter Lifetime Achievement Award. Nationally, Marthe has chaired ICRI Committee 130 – Guidelines for Contracts, Warranties, and Agreements as well as ICRI Committee 710 – Coatings and Waterproofing. Her expertise is further demonstrated by her industry certifications and her current role as CSI Regional Certification Chair. Marthe has consistently shared her knowledge by authoring technical articles for the ICRI *Concrete Repair Bulletin* and presenting at ICRI Conventions, most recently in Vancouver in 2023. Marthe's exceptional leadership, industry knowledge, and passion for sharing her expertise are invaluable assets to this organization.

LIYING JIANG

Liying Jiang has conveyed a dedication and passion for the concrete repair industry during her relatively short time in the industry. She has attended all ICRI national conventions since joining ICRI in 2010. She only missed one, and that was due to her being sworn in as a new citizen of the United States. She has been an active participant in numerous ICRI technical committees including 110, 130, 710, and is currently serving as Vice-Chair of the Technical Activities Committee. On the administrative side, Liying has worked with the Women in ICRI Committee, Finance Committee, and served a three-year term on the ICRI Board of Directors from January 2020 to December 2022. When not volunteering, Liying has shared her breadth of industry knowledge by producing numerous technical presentations for ICRI and ACI Conventions as well as authoring or co-authoring quite a few articles for the ICRI *Concrete Repair Bulletin* and other industry publications, like ACI's *Concrete International*. She has also been an active member of the New England Chapter of ICRI since 2010 and is currently serving on their Board of Directors.



BRAD KAMIN

New ICRI Fellow Brad Kamin has been called a luminary whose dedication and unwavering commitment have left an indelible mark on the International Concrete Repair Institute. First and foremost, Brad's service to the Northern California Chapter of ICRI is legendary. As a founding member, he laid the foundation for excellence. His tenure as Past President exemplified leadership at its finest. And now, after 26 years, Brad continues to serve as a Board member, guiding the next generation of concrete repair enthusiasts. His passion for education shines through, especially with the Chapter's biannual educational symposiums, where he selflessly imparts wisdom and fosters growth. But Brad isn't about titles and accolades. His spirit is infectious—enthusiastic, cooperative, and always ready to help. His happy and fun personality draws people in, creating a sense of belonging and a room buzzing with energy, laughter, and camaraderie. But there is also a technical brilliance that further defines Brad. With fourteen ICRI national awards under his belt, he's a force to be reckoned with. When you hear the name "Sika Brad," you know you're in the presence of someone who lives and breathes concrete repair. His dedication to SIKA Corporation and the concrete industry is unwavering, and his expertise is unmatched.

JOHN MCDOUGALL

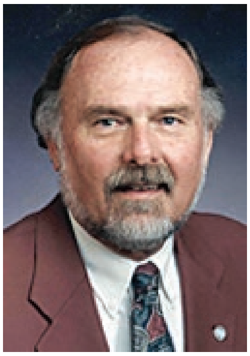
John McDougall has demonstrated his commitment to ICRI in many diverse and positive ways. He has continued over the years to serve on many committees and has in countless ways added to the structure and professionalism of our organization. John joined ICRI in 2004 and within 10 years was serving on the Board of Directors as the Region 2 Representative and soon took on the role of the Chair of the ICRI Chapters Committee. After moving up from the Board to the Executive Committee as Secretary in 2018, John was destined to become President of the association in 2022. Besides serving as President, his dedication to providing leadership and guidance in helping achieve the goals of the institute could be seen by many in subtle, yet firm ways. From the very beginning of his membership in ICRI, he has been involved with the Carolina Chapter, instrumental in planning events, seminars, and presentations. Always wanting to give back to the repair and restoration industry, he is the recipient of several industry awards.

We are now accepting nominations for 2025.

Complete the application online at the ICRI website at:

www.icri.org/awards/icri-fellows

REMEMBERING JAMES E. MCDONALD



With great sadness, we share the news that founding ICRI Member and Past President James E. (Jim) McDonald passed away peacefully at home on June 7, 2024, at the age of 83. He was born in Newton, Mississippi, on October 1, 1940. He grew up in Philadelphia, Mississippi, where he graduated from East Neshoba High School and met and married his wife of almost 62 years, Jean Welch McDonald.

