

# CRB

July/August 2021  
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CONCRETE REPAIR BULLETIN

## NONDESTRUCTIVE TESTING AND EVALUATION

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Shields Million Dollar Artwork in World Trade Center Subway Station



"CHORUS," a marble mosaic by multimedia artist Ann Hamilton, New York City

A TACTILE SURFACE INVITES SUBWAY RIDERS TO TOUCH THE MARBLE MURAL AS THEY PASS. THIS PHYSICAL CONTACT REMINDS PEOPLE OF THE EMOTIONAL AND HISTORICAL SIGNIFICANCE OF THE AREA AS THEY TAKE IN THE CIVIC IDEALS MEMORIALIZED THERE.

**Evonik Protectosil® products were applied days before the grand opening of the stop in 2018, which marked the 17th anniversary of the September 11 terrorist attacks.**

The WTC Cortland Street subway station in New York City is located on the World Trade Center grounds. The station's reopening is viewed as a major milestone in recovery for the neighborhood impacted by events of that tragic day.

A white, monochromatic marble mosaic by multimedia artist Ann Hamilton was designed with the adjacent World Trade Center Transportation Hub in mind. Commissioned by Metropolitan Transit Authority Arts & Design, "CHORUS" spans a total of 4,350 square feet across the walls of both platforms and comprises small marble tesserae forming a white-on-white surface of text from the 1776 Declaration of Independence and the 1948 United Nations Universal Declaration of Human Rights. The piece has been valued at more than \$1 million.

**Evonik Protectosil® products provide this meaningful artwork a safeguard against physical contact and exposure to the elements. Protectosil® SC 100 and Protectosil ANTIGRAFFITI® SP keep "CHORUS" free from water damage, staining, and graffiti, for the long term.**

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## NOTE FROM THE EDITOR



The industry is getting busier, and contractors are scrambling to secure staffing and materials as the workload increases. Engineers and consultants are working hard to get late-breaking projects on the street. The world is slowly returning to normal, people are returning to their office, restaurants are re-opening, and chapters have begun in-person meetings and events. ICRI has scheduled the 2021 Fall Convention for October 11-13 in Minneapolis, Minnesota.

The theme of this issue of the *Concrete Repair Bulletin* is "Nondestructive Testing and Evaluation." Articles include a case study on nondestructive testing of fatigued concrete, nondestructive testing and photogrammetry for concrete condition imaging, evaluation of fire damaged concrete, and an article for structural engineers on a rational approach to responding to a crisis.

ICRI is accepting applications for the 2021 Project and Safety Awards. Visit the ICRI website for more information on submitting for each award. Please continue to send your ICRI chapter events and updates to Dale Regnier.

I hope you are having a great summer and look forward to seeing you in Minneapolis in October for the ICRI Fall Convention!

Jerry Phenny  
RAM Construction Services  
Editor, Concrete Repair Bulletin

# PRESIDENT'S MESSAGE

## On the Road Again!



ELENA KESSI

*"On the road again.  
Just can't wait to get on the road again.  
The life I love is making music with my friends..."*

Willie Nelson's iconic song pretty much says it all! Well, I might improvise the last line to reflect our industry and sing, "The life I love is fixing concrete with my friends!"

These past few months have seen a re-opening in many parts of the U.S., and prior to writing this article I was fortunate enough to participate in two in-person ICRI chapter events, and ICRI Executive Director Eric Hauth joined me at the Baltimore-Washington golf scramble in May. Thank you, Baltimore/Washington and Southeast Florida!



Left to Right: Brian Baker, Preservation & Protection Systems; Eric Hauth, ICRI; Elena Kessi, Aquafin; Brian Radigan, Tremco; and Tom Ouska, Valcourt

The pandemic era has shown us that the concrete repair industry is not only resilient, but also cutting-edge and quick to adapt to new technology and change. Our fine organization, powered by more than 1,800 dedicated members, hosted its second virtual convention with great success. Planning is now underway for a return to an in-person Fall Convention in Minneapolis, October 11-13. So, mark your calendars for what promises to be a fantastic event that gets us back together again. I want to recognize all the hard work of the Conventions Committee, under the leadership of co-chairs Ingrid Rodriguez and Pat Gallagher, in adapting to the new virtual format and planning for our future live conventions.

In addition to the great work on conventions, ICRI's technical committees are launching new technical products—including the recently released Guide Specification on Epoxy Injection—with more being released in the coming months, including the 210.4 Nondestructive Evaluation (NDE) guideline and the 710.1 joint guideline with SSPC/

NACE on polymer flooring systems. Kudos to all the hard-working members who are volunteering their expertise to better our industry.

As we get back out there, I am excited by the new opportunities enabling us to facilitate even greater industry collaboration, including tools like Zoom. Even though this past year was spent "geographically" isolated, I have expanded my network of industry connections by getting to work with some of our members who typically do not attend ICRI national conventions. As our committees have all shifted to virtual meetings, it has opened the door for more people to participate. This makes us stronger and is something ICRI is committed to in the months and years ahead. So, it's a great time to pose this question:

**Q: Have you not participated in an ICRI committee meeting because you do not normally attend national conventions?**

**A: Now that all administrative and technical committee meetings meet virtually, your excuse is gone!**

ICRI depends on the expertise of our volunteers, and we want your expertise on our committees. There is no excuse left not to participate! To learn more about our great committees, visit [www.icri.org/page/Committees](http://www.icri.org/page/Committees). I challenge you to take part in one committee meeting between now and the end of the year and send me an email about your experience. I want to hear from you! Drop me a line at [elena@aquafin.net](mailto:elena@aquafin.net) and do not hesitate to reach out to ICRI Executive Director Eric Hauth at [erich@icri.org](mailto:erich@icri.org), for any information on how to get involved on a committee.

Last but definitely not least, I want to call on everyone to remember jobsite safety. Many of us spent the past year working remotely, so as we get back out there, please stay safe and encourage your teams to do the same. There is so much to look forward to as our world opens up and I look forward to seeing and meeting you in person soon.

*"On the road again, Goin' places that I've never been,  
Seen' things that I may never see again,  
And I can't wait to get on the road again."*

Sincerely,

Elena Kessi  
2021 ICRI President



# PEDESTRIAN DECK COATING SYSTEMS



MiraFlex XL is a cementitious, fabric- reinforced, waterproofing membrane system engineered for exterior pedestrian traffic applications.

## MIRAFLEX XL

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- Over interior/exterior concrete surfaces
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MiraFlex II is a multi-layered pedestrian deck coating system consisting of a lath-reinforced cementitious underlayment, fluid-applied waterproofing membrane, and decorative finished deck surface. It can also serve as an under tile waterproofing membrane system.

## MIRAFLEX II

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- Interior/Exterior over occupied space
- Mixed-use, residential and commercial
- Over plywood and concrete substrates

### Advantages:

- Monolithic, seamless protection – waterproofing membrane
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- VOC and LEED-compliant, low odor and fast cure time
- Wide array of slip resistant textures, colors and finishes

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## Highlighting the Difference-Makers— the Women in the International Concrete Repair Institute



by Michelle Nobel and Tara Toren-Rudisill, Thornton Tomasetti

In 2020, ICRI proudly announced the first 40 Under 40 honorees. Nominated by their peers, these individuals demonstrated their commitment to continued professional growth, high potential for continued success in leadership roles, and a strong passion for and commitment to the mission of ICRI. Four inspiring women were among the inaugural class. This month we caught up with two of them to learn more about their career paths, thoughts on leadership and mentoring, and ideas about the future of the repair and restoration industry.



### Julie Bolding

Julie Bolding is a professional engineer at Armstrong-Douglass Structural Engineers in Plano, Texas, and has been active in ICRI for ten years. She is the current Scholarship Committee Chair and is a past president for the North Texas Chapter. She is also a member of the ICRI Nominating Committee, the Women in ICRI Committee, and the 410 Masonry Committee at the ICRI National level.

Julie's passion is historic preservation. She loves the challenge of generating creative solutions for what many might feel is a lost cause. Her inspiration comes from her father, a third-generation farmer who taught Julie the value of work and dedication. He inspired her to respect working with her hands and to find deep satisfaction in hard work.

What Julie enjoys most about her career is working on a wide variety of projects and getting out into the field instead of being behind a desk all day, every day. Conversely, what Julie likes the least is managing hectic deadlines and preparing complete repair documents from scratch. Her biggest challenge of late has been determining how to correct the improper installation of post-installed anchors. On one unique project, the anchors were installed upside down. Challenges with anchor spacing, edge distance, anchorage options, and substrate design requirements are all issues that require detailed review to ensure proper performance. She has approached manufacturers to help develop improved testing protocols.

Julie finds inspiration in her career by returning structures that are in disrepair to their original glory. She also finds inspiration in developing

solutions to make these structures safe for occupants and users. Julie also finds career motivation through networking events she attends with people from all over the country and world through ICRI.

Julie's mentor is 2020 ICRI Fellow Mark LeMay, who introduced her to ICRI. Because she is an engineer, she finds it interesting and engaging to hear Mark's perspective as an architect. Mentors can help a mentee understand their own perspectives, and as a mentor, Julie believes it is important to keep that mentee's perspective in mind and remember to explain the why, not just the how.

As a 40 Under 40 Award professional, Julie enjoys collaborating with hardworking individuals who can communicate and effectively delegate tasks to other people. Julie is planning to get more involved in technical committees at ICRI International and working with her local ICRI North Texas Chapter.

Julie noted that ICRI has done a great job of increasing the webinar offerings and providing the virtual conventions in the ICRI eLearning Center. Julie noted the Structural Engineering Association of Texas and American Society of Civil Engineers also have strong outreach programs to get younger people actively involved. Julie's advice for those entering this industry is don't be afraid to ask questions and get involved locally and nationally with ICRI. ICRI is full of great people who are always willing to lend a hand.

Julie anticipates preservation work will increase in the next ten to twenty years, with an increased focus on repairing buildings instead of tear-downs. The concrete repair industry is a fascinating field and will be strengthened with increased preservation projects.



### **Stacia Van Zetten**

Stacia Van Zetten is the Chief Strategy Officer of EXACT Technology Corporation and presented at the ICRI Spring 2021 Convention about emerging technologies in the concrete industry.

Originally studying architecture at university, Stacia knew engineering was the right path after a statics course. After graduation, Stacia began working for a general contractor with a focus on concrete—providing education to contractors in the field, establishing best practices, and troubleshooting field issues. She became active in the American Concrete Institute (ACI) after a mentor piqued her interest in the development of codes and standards and invited her to join the organization.

While spending long hours on site to perform reviews for the general contracting firm, she wondered if there might be better ways to provide construction monitoring services. Some existing methods seemed a bit reactionary which could potentially cause schedule delays or cost increases. In 2017, Stacia co-founded EXACT with a goal of modernizing concrete monitoring by developing solutions to provide real-time data.

Having great role models in her parents and grandfather, an architect, helped prepare her for challenges in the construction industry. Stacia focused on proving herself capable and knowledgeable early in her career to dispel any notion that, as a woman, she might be less capable than others. Through that process, she found a fantastic mentor who has been invaluable as a resource when new challenges arise.

Involvement with ICRI, ACI, and World of Concrete has allowed Stacia to build her professional network, to share knowledge with the best in the industry, and to find others with a shared vision and purpose. Stacia believes taking an active role to include and engage younger professionals is critical to success. She noted ICRI Toronto Chapter's success hosting joint events between organizations, such as ICRI and ACI, or with other ICRI chapters has provided increased opportunities to engage professionals at all levels.

As a 40 Under 40 professional, Stacia looks for strong leaders who are passionate about their work and have good communication skills. She also encourages senior professionals to include less experienced professionals in events and conversations and encourages them to provide a range of activities designed to be inclusive of all.

Stacia continues to enjoy the challenge of problem solving and finds it rewarding to watch others progress and grow into their careers. For younger professionals, she recommends finding what you truly enjoy doing because then you will never work a day in your life. She admitted, however, one may never find joy during a cold and rainy site visit.

Looking ahead over the next several years, Stacia sees an increased push for digitalization in the construction industry which will allow for better data to be used to build better structures. Stacia expressed excitement that her vision of where the construction industry could go with the support of better data is finally coming to life.

*It's not that far off...*

## **2021 ICRI Fall Convention**

*Evaluation and Forensics—“Despair to Repair”*

**Minneapolis, Minnesota**

**SAVE THE DATE  
OCTOBER 11-13, 2021**

Photo Courtesy of Meet Minneapolis



MARK NELSON

## TAC GOALS FOR 2021—EXPAND TECHNICAL COMMITTEE PARTICIPATION

The third of our four TAC goals for 2021 is to expand each of our Technical Committees by at least five new active members. I challenge all of our technical committee chairs and technical committee members to reach out to ICRI members to sign up and get involved in your technical committees. With your support, we will have at least 60 new active technical committee members by the end of 2021.

### Technical Committee Chairs

I ask all Technical Committee Chairs to personally contact at least five ICRI members who are not currently on your committee roster. You can reach out to them via email or phone call. You should all know of members who are in your specific industry but are not currently participating in your committee. Please reach out to them and ask them to join before the next convention. Sometimes it just takes someone to ask to turn an inactive member into an active committee member.

### ICRI Members

Joining a technical committee provides numerous benefits to anyone in this industry. You will have the opportunity to learn from industry leaders. You will be able to put your mark on the industry by helping to create practical and relevant technical offerings. You will be making contacts to help you with your career. You will be making lifelong friends.

If you are an inactive ICRI member, I ask you, why not sign up for at least one ICRI technical committee? Here are some reasons I have heard over the years:

#### *Reason 1: I am not able to attend the national conventions.*

You are now able to attend virtual committee meetings without having to travel to a convention. All committees are conducting virtual meetings between conventions. In addition, we will hold hybrid meetings during our conventions with the ability for all committee members to participate whether they are present at the convention or at home in front of their computer screen.

#### *Reason 2: I do not consider myself an expert in the industry.*

The way to become an expert is to get involved. Every active ICRI Technical Committee Member started their involvement by simply attending a committee meeting. When you attend, you do not need to participate. You can just listen and learn. However, I believe once you sit in on some meetings, you will find you have something to offer.

#### *Reason 3: I don't have the time to participate.*

When you start on a committee, you will be considered a consulting member. All you need to do is attend the meetings. The time commitment would be about 4 to 6 hours per year. From that point, you can determine if you want to get more involved and possibly become a voting member. You can also get more involved by helping to create a technical offering. However, those commitments will be clear, and by your choice, only when you are ready to commit. Initially, getting involved in a technical committee as a consulting member would simply require 1 hour every two or three months.

### ICRI Technical Committee Chairs

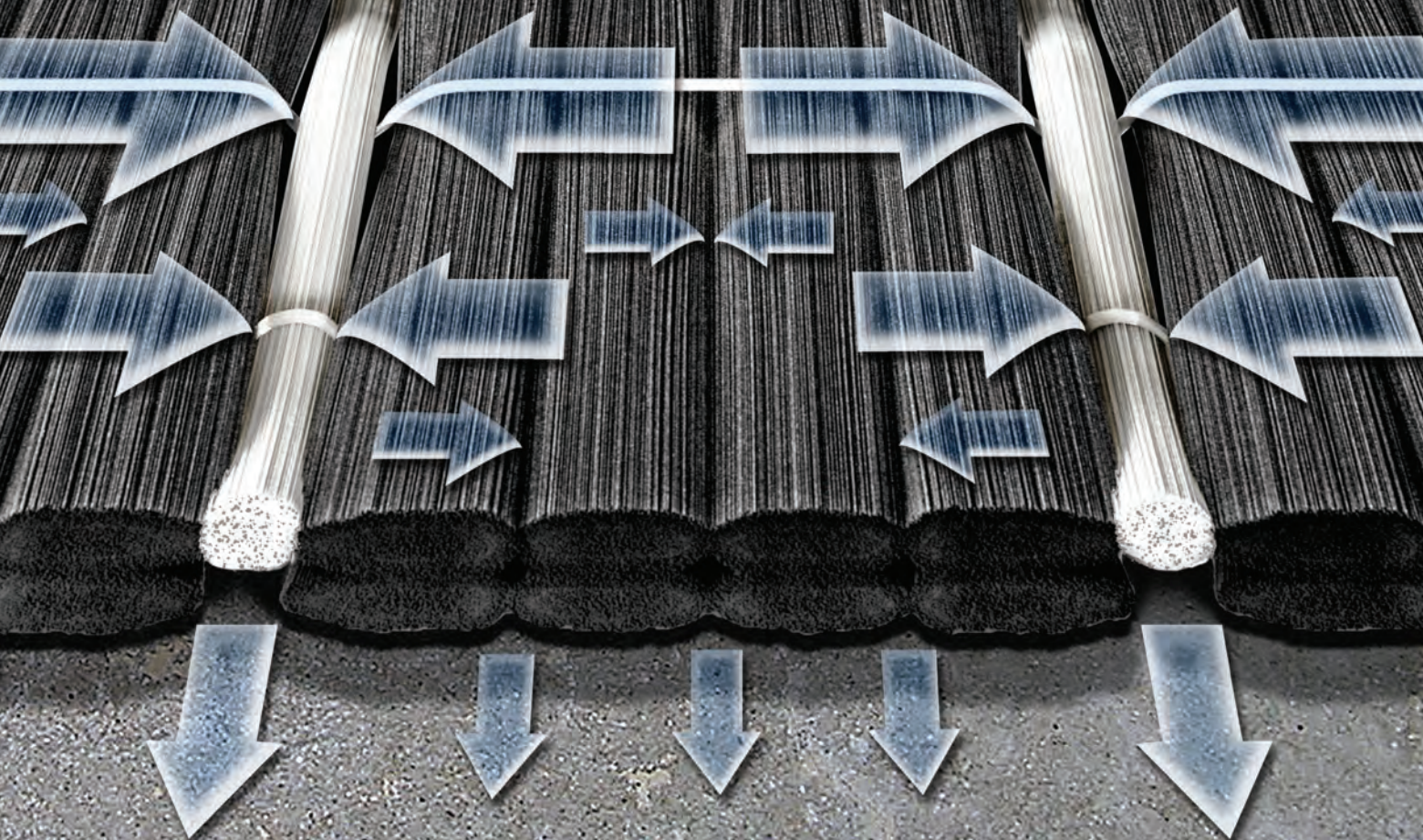
Here is a list of the ICRI Technical Committee Chairs. If you want to become more active in ICRI and the repair industry, please feel free to contact them directly to learn more about their committees.