Jim received his Bachelor of Science and Master of Science degrees in Civil Engineering from Mississippi State University. His career as a Senior Research Civil Engineer in the Geotechnical and Structures Laboratory, Engineer Research and Development Center (formerly the Waterways Experiment Station), U.S. Army Corps of Engineers in Vicksburg, Mississippi spanned from 1961 to 2003; he received numerous accolades during his career including Superior Civilian Service Medals in 2002 and 2003 and was inducted into the WES Gallery of Distinguished Civilian Employees in 2005. As a result of his expertise, he prepared official Corps guidance, letters, and manuals in addition to publishing numerous technical papers.

Jim's involvement with ICRI goes all the way back to the beginning. Jim was a charter member, served on the Board, and served as ICRI President in 1999. Jim also has served on the Technical Activities Committee (TAC) of ICRI as a Member, Secretary, and Review Chief. He also served as chair of the Repair Material and Methods committee. Among his many accomplishments and contributions to ICRI, Jim completed the original draft of the ICRI Concrete Repair Terminology document in 1998. He drafted another version of the Concrete Repair Terminology document in 2010. He drafted the original ICRI Task Group Manual in 1997 and drafted the ICRI Style Manual in 2007. He was also a contributor in the development of an outline and identification of appropriate documents for the first edition of the joint ICRI/ACI Concrete Repair Manual. He quite literally was involved and helped shape a majority of the technical offerings produced by ICRI over the past 31 years.

Jim McDonald's career has combined major technical contributions in concrete materials and repair, dedicated professional society service, and enduring education and training. His applied research and consulting work has led to advancements in concrete durability and new technology for the evaluation and repair of concrete. His tireless efforts and leadership in ICRI, ACI, and other professional organizations have made a significant impact on the advancement of the concrete repair industry, earning Jim the utmost respect of his colleagues and numerous honors and awards.

Through his many years of ICRI involvement, Jim has contributed his vast knowledge, but he has also been a friend, colleague, ally, and mentor to dozens of leaders in the repair and restoration industry. As Fred Goodwin said: "I will miss Jim, a friend, mentor, and amazing contributor to the Concrete industry. I am sad to hear of his passing and hope together we can keep his memory alive." Longtime ICRI member and past TAC Chair Kevin Michols had this to say, "Jim advanced the quality and durability of concrete repairs through significant project work, practical research, knowledge sharing, and countless hours of technical committee work in industry organizations including ICRI and ACI." He added, "His expertise, wisdom, and giving spirit live on through his many contributions to the concrete repair industry."

"This picture was taken in Dallas at an ICRI convention; and it represents to me the personality of the man who had a smile for everyone." Monica Rourke, ICRI Past President. Pictured in this photo are (left to right); Jean McDonald (Jim's wife), Rick Edelson, Jim McDonald, and Monica Rourke

Continuing to show the impact Jim had on ICRI and the industry, founding member and past ICRI Technical Director (now retired) Ken Lozen said, "He was a great guy who significantly supported and contributed to both ICRI and ACI. He will be missed." Furthering those sentiments, Jim's good friend and Past ICRI President, Monica Rourke added, "He was a true teacher and mentor with a sense of wit and humor that was as priceless as he was."

Jim has been an instrumental part of nearly all research and development of best practices in concrete repair for the last five decades. He was made an ICRI Fellow, was selected as an Honorary Member of ICRI in 2013, and was awarded the Distinguished Service Award by ICRI in 2017. He was also the

Jim in his element at an ICRI Technical Committee Meeting

very first recipient of the ICRI President's Award in 2019.

Jim was unable to attend the ICRI Convention where he was named the first recipient of the ICRI President's Award, an award created specifically to further honor a man who had already received every award that ICRI could give for contributions to furthering the industry. Jim sent an acceptance letter to then-President Ralph Jones, and this is an excerpt from that letter.

As a Charter Member of ICRI, I have been fortunate to meet and work with many outstanding members of the concrete repair industry. Consequently, general guidance and technical input resulting from these interactions are largely responsible for any personal recognition that I have received. My sincere thanks to all of you.