- **Liying Jiang**, *Jensen Hughes*  
Committee 110—Guide Specifications
- **Paul Farrell**, *Carolina Restoration & Waterproofing*  
Committee 120—Environmental Health and Safety
- **Jeff Carlson**, *Consulting Engineers Group*  
Committee 130—Procurement Methods and Relationship Arrangements
- **Michael Saulnier**, *Pegasus Painting & Waterproofing*  
Committee 130—Procurement Methods and Relationship Arrangements
- **Vincent LaPointe**, *SIMCO Technologies*  
Committee 160—Life Cycle and Sustainability
- **Charles Mitchell**, *SK&A*  
Committee 210—Evaluation, (Co-Chair)
- **David Rodler**, *SK&A*  
Committee 210—Evaluation, (Co-Chair)
- **Peter Haveron**, *Texas Concrete Restoration*  
Committee 310—Surface Preparation
- **Mark Kennedy**, *Construction Sales Group, Inc.*  
Committee 320—Concrete Repair Materials and Methods
- **Tarek Alkhrdaji**, *Structural Technologies*  
Committee 330—Strengthening and Stabilization
- **Jason Coleman**, *Wiss, Janney, Elstner Associates, Inc.*  
Committee 410—Masonry
- **Jorge Costa**, *Durability, Inc.*  
Committee 510—Corrosion
- **Eric Muench**, *Sika Corporation*  
Committee 710—Coatings and Waterproofing

**Mark Nelson** is chair of the ICRI Technical Activities Committee (TAC).



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# SECRETARIAT UPDATE

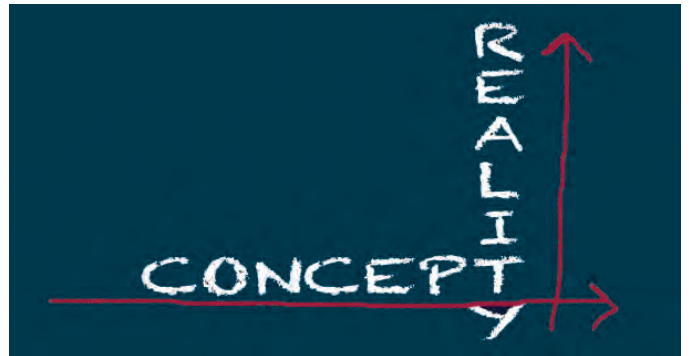


JOHN McDOUGALL

While much of the focus for both the volunteers and staff at ICRI had been dedicated to the recent spring convention's technical presentations, product demonstrations and numerous committee meetings, the work of the Secretariat continues. One idea submitted that caught my attention was the notion that ICRI members could benefit from an app. Not just the convention app, which I happen to think was a great idea, but a year-round technical app.

The concept for the app is to have all things ICRI available on your cell phone or tablet. As a contractor in the field where much of the work of concrete repair happens, the app could house all of our guidelines, links to our webinars and presentations, a live directory for our members, and ultimately a universal calendar for all industry events. For the members who travel regionally, the app could provide a single platform for all chapter events (poke poke—chapter leaders are always encouraged to send all chapter event details to Dale Regnier and update their chapter page at [www.icri.org](http://www.icri.org)).

In addition to the app, we have also been working on a spreadsheet for prioritizing our collective ideas. This allows Eric Hauth to better prompt the idea stakeholders and influencers to keep initiatives progressing. It will keep track of “in process tasks,” lay out next steps for each of our



initiatives, and allow the volunteers and staff to review and coordinate their talents and passions with specific initiatives.

As always, we are looking for ideas from our members for new offerings to our membership and the industry. We will find a volunteer role to allow you to contribute to YOUR association—both in support of an initiative you are passionate about, and in a capacity matching your ability to contribute.

Let's talk about how ICRI can help you and how together we can help the industry.

Email me anytime at [johnmcdougall27540@gmail.com](mailto:johnmcdougall27540@gmail.com).

**John McDougall** is ICRI President-Elect, Secretariat Chair, CSRT certified, and Past President of the ICRI Carolinas Chapter.



## Volunteer

### Why Volunteer?

The success of the International Concrete Repair Institute and its work in the industry depends on a strong, active volunteer force. As a member of ICRI, you are invited to participate in the meetings and projects of any ICRI administrative or technical committee. All are volunteer-led and depend on your expert contributions.

ICRI's volunteer program strives to create an environment that is friendly and welcoming. As an ICRI volunteer, you work closely with volunteer leaders and ICRI staff—active parts of each committee—and available to assist you to answer questions about how ICRI operates, and to help you be the most effective volunteer possible.

### Follow Your Interests

Check out the administrative and technical committees of ICRI, attend their meetings and learn what each is working on. Then decide where your area(s) of interest fit best. The ICRI staff is here to answer your questions and help align you with your interests. You are welcome to attend any meeting of any committee on the administrative or technical committee list. You attend—you can decide if you want to join.

### Length of Commitment

Most volunteer commitments are ongoing; leadership positions are a 3-year commitment. Committees usually meet monthly for 1-1.5 hours. In addition, committees often require tasks to be completed outside of the meetings on the volunteer's own time. Visit [www.icri.org](http://www.icri.org) for more information.

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*ICRI would like to thank its Supporting Members, whose dedication to ICRI is greatly appreciated, and...*



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# Nondestructive Evaluation of Fire-Damaged Reinforced Concrete

by Jacob Borgerson and Joshua White



Fig. 1: A reinforced cast-in-place concrete structure that was damaged due to a fire event

**W**hen reinforced concrete is exposed to fire, both the concrete and reinforcement may be altered, which can result in structural and material damage. Figure 1 shows a photograph of a cast-in-place concrete structure that was damaged due to a fire event.

The repair strategy for fire-damaged structures depends on the severity of damage. When characterizing severity, it is important that an evaluation considers both the extent of damage (i.e., identifying portions of the structure affected) as well as the depth of damage (i.e., how much of a particular beam, column, or slab section is damaged). While both can be characterized by laboratory testing of extracted samples (i.e., concrete cores and steel reinforcing), the scale of material sampling can often be very large, expensive, and time consuming. The nondestructive evaluation (NDE) methods discussed in this article can be used to better understand the extent of damage more efficiently than laboratory testing alone. Once the extent of damage is characterized by NDE, targeted laboratory testing can then be used to determine the depth of damage and approximate exposure temperatures in order to develop repair strategies.

## FIRE EXPOSURE FAILURE MECHANISMS AND DISTRESS CONDITIONS

When reinforced concrete is subjected to fire exposure, both the concrete and reinforcement can be altered and exhibit distress conditions.<sup>1</sup> As the surface temperature of a concrete element increases, surface crazing may occur, followed by cracking and spalling as heat transfers to the interior of the concrete. At relatively high temperatures, there may be a loss of concrete compressive strength due to irreversible microcracking and volume change of the matrix. Depending on the size and duration of the fire, some heat may transfer to the steel reinforcement. At elevated temperatures, there may be a reduction of the steel yield strength, particularly if spalling occurs and exposes the reinforcement.

Assuming there is fuel and ventilation available, compartment fires (e.g., room fires) can fully develop and achieve flashover. Flashover can be visually characterized by flames extending from a doorway/window and involving the available fuel in the compartment. When flashover occurs, the upper gas layer will achieve temperatures exceeding 1110°F (600°C).<sup>2</sup> As such, if flames extend out of the space of the compartment during the fire, it is likely



that portions of the concrete structure would be exposed to gas temperatures exceeding 1110°F (600°C), particularly the elements toward the ceiling space (i.e., slab, joists, beams).