Many of my most satisfying moments were the result of the 20-plus years association with the Technical Activities Committee (TAC). Most of this time I served as the TAC Secretary. This resulted in many TAC requests to technical committee Chairs for updates on committee activities, document development and ballot status, etc. Responses were not always positive with occasional "pain in the butt" comments. However, with persistence TAC was able to significantly expand the number, quality, and scope of technical guidelines, introduce additional forms of technology transfer, assist in development of certification programs, etc.

I was reluctant to thank specific individuals for their contributions to this Award because there are so many and space is limited. However, I would be remiss if I did not thank Fred Goodwin, (then) TAC Chair, for his contributions. Fred is a boundless fountain of knowledge and can instantaneously provide at least 3 references on any imaginable subject. He is a tireless worker yet has the patience to mentor a computer novice like myself. Without his leadership and persistence ICRI committees would still be using the cut-and-paste, paper ballot document development process.

Jim was memorialized at Wright & Ferguson Funeral Home in Clinton, Mississippi on Tuesday, June 11, 2024. Our hearts go out to Jim's wife, Jean, and his family during this difficult time of loss.

Taken in 2006, this is a photo of many of ICRI's Past Presidents. Front row (left to right) are Jack Morrow (1990), Peter Craig (1996) and Rick Edelson (2000). Back row (left to right) are Joe Solomon (1997), Rob Puschek (2005), Robert Thaxton (2002), Ken Currence (2001), Bob Terpening (1994), Alan Roth (2003), Robert Johnson (2004), Steve Royer (1992) , and James E. McDonald (1999)

Jim loved all things Mississippi State but especially enjoyed following the football and baseball teams, traveling, fishing, and spending time with his grandchildren. He is survived by his wife, Jean Welch McDonald, daughter Julie McDonald Thames, son James Edward (Jim) McDonald Jr. (Ann), five grandchildren: Conner Benjamin Thames, Tyler James Thames (Katie), Anna Kathryn Thames Smith (Dillon), Carlee McDonald Soignier (Tyler), Camryn Welch McDonald, his great-granddaughter, Anne Charlotte Soignier, and his sisters, Vivian McDonald Gray and Becky McDonald Moore.

ICRI is making plans to honor Jim's legacy and contributions to the association by changing the name of the institute's Distinguished Service Award to the James E. McDonald Distinguished Service Award. Jim will be greatly missed.

WOMENINICRI

SPOTLIGHT— Monica Rourke

by Michelle Nobel, Women in ICRI Committee member

MONICA ROURKE

Monica has over 30 years of experience in concrete waterproofing and leak mitigation for both new construction and repair of existing structures. She worked for Mapei Corp for almost thirteen years and recently started her own consulting and contracting business, Dry Works, LLC, which she had been involved with for many years before joining Mapei Corp in 2012.

Monica is a Fellow of the International Concrete Repair Institute (ICRI) and was elected as ICRI's first woman National President in 2008. She has published papers and co-authored technical guidelines on the selection of grouts to control water leakage in concrete structures. Additionally, she has published papers covering chemical grouting and watertight joints in tunnels. Monica has presented at both national and local ICRI conventions and chapter meetings. In recognition of her outstanding dedication and contribution to the concrete repair industry, Monica received the 2022 President's Award from ICRI.

Monica is currently the chair of the ICRI Grouting Committee and is focusing the committee's efforts on a new guideline for curtain grouting in tunnels and underground structures.

Monica also participates at TRB (Transportation Research Board) on the Tunnels and Underground Structures Committee. She presented her paper on Watertight Joints in Tunnels, which led to a new waterproofing grout hose technology for all construction joints on the Big Dig Tunnel project in Boston, Massachusetts in 1999.

She also was a presenter at the Rilem – 2nd International Symposium on Adhesion between Polymers and Concrete; DFI (Deep Foundations Institute) and was inducted into Who's Who of International Professionals in 1997.

Monica provides technical support in the office and serves as a hands-on supervisor. When working in the field, she specializes in leak repair, grouting, waterproofing, and soil stabilization.

Born and raised in California, Monica attended San Jose State University and San Francisco State University. She currently lives in Connecticut and has two sons: Tony Marciano and Kevin Rourke, as well as, two granddaughters, Rihanna and Mia. She enjoys cooking, spending time with her family and friends, and caring for her "rescue" dog, Bob Barker.

I'm honored to call Monica Rourke my friend. She is my sister from another mister and our special day is November 4. She brightens every room she walks in with her warm smile and intoxicating personality. She is a trailblazer in the concrete repair industry and an inspiration to all women.

PRODUCTINNOVATION

MCI® CORROSION INHIBITING ADMIXTURES

Some climates such as those in GCC (Gulf Cooperation Council) countries make it extremely difficult to build structures with long service lives. Hot temperatures and other harsh elements make corrosion a constant threat to the durability of reinforced concrete. Rather than default to expensive options such as epoxy coated rebar and extra thick concrete cover, Cortec's MCI® Technology offers a cost-effective alternative to extend structural service life in high temperature areas.

Learn more about counteracting corrosion in hot, corrosive climates in our press release: https://www.cortecvci.com/press-release-how-to-slow-down-corrosion-with-mci-in-high-temp-gcc-states/

Got a great product to share? Send your submission to *editor@icri.org* to be featured in the *CRB*.

ICRICHAPTERNEWS

CHAPTERS COMMITTEE CHAIR'S LETTER

DAVID GRANDBOIS
Chapters Chair

And just like that Summer is here! Where does the time go? I mean really, the year is almost halfway over. The Spring Convention came and went and plans for the Fall Convention are well under way. For those of us in the Northern part of the U.S., the heat is finally rolling in and that means construction season is in full swing. With this comes many new routine hurdles of battling through extended traffic, working extra hours to maintain strict schedules, and taking extra precautions for working in the heat.

Speaking of heat, how about that Spring Convention in Boston? The turnout was on fire! We enjoyed the accommodations of Westin Copley Place in the bustling Back Bay neighborhood along the Charles River. I would like to give a huge thank-you to the New England chapter for hosting this amazing convention. We were spoiled with an amazing tour of Fenway Park; coincidentally there were some minor concrete repair operations taking place on the upper level—which of course pulled all of us concrete nerds away from the tour to nitpick on the repairs. Aside from the Fenway Park tour, we enjoyed a lovely evening dinner cruise in the Boston Harbor. No tea was harmed in the making of this cruise.

I was lucky enough to make my first appearance on the ICRI national convention stage to present the 2023 chapter awards. Mr. MacNeil was a tough act to follow with his tribute to the Vancouver Canucks, which gave us all a good laugh. 2023 was the first year of the chapter awards since COVID. The ICRI Chapter Awards Program is a way to recognize the chapters for all their commitment to success. As I shared in the last issue, the awards program is a playbook for your chapter to succeed. There were nine chapters that participated in the 2023 ICRI Chapter Awards; eight chapters were outstanding and 1 was Chapter of the Year. Congratulations to Chicago for winning the 2023 Chapter of the Year award.

2023 Chapter of the Year:
Chicago

2023 Outstanding Chapters:
Delaware Valley
Florida West Coast
Georgia
Indiana
Minnesota
North Texas
Pittsburgh
Rocky Mountain

Thank you to all who completed the chapter awards form for the activities of 2023! I look forward to seeing the submissions for 2024. How great would it be if all chapters submitted?!

Please remember to turn in your chapter events so that they can be listed on the ICRI website. Please turn them in early and often. Please share your post-event write-ups and pictures so that we can brag about you to the entire ICRI community.

Lastly, I would like to extend congratulations to the newest fellows: Marthe Brock, Liying Jiang, Brad Kamin, and John McDougall. Your unwavering dedication to this organization is unmatched. Individuals like you and the other Fellows help lead the way in this industry for new and existing members alike.

Enjoy your summer vacations while they last. If you have children, remember that you are only guaranteed eighteen summer breaks with them until they legally do not have to listen to you anymore.

Best Regards,

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

CHAPTER CALENDAR

ICRI Chapters are hosting events in 2024. 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 about added events.