When concrete is exposed to heat (i.e., fire), cracking, spalling, and discoloration can occur. An understanding of these mechanisms can provide insight into the extent and nature of the fire damage. In addition, knowledge of the fire damage failure mechanisms and distress conditions helps provide context for an evaluation methodology.

Cracking related to fire damage is typically a result of restraint from thermal expansion due to temperature differentials between the exterior surfaces of a concrete element and the cooler interior concrete, often seen at the corners of concrete elements. Depending on the type of aggregate present, cracking can also be attributed to thermal expansion of aggregates which can lead to internal microcracking, popouts, and/or crazing. Figure 2 shows an example of cracking that occurred in a concrete joist due to fire exposure.

Spalling is the surface flaking or disengagement of a fragment of concrete and can occur in the temperature range between approximately 300°F to 570°F (150°C to 300°C).<sup>3</sup> Figure 3 shows an example of spalling that occurred on a concrete column due to fire exposure. While opinions differ on the dominant mechanism that causes concrete spalling, it is generally believed to be caused by a combination of vapor pore pressure and thermal stresses.<sup>3,4</sup> Spalling induced by vapor pore pressure occurs when the free water in the concrete vaporizes and expands, causing the internal pressure to exceed the tensile strength of the concrete. Spalling induced by thermal stress is the result of a thermal gradient that induces near-surface compressive stress (due to restrained thermal expansion), creating a fracture plane between the heated surface and the cooler interior region.

The color of concrete aggregates and paste may change during heating, depending on the concrete constituents. Color changes, if observed, can provide an indication of the maximum exposure temperature. At approximately 480°F to 570°F (250°C to 300°C), there is often a color change to pink/red; at approximately 930°F to 1110°F (500°C to 600°C) there can be a color change to purple/grey.<sup>5</sup> 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 can thus provide an indication of the approximate temperatures of the underlying steel reinforcement.

The reinforcing steel within concrete elements may be exposed during a fire event (Fig. 4) and, as a result, may also be affected by elevated temperatures. Strength reduction in reinforcing steel may occur while the steel is at high



Fig. 2: Cracking along the length of a reinforced concrete joist due to fire exposure



Fig. 3: Spalling that occurred on a concrete column due to fire exposure



Fig. 4: Spalling of concrete box beam and exposed prestressed strand due to fire event

temperatures; however, the yield strength may recover after cooling. For hot-rolled steel reinforcing bars, the yield strength is typically recovered for temperatures less than approximately 1110°F (600°C).<sup>1,6,7</sup> As such, for exposure temperatures greater than 1110°F (600°C), yield strength and/or ductility of the steel reinforcement may be reduced.

## NONDESTRUCTIVE EVALUATION OF REINFORCED CONCRETE STRUCTURES EXPOSED TO FIRE DAMAGE

Visual assessment is one of the simplest methods for non-destructively evaluating reinforced concrete structures for fire damage. As described earlier, evidence of fire damage typically consists of surface defects such as cracking, spalling, and concrete discoloration. While visual assessment is effective, it does not provide an evaluation of the concrete beyond what is visible (e.g., beyond the exterior surface). Consequently, visual assessment should be performed in conjunction with other nondestructive evaluation techniques, such as acoustic sounding, techniques utilizing stress waves (e.g., impact echo, ultrasonic pulse velocity, ultrasonic tomography), and ground penetrating radar.

Acoustic sounding can be used to determine if concrete has delaminated. The method involves applying an impact and listening (i.e., via the unaided human ear) for dull or hollow sounds. For vertical and overhead concrete elements, an impactor (typically a hammer) is used to tap the concrete surface. For locating delaminations on top of reinforced concrete slabs, the chain drag method is usually implemented because larger areas can be evaluated more efficiently. While acoustic sounding is a straightforward and relatively simple technique, experience is required in order to differentiate between dull/hollow sounds that are consistent with delamination and other sounds that appear dull or hollow but are due to the concrete element's

geometry. For example, acoustic sounding at the bottom of a narrow double tee beam stem may sound more or less hollow than sounding at the top of the stem. This acoustic difference is due to the support condition of the concrete element and should not be interpreted as delamination.

Impact echo (IE) can be an effective method for detecting micro-cracking and delaminations within concrete elements exposed to fire. The IE method involves introducing mechanical energy, in the form of a brief impact, to the concrete test element (e.g., slab, beam, or joist). An impactor is used to generate a stress wave through the concrete element. Stress waves reflected from internal discontinuities or member boundaries are measured using a signal displacement transducer positioned near the impact. As the transmitted energy travels through the material, any changes in acoustic impedance within the material reflects a portion of the energy back to the surface. With knowledge of the propagation velocity (i.e., wave speed) of the material and the frequency spectrum of the reflected waveform, the depth to discontinuities (i.e., internal flaws) or the member boundary can be determined. Figure 5 provides a comparison of representative IE results in undamaged and damaged areas. For example, Signal 1 provides a typical frequency domain for sound concrete with a dominant peak frequency corresponding to the thickness of the element, while Signal 2 shows a frequency domain with multiple frequency peaks which is likely caused by cracking and/or a spall in the concrete. In Signal 2, the dominant

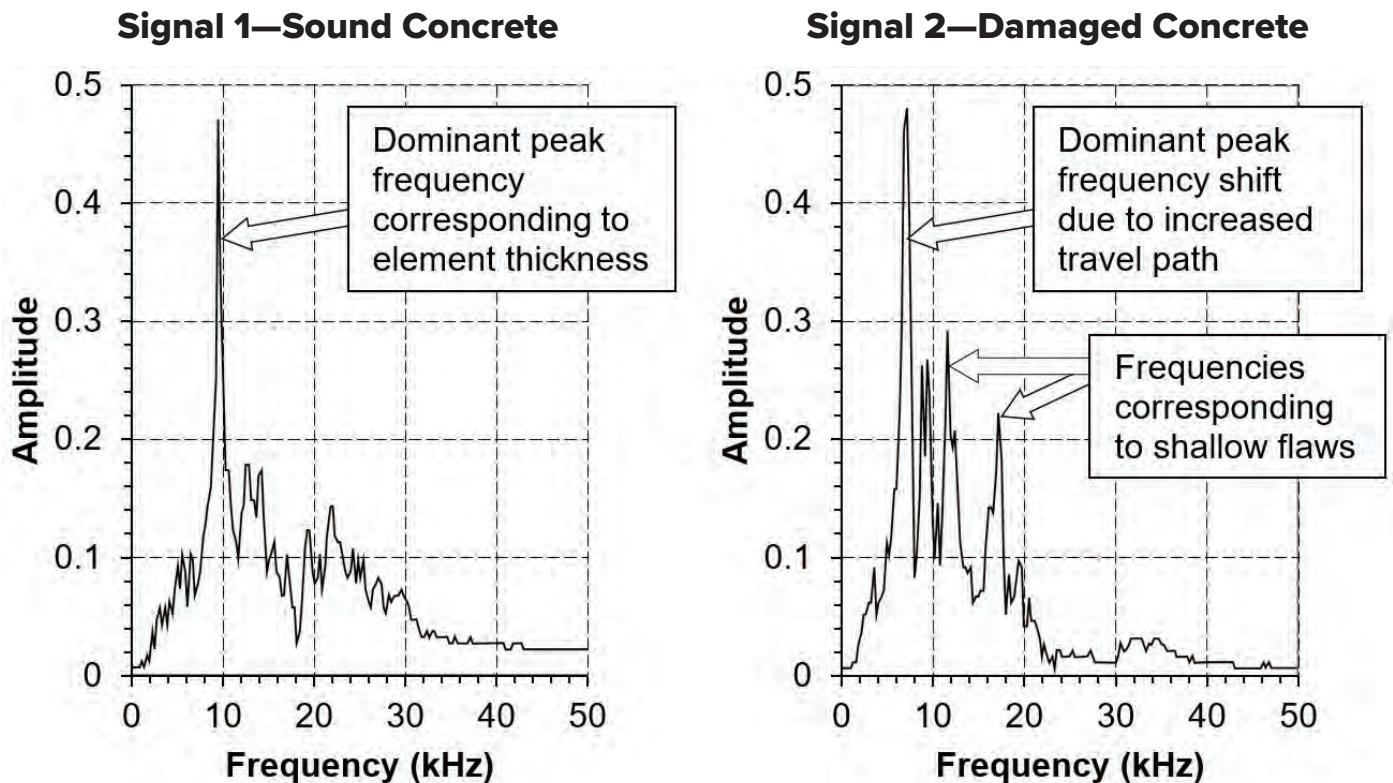


Fig. 5: Comparison of representative IE results in damaged and undamaged areas

frequency peak has shifted compared to the sound concrete, which is characteristic of damaged concrete members due to the increased travel time of the stress waves.

Shear wave ultrasonic tomography (UST) is a reflective ultrasonic test method capable of generating 2D and 3D tomographic images of internal conditions within concrete elements. The method can be used to detect internal flaws such as spalls and cracking. UST testing devices consist of a sensor array incorporating dry point contact piezoelectric transducers. Each transducer emits ultrasonic shear waves (S-waves) and receives waves reflected from relative changes in acoustic impedance (e.g., material boundaries or flaws). Scans that are collected at sound concrete (free of sizable voids, cracks, or spalls) are characterized by a strong signal reflection that corresponds to the back wall, or full-thickness of the tested element. Areas where internal flaws are present are characterized by 1) the absence of a back-wall reflection due to the presence of internal reflectors, near-surface degradation, or both; and/or 2) signal reflections corresponding to the depth of the flaw. Figure 6 provides a comparison of representative UST results in undamaged and damaged areas. For example, Signal 1 provides a typical frequency domain for sound concrete with a dominant frequency peak corresponding to the thickness of the element, while Signal 2 shows a frequency domain with multiple frequency peaks which is likely caused by cracking and/or a spall in the concrete. In Signal 2, the dominant frequency peak has shifted com-

pared to the sound concrete, which is characteristic of damaged concrete members due to the increased travel time of the stress waves.

The ultrasonic pulse velocity (UPV) method involves introducing pulsed longitudinal stress waves (P-waves) at the surface of a test element and then measuring the waveform at an opposing face. Stress waves are transmitted and received using piezoelectric transducers that are acoustically coupled to the test surfaces. Transit time and signal amplitude of a transmitted pulse are measured, and detected changes in arrival time, amplitude, and characteristics of the propagated waves can indicate corresponding differences in the internal condition of the element. For the testing of concrete, sound regions exhibit little variation in propagation velocity and exhibit strong signal transmittance, with nominal signal attenuation normally associated with varying path lengths through the member. The presence of internal flaws or areas of deterioration typically adversely affect the velocity and amplitude during stress wave propagation. Poor surface conditions, such as delaminations, laitance, or unsound surfaces, can also result in significant signal attenuation during testing. Figure 7 provides an example showing the effective wave velocity along the height of two concrete columns that were exposed to a fire event.

Ground penetrating radar (GPR) is a geophysical method used for the assessment of structural elements and geo-

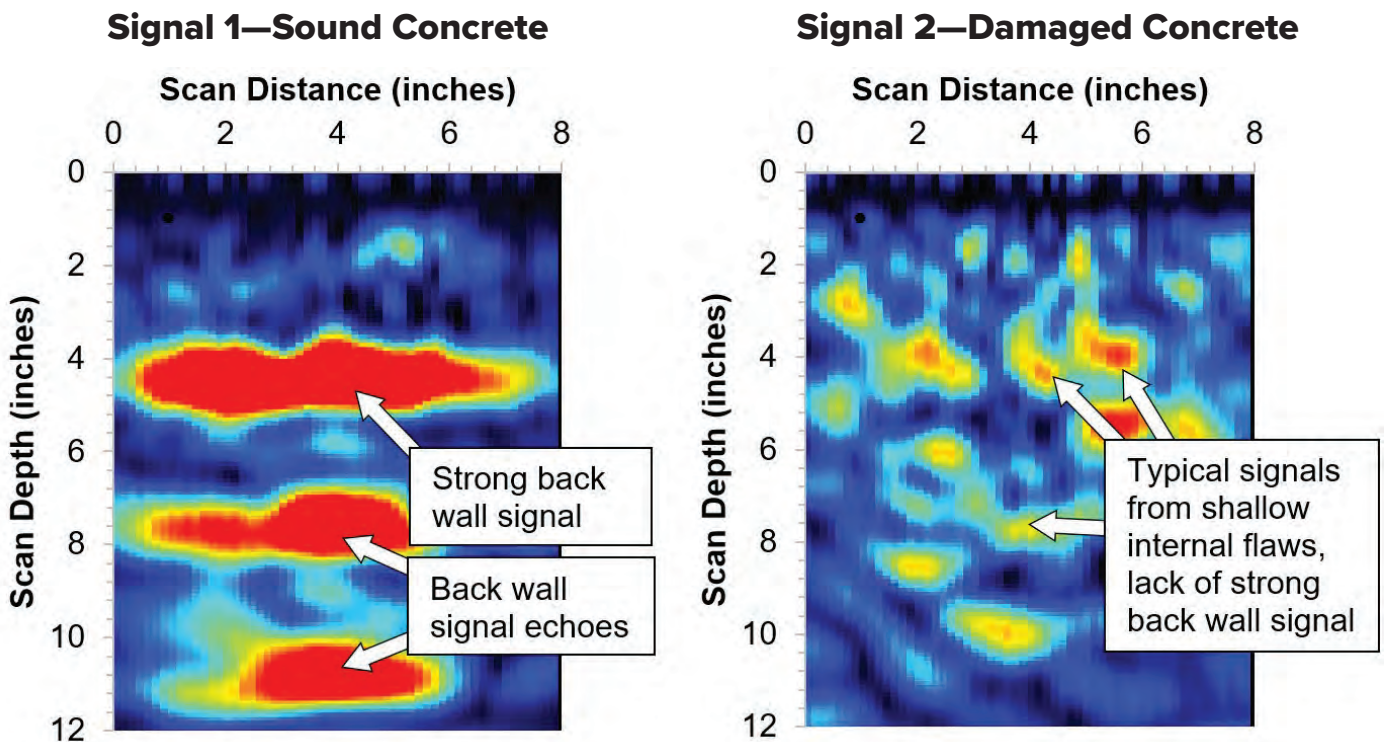


Fig. 6: Comparison of representative UST results in damaged and undamaged areas

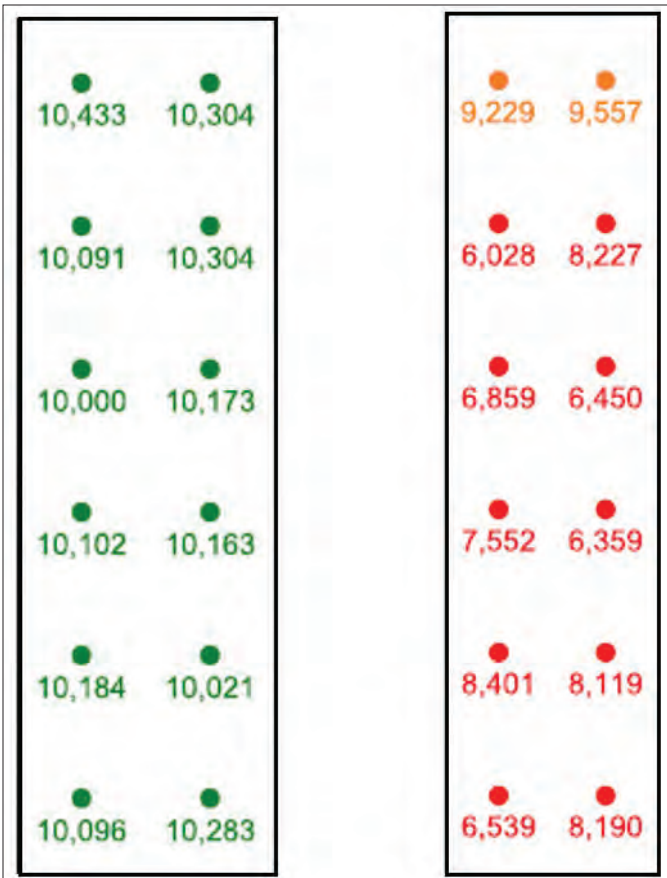


Fig. 7: Comparison of representative UPV material velocities (feet per second) for an undamaged concrete column (left image) and a damaged concrete column (right image)

logical materials. GPR testing of concrete allows for the detection and location of embedded elements (e.g., steel reinforcement, prestressing/post-tensioning strand, metal and plastic conduit), internal voids (such as poor consolidation), and assessment of member thickness and element geometry. The test method involves the use of a dipole radar antenna which transmits electromagnetic wave pulses along discrete scans at the surface of the structural element. The electromagnetic waves propagate through the material and reflect at material interfaces characterized by a change in dielectric properties. The reflected waves are collected by the antenna and are amplified, filtered, and displayed for subsequent interpretation. Post-processing software integrating signal filtering and visualization options allows for subsequent analysis of collected GPR scans. When the depth of damage (i.e., estimation of temperature as a function of depth) is known, knowledge of the reinforcement placement using GPR helps determine if damage to the reinforcing steel is expected in areas where the concrete cover remains intact.