DELAWARE VALLEY
September 16, 2024
CHAPTER GOLF OUTING
Radley Run Country Club
West Chester, PA

FLORIDA WEST COAST
July 10, 2024
CHAPTER BOARD MEETING
St. Pete Yacht Club
St. Petersburg, FL

August 7, 2024
CHAPTER TECHNICAL PRESENTATION
Topic: Florida Condo Inspection Requirements
St. Pete Yacht Club
St. Petersburg, FL

INDIANA
September 12, 2024
CHAPTER GOLF OUTING
Plum Creek Golf Club
Fishers, IN

METRO NEW YORK
September 19, 2024
CHAPTER GOLF OUTING
Livingston Country Club
Livingston, NJ

MICHIGAN
July 19, 2024
SUMMER SOCIAL
Night at the Park
Jimmy John's Field
Utica, MI

MINNESOTA
July 16, 2024
ANNUAL GOLF TOURNAMENT
Bunker Hills Golf Club
Coon Rapids, MN

NORTHERN OHIO
July 10, 2024
CHAPTER BREAKFAST MEETING
Holiday Inn Cleveland South
Independence, OH

PITTSBURGH
September 10, 2024
CHAPTER ROUNDTABLE PRESENTATION
Topic: Concrete Mix Design and Placement
11 Stanwix Conference Center
Pittsburgh, PA

SOUTHEAST FLORIDA
July 25, 2024
CHAPTER PRESENTATION & NETWORKING
Topic: Champlain Towers South Collapse – WJE Investigates
The Westin Fort Lauderdale
Fort Lauderdale, FL

VIRGINIA
July 24, 2024
CHAPTER SOCIAL OUTING
Richmond Flying Squirrels Baseball Outing
The Diamond
Richmond, VA

ICRICHAPTERNEWS

CHAPTER NEWS

NORTH TEXAS HOSTS HYDRODEMOLITION TALK

The North Texas Chapter's May Membership Meeting was held on May 9, 2024, at the Las Colinas Corporate Center in Irving, Texas. The chapter members and friends of the chapter dined on a lunch of rotisserie chicken, sides, and dessert, while Andy Anderson of Conjet gave a presentation about hydrodemolition. Mr. Anderson presented an overview of the many applications for hydrodemolition, including selective removal of concrete, surface preparation and profiling, and membrane or coating removal. The benefits of hydrodemolition were highlighted, including elimination of the potential for microcracking during concrete removal, and simultaneous cleaning of corroded reinforcement. Those who attended were interested in incorporating hydrodemolition into future projects and were grateful to Mr. Anderson for sharing his knowledge.

North Texas Chapter Treasurer Pete Haveron provides an update to the chapter members

Andy Anderson from Conjet presents to the North Texas Chapter

OKLAHOMA PRESENTS ON ACI 562

On Monday, April 29, 2024, the ICRI Oklahoma Chapter welcomed guest speaker Aaron Larosche with Pivot Engineering. His presentation was on "Use, Applicability, and History of the ACI 562 Code". The meeting was well attended and held at Cyntergy's office in Tulsa. The chapter was able to offer the meeting with PDH credit for those attending.

Members of the Oklahoma Chapter gathered in April for a presentation on ACI 562

INTERESTED IN SEEING YOUR CHAPTER NEWS & EVENTS LISTED HERE?

2024 Chapter News & Event Deadlines

NOVEMBER/DECEMBER 2024 CRB
Deadline: September 1, 2024

Send Chapter News and Events by the deadlines above to Program Director Dale Regnier at daler@icri.org.

ICRI
CONCRETE REPAIR
Restore | Repurpose | Renew
CHAPTERS

CHAPTER NEWS

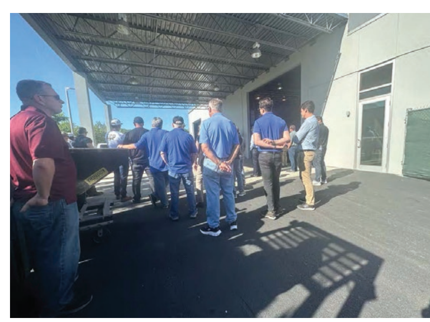
FLORIDA WEST COAST MEGA DEMO A HIT

On Friday, April 12, 2024, the ICRI Florida West Coast Chapter hosted their annual Mega Demo at Complete Property Services in Tampa, Florida. This annual event brings out between 90 and 120 attendees flowing through 7 different demonstrations and 14 unique vendors providing information on their products and services. On this spectacular day, the chapter was able to welcome a new sponsor to the mix as the crowd enjoyed the demonstrations and visited the vendors.







Attendees viewed several product demonstrations, both outdoors and indoors

The sponsored lunch was provided by Jimmy John's

CHAPTER NEWS

Demonstrations continued throughout the day

A variety of vendors set up tents throughout the property to show off their newest and best products

NEWMEMBERS

COMPANY MEMBERS

AK Industrial Services, LLC
Everett, Massachusetts
United States
Mark McLellan

Bulley & Andrews Concrete Restoration LLC
Chicago, Illinois
United States
James Masterfield

Jablonski Building Conservation, Inc.
New York, New York
United States
Mary Jablonski

Martin Restorations LLC
Schaumburg, Illinois
United States
Martin Bazula

RestoreWorks Masonry Restoration
Griffith, Indiana
United States
Don Zuidema

V-Rod
Rockford, Illinois
United States
Chuck Toth

Yates Exterior Restoration Services
Long Island, New York
United States
Michael Yates

INDIVIDUAL MEMBERS

Adam Zuber
United States

Ally Hodges
Tampa, Florida
United States

Asher Rudyan
Auburn, Washington
United States

Austin Darrimon
Turlock, California
United States

Bob Wiley
Orlando, Florida
United States

Charles Ohrnberger
Virginia
United States

Charles Pham
Kent, Washington
United States

Clemente Zamarripa
Houston, Texas
United States

Craig Greenfield
Santa Ana, California
United States

Darren Ashford
Golden, Colorado
United States

Emilio M. Takagi, MSc.
East Setauket, New York
United States

Emmanuel Allen
Lebanon, Tennessee
United States

Erric Jackson
Powder Springs, Georgia
United States

Fernando Guzman
Hollywood, Florida
United States

Gerald Delaune
Dallas, Texas
United States

Harry Burbank
Edison, New Jersey
United States

Heath Pederson
Phoenix, Arizona
United States

Henry Dearing
St. Petersburg, Florida
United States

HJ Royston
Denver, Colorado
United States

Jack S. "Sandy" Crump Jr, P.E., S.I.
St. Petersburg, Florida
United States

Jaime Castillo
Doral, Florida
United States

Jake Lang
McKees Rocks, Pennsylvania
United States

James Reed
Winter Haven, Florida
United States

Jason Borden
Hollywood, Florida
United States

Jhon Chavez
Washington, DC
United States

John Lackey
Laurel, Maryland
United States

Jose Vazquez
Hollywood, Florida
United States

Juan Velasquez
Houston, Texas
United States

Julio Rivas
Greenacres, Florida
United States

Kerry Pierce
Florida
United States

Kevin Marks
Chicago, Illinois
United States

Khaalid Lockett
Vallejo, California
United States

Marc Barter
Mobile, Alabama
United States

Marc Shen
Palmetto, Florida
United States

Mark Doughty
Wintersville, Ohio
United States

Matt Garrett
Houston, Texas
United States

NEWMEMBERS

Max Dashine
Oreland, Pennsylvania
United States

Michael Badeaux
Thibodaux, Louisiana
United States

Michael Solimine
Illinois
United States

Mike Hyland
Michigan
United States

Mina Savaroliya
Houston, Texas
United States

Nick Smith
Lanham, Maryland
United States

Orestes L. "Ore" Lopez Recio, BA
United States

Patrick Kenealy
Illinois
United States

Paul Greenhalgh
Phrapradaeng, Samutprakarn
Thailand

Paul Noyce
Poughkeepsie, New York
United States

Pratik Murkute
Tampa, Florida
United States

Ronald Woods
Florida
United States

Sawyer Wilson
Dunedin, Florida
United States

Scott Meredith
Safford, Arizona
United States

Stefano Leonardi
Hampton, Virginia
United States

Stephen Hughes
Levittown, Pennsylvania
United States

Stephen Tennant
Richmond, British Columbia
Canada

Yang Li
Akron, Ohio
United States

Yolani Negron-Rivera
Cidra, Puerto Rico
United States

Zack Ballard
Denver, Colorado
United States

Zeyad Sattar
Surrey, British Columbia
Canada

SAVE THE DATE

SAND • CEMENT

Back to Basics

WATER • AGGREGATE

2024 ICRI FALL CONVENTION

SHERATON DENVER DOWNTOWN, DENVER, COLORADO

OCTOBER 22-25, 2024

PHOTO BY ACTON CRAWFORD VIA UNSPLASH


Gary Carlson Equipment
Rental and sales for grouting and wet and dry shotcrete equipment
Available Nationwide