### SUPPLEMENTING NDE FINDINGS WITH LABORATORY TESTING

Once the extent of damage is characterized by NDE (e.g., one might subdivide the structure into areas of “poor”, “fair/questionable”, or “good” condition), the depth and

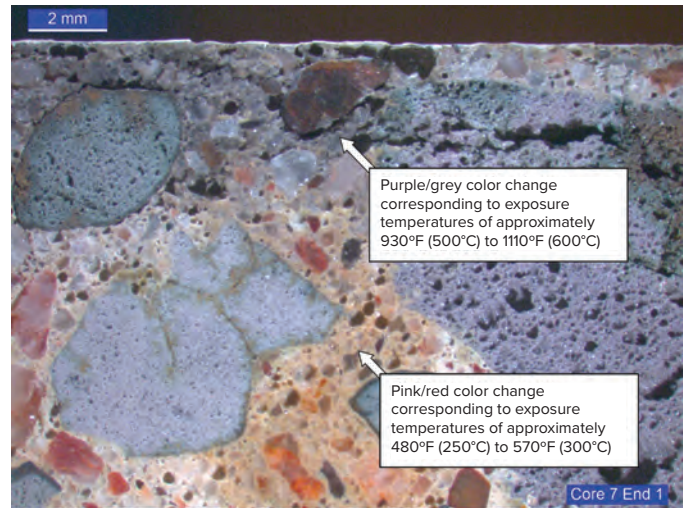


Fig. 8: Lapped cross-sectional surface of concrete core showing color change due to variation in exposure temperatures

nature of the fire damage can be evaluated by extracting samples for laboratory testing.


Concrete cores are typically extracted from the structure and examined microscopically using petrographic examination. Petrographic examination is often used to assess the quality of hardened concrete and can help determine the effects of exposure to elevated temperatures on the concrete. Alterations in the aggregate and paste are associated with exposure to a range of elevated temperatures, but these alterations are also dependent on the duration of the exposure, features of the concrete, and the quenching operations used to extinguish the fire. Figure 8 provides a lapped cross-sectional surface of a concrete core showing color change due to fire exposure.

If the majority of the defective concrete is near-surface damage, it should not have an appreciable impact on the concrete compressive strength of the tested cores. Conversely, cores can be extracted and tested to directly measure potential reduction in concrete compressive strength that may be attributable to heat exposure during the event.

If the petrographic examination indicates that the concrete at the depth of the reinforcing steel (e.g., as determined by GPR) did not exceed 1110°F (600°C), no damage to the reinforcing steel is expected in areas where the concrete cover remains intact. In areas where steel reinforcement is exposed (presumably during the fire event), it may have achieved surface temperatures exceeding 1110°F (600°C) and some strength reduction in the reinforcement may have occurred. As such, sections of the steel reinforcement may be removed at select locations to evaluate its mechanical properties (i.e., yield and ultimate tensile strength).

### SUMMARY

Assessment of a reinforced concrete structure exposed to fire damage is often necessary to determine the scope

of repairs. While there are many approaches to evaluating fire damage of reinforced concrete, NDE can provide an effective approach for surveying the extent of potential fire damage and can be valuable in a structural and materials evaluation. When considering NDE as part of a fire damage assessment, it is typically beneficial to utilize a multi-method approach. The findings from NDE should be supplemented with laboratory testing to determine the depth of damage and, if needed, quantify strength reduction in the concrete and/or steel reinforcement. 

## REFERENCES

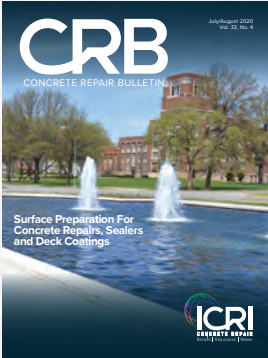
1. Suprenant, B. A., Evaluating Fire-Damaged Concrete, *Concrete Repair Digest*, 1997, pp. 20-23.
2. Quintiere, J. G., *Fundamentals of Fire Phenomena*, John Wiley & Sons Ltd, West Sussex, England, 2006.
3. Jansson, R., *Material Properties Related to Fire Spalling of Concrete*, Lund Institute of Technology, Lund University, 2008.
4. Khoury, G. A., and Anderberg, Y., *Fire Safety Design: Concrete Spalling Review*, 2000.
5. Poole, A. B., and Sims, I., *Concrete Petrography: A Handbook of Investigative Techniques* (2nd Edition), CRC Press, Boca Raton, Florida, 2016.
6. Holmes, M., Anchor, R. D., Cook, G.M.E., and Crook, R. N., The Effects of Elevated Temperatures on the Strength Properties of Reinforcing and Prestressing Steels, *The Structural Engineer*, Vol. 60B, No. 1, 1982, pp. 7-13.
7. Concrete Society, *Assessment, Design and Repair of Fire-Damaged Concrete Structures* (TR 68), Concrete Society, England, 2008.



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# Fusion of Nondestructive Testing and Photogrammetry for Concrete Condition Imaging

by Larry Olson

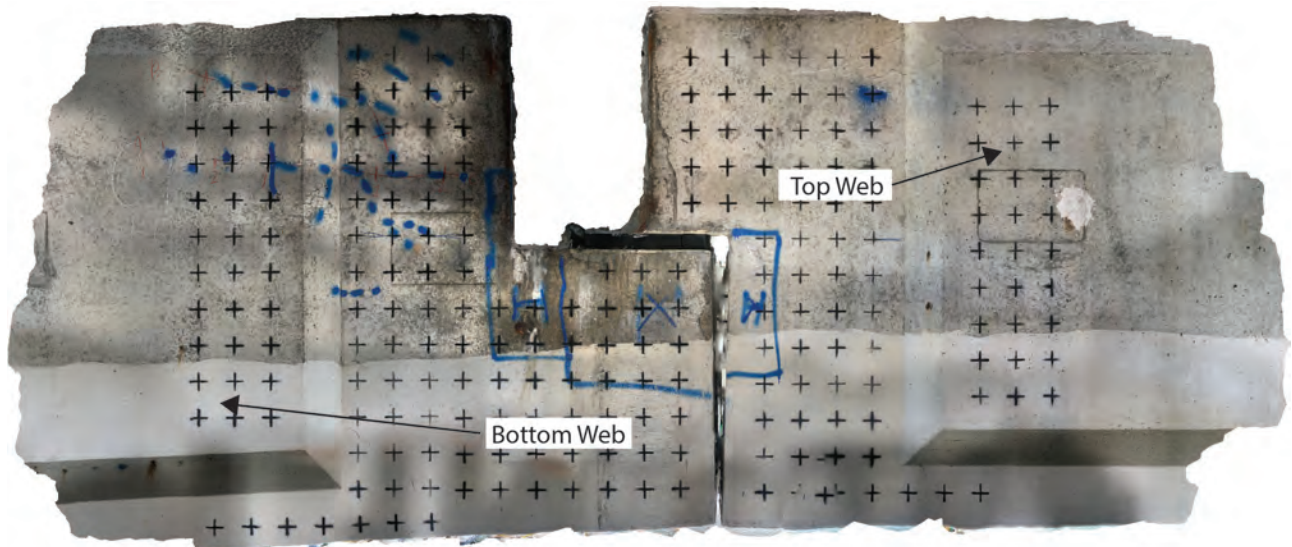


Fig. 1: Digital photogrammetry example Image for bridge girders with 6 in (150 mm) NDE grid marked out on girder webs and ends (note 3D-like depth effect in image)

Concrete repair projects are increasingly benefitting from the use of nondestructive evaluation (NDE) methods to diagnose and identify where internal concrete conditions are in need of repair. ICRI's 210 Evaluation Committee has produced two technical guidelines involving NDE: ICRI 210.4<sup>1</sup>, *Guide for Nondestructive Evaluation Methods for Condition Assessment, Repair, and Performance Monitoring of Concrete Structures*; and ICRI 210.1R<sup>2</sup>, *Guide for Verifying Field Performance of Epoxy Injection of Concrete Cracks*—both reference and discuss the NDE methods in this article.

Once flawed/damaged conditions are identified from NDE, destructive drilling/coring along with video borescopes are used to determine the nature of the anomaly and choose repair methods and materials. By taking multiple high-resolution digital photographs at different angles and using photogrammetry to process the photos, a high-resolution image is produced with minute detail for the current concrete surface distress conditions. Photogrammetric images also provide an important baseline against which to evaluate the progression of surface distress over time. The overlay of NDE data on photogrammetric images of

concrete surface conditions is known as data fusion and can be done in a 2D/3D fashion. Data fusion is being increasingly performed to provide engineers and repair contractors with a better understanding of visible surface conditions integrated with internal concrete conditions for concrete repair projects.

## DATA FUSION APPROACH—CONCRETE BRIDGE GIRDERS

The use of the data fusion approach is discussed below for evaluation of concrete bridge girders using photogrammetry along with the NDE methods of ground penetrating radar (GPR), impact echo scanning (IES) and spectral analyses of surface waves (SASW). The post-tensioned, pre-stressed and reinforced concrete bridge girders are from an older bridge and subject to chlorides exposure and corrosion over time.