Allentown Shotcrete Pumps and Guns
Putzmiester Shotcrete Pumps
Chemgrout Mixers Pumps and Plants
Sullivan Air Compressors and Tools
Reed Shotcrete Systems Pumps and Guns
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gary carlson equipment
Gary Carlson Equipment Co.
Rentals - Sales - Service - Delivery
1380 County Rd C West, Roseville, MN
10720 Mankato St., Blaine, MN
Phone 763.792.9123
http://www.garycarlsonequip.com


Concrete Slab Moisture Testing (CSMT) Program
If you are involved with the measuring or assessment of moisture in concrete floor slabs, ICRI's CSMT program is for you!
Comprehensive Education and Certification Courses will give you the knowledge and skills to:
✓ Improve the performance of concrete slab moisture testing
✓ Report more consistent, accurate, and reliable test results
✓ Make better decisions on when a concrete slab is ready for a floor covering installation
✓ Reduce risks for your clients and your team
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Learn more at www.icri.org
Questions? Contact ICRI Program Director Dale Regnier at daler@icri.org

Handle any job with the Simpson Strong-Tie® 3G family of epoxy and hybrid acrylic anchoring adhesives. Code listed for cracked and uncracked concrete, they're easy to install and provide a high-strength hold. SET-3G™ epoxy is our most versatile adhesive with ultimate bond strength for heavy-duty, structural work. Choose ET-3G™ epoxy for general rebar doweling and threaded rod. For a fast-cure option, AT-3G™ hybrid acrylic allows same-day bolt-up in a wide range of temperatures, including extreme cold. Stocked nationwide at local retailers, our adhesives are backed by expert service and technical support.

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ICRI
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P: 651-366-6095 | E: info@icri.org | W: www.icri.org

ICRI Mission and Strategic Plan Benefit Members and the Industry

INDUSTRY LEADERSHIP
ICRI will be the state-of-the-art, trusted and reliable source of delivering best industry practices and professional networks in the repair industry.

- Develop industry professionals
- Professional networks
- Champion innovation and safety

PROFESSIONAL DEVELOPMENT
ICRI will develop and deliver programs, products, and services that provide knowledge, build skills, and validate expertise.

- Expand certification
- Quality programs and products
- Enhanced product program services

ICRI Vision: ICRI will be the center for repair leadership supporting a profession built on science and craftsmanship making the built world safer and longer lasting.

ICRI Mission: ICRI provides education, certification, networking and leadership to improve the quality of repair, restoration, and protection/preservation of concrete and other material systems.

ORGANIZATION STRENGTH
ICRI will have the resources, staff, and structures to fully support its strategic priorities.

- Engage members
- Strengthen chapters
- Grow staff capacity and capabilities
- Serve members

ORGANIZATION CREDIBILITY
ICRI will be a well-connected organization backed by a recognized and respected brand locally, nationally, and globally.

- Strengthen strategic partnerships
- Strengthen brand
- Engagement of diverse participants

CONCRETE REPAIR
Restore | Repurpose | Renew

ICRI Mission: ICRI provides education, certification, networking, and leadership to improve the quality of repair, restoration, and protection/preservation of concrete and other material systems.

Our Vision: ICRI will be the center for repair leadership supporting a profession built on science and craftsmanship, making the built world safer and longer lasting.


THINK PAST
THE *REPAIR*
Reintroducing the classics: *Thorocoat* and *Thorolastic*!
Trusted for decades, these brands are renowned for
being the best wall coating solutions on the market.