### Photogrammetry

The need for concrete repairs generally arises when surface distress is visually noted. Photogrammetry was used to provide detailed images of concrete distress conditions of bridge girders for fusion with NDE results and to

evaluate the progression of surface distress over time with subsequent photogrammetric studies. The first step is to capture raw photographic digital images with a high-resolution phone camera at a minimum; however, a telephoto lens digital camera is useful for larger structures. Camera orientations are then determined and multiple overlapping photographs taken at different view angles (overlapping) with identifiable features for image processing. There are a number of commercial and shareware software packages available for photogrammetric image analyses that can be used to generate 2D and 3D model images. An example photogrammetric bridge girder image with high-resolution (0.025 to 0.04 in [0.6 to 1 mm]) images took 3-4 hours of processing time on a computer with a very good GPU video processor (Fig. 1).

### Ground Penetrating Radar (GPR)

The GPR method involves moving an antenna across a test surface while periodically pulsing the antenna and recording the received echoes (Fig. 2). A handheld GPR unit was used to scan the girder webs and ends both vertically and horizontally (Fig. 3) to produce 3D images of embedded pre-stress, post-tensioning ducts, reinforcement, and steel plates in the girders.

The raw GPR data from a vertical 2D straight scan line is presented in Figure 4(a) with the hyperbolic-shaped reflections at a 2 in (50 mm) concrete cover depth indicating the near-surface horizontal rebar. Note the post-tensioned metal tendon ducts are larger in diameter and have broader and deeper hyperbolic reflections at 3 to 4 in (75 to 100 mm) deep. The GPR data are then migrated to collapse the rebar and duct reflections to a dot shape as shown in Figure 4(b). The final step is a Hilbert Transform that further clarifies the depths and locations of the rebars as the pulses are merged into a single pulse envelope as shown in Figure 4(c). The horizontal and vertical processed 2D GPR scans were then combined to produce the 3D GPR image that is overlaid on the photogrammetric image (Fig. 5). Review of this figure reveals the locations of embedded rebar, tendon ducts, and metal plates overlaid on the photogrammetric image in Figure 1.



Fig. 3: Horizontal GPR scanning on a 3 in (75 mm) grid (vertical scans were also completed) for 3D GPR image

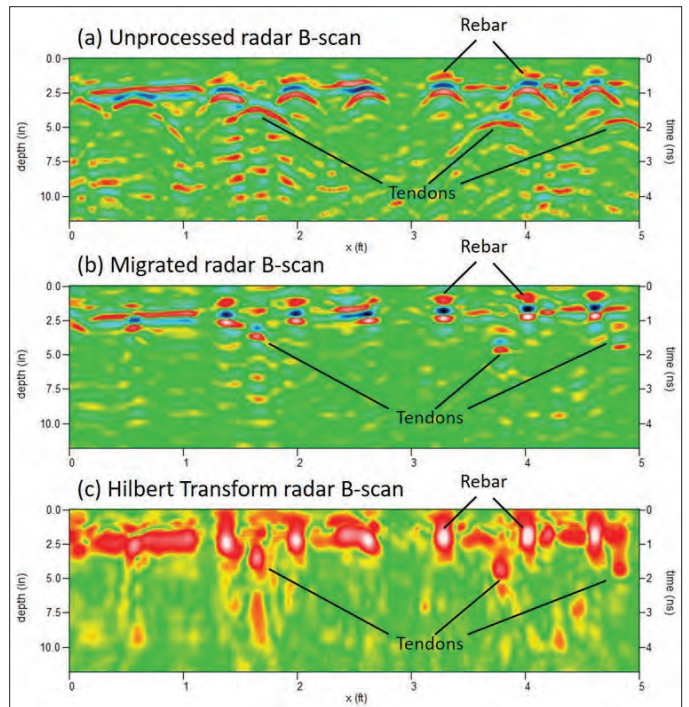


Fig. 4: 2D GPR vertical scan data analyses steps before combining into 3D GPR image

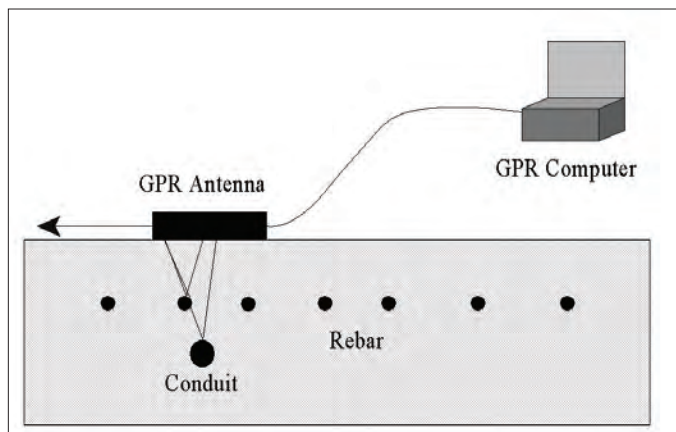


Fig. 2: Ground penetrating radar (GPR) scanning

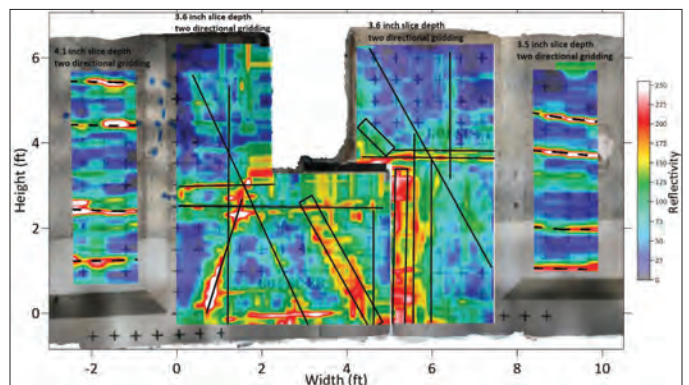


Fig. 5: Data fusion: 3D GPR depth slices for PT ducts, rebar, and embedded plates

## Impact Echo Scanning (IES)

The impact echo test method is based on impacting the concrete and recording the resulting compressional wave echoes with a receiver in the time domain and analyzing the time data to obtain the resonant echo frequency with a Fast Fourier Transform (Fig. 6). The bridge girders were tested with an impact echo scanner that consisted of a rolling displacement transducer/solenoid impactor scanner system that covers more testing area in less time with a test every 1 in (25 mm) on vertical scan lines spaced 6 in (150 mm) apart (Fig. 7). The IES unit was used to check the concrete thickness/integrity and to detect voided vs. grouted post-tensioned tendon duct conditions in the web

walls. Sound concrete web wall and grouted duct conditions are shown on a thickness echo plot on the left in Figure 8. Sound concrete web wall with a poorly grouted/void tendon duct condition are indicated by the increase in thickness echo on the right in Figure 8.

## Spectral Analyses of Surface Waves (SASW)

The SASW method measures the propagation speed of surface waves with various wavelengths (Fig. 9) for tests across a crack to determine its depth. Short wavelength waves sample shallow, longer wavelengths sample deeper, and surface wave velocity = frequency x wavelength. SASW testing allows the measurement of the velocity

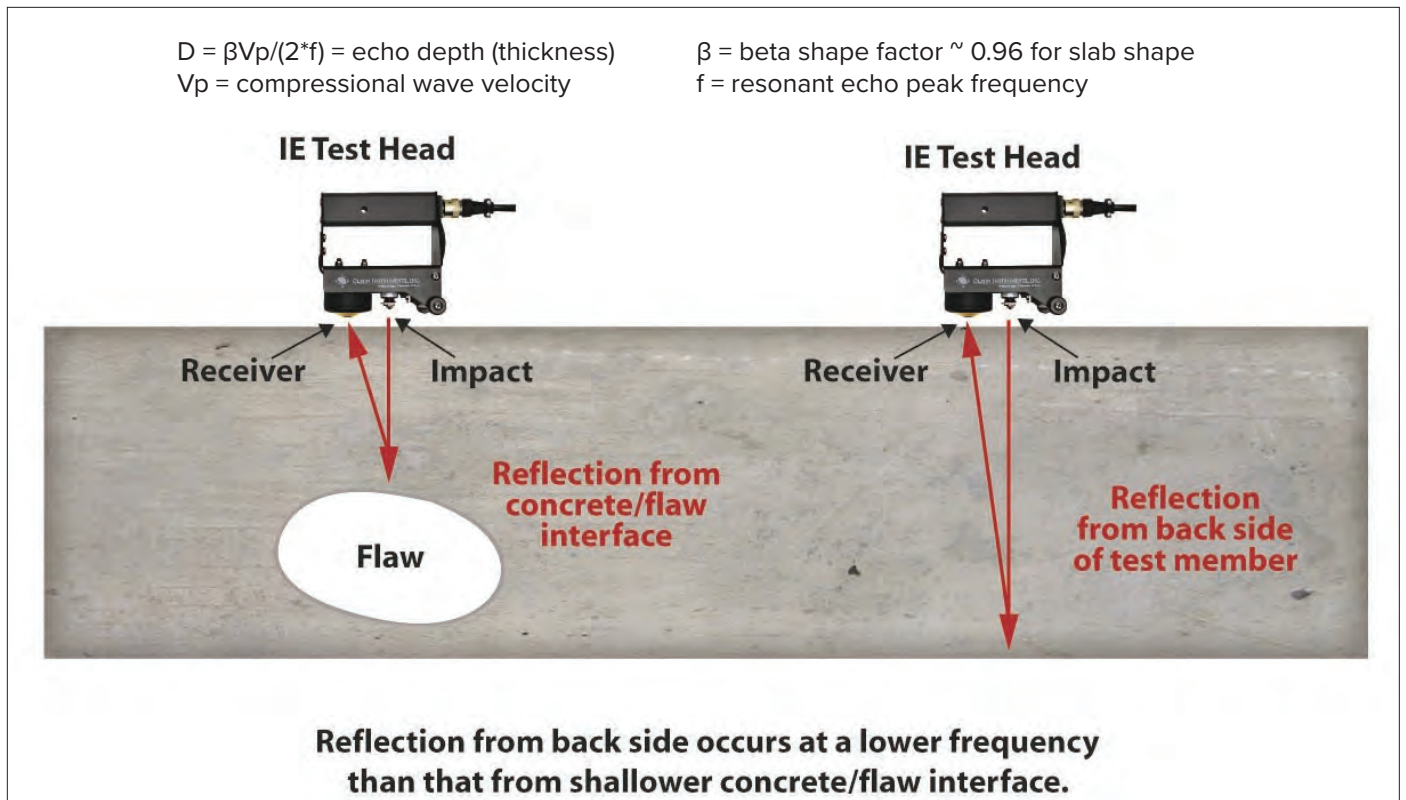


Fig. 6: Impact echo test method (ASTM C1383<sup>3</sup>) and data analysis steps



Fig. 7: Impact echo scanner with rolling transducer wheel and solenoid impactors (left) and impact echo scanning of girders on vertical lines at 6 in (150 mm) spacing (right)



profile versus depth into the structure, which can be related to the strength and condition of the concrete versus depth and the depth/extent of cracking damage. Refer to ACI 228.2R<sup>4</sup>, *Report on Nondestructive Test Methods for Evaluation of Concrete in Structures*, for detailed information on the SASW, IE, and GPR methods. SASW velocity vs. wavelength plots (dispersion curves) are presented for sound concrete on the left in Figure 10 and for cracked concrete on the right in Figure 10. Review of these plots indicates a crack depth extending to about 7 to 8 in (175

to 200 mm) deep in the right plot where the surface wave velocity increases.

### DATA FUSION OF PHOTOGRAMMETRIC IMAGES AND NDE RESULTS

The IES and SASW results were fused (overlaid) onto the photogrammetric image (Fig. 11) along with the GPR 3D locations of the tendon ducts. Review of this figure provides combined data as to where the tendon ducts are (from GPR) and their grout conditions (from IES) plus crack depth data (SASW colored circles) and the surface conditions of the photogrammetric image for the web walls. An overall fusion image plot for the girder end walls of the IES and SASW results is presented in Figure 12. Note that this figure provides combined data as to the locations and depths of shallow to deep delaminations (from the IES results) along with crack depth data (SASW colored circles) and the surface conditions of the photogrammetric image.

### SUMMARY OF DATA FUSION WITH PHOTOGRAMMETRIC AND NDE METHODS

Photogrammetry provides detailed imaging with 3D-like depth views of concrete surface conditions for overlay of NDE results and future comparisons of how surface distress is advancing. The use of 3D Ground Penetrating Radar (GPR) can image complex reinforcement, PT duct and metal plate embedment conditions. Spectral Analyses of Surface Waves (SASW) provides data

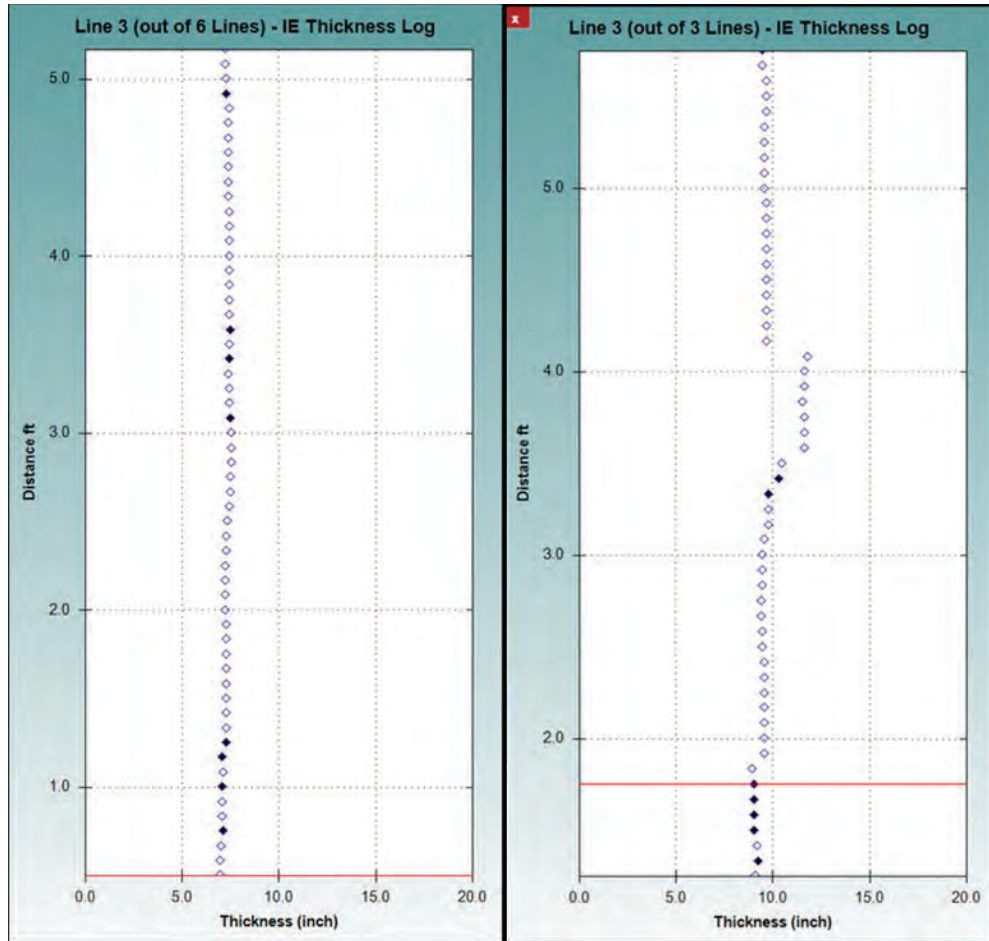


Fig. 8: Vertical scan IES results of approximately 7.5 in (190 mm) thickness echoes for sound web wall with grouted tendon ducts (left) and poor/void tendon duct grouting conditions shown by increase in echo thickness from 8 to 9 in (200 to 225 mm) to 12 in (300 mm) at 3.6 to 4.1 ft (1.1 to 1.25 m) (right)

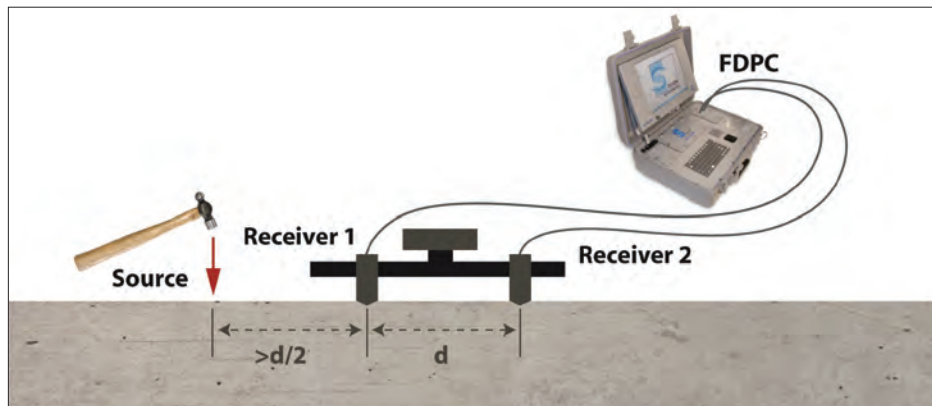


Fig. 9: Spectral analysis of surface waves method (SASW) and SASW bar with 2 receivers testing across surface-opening crack on girder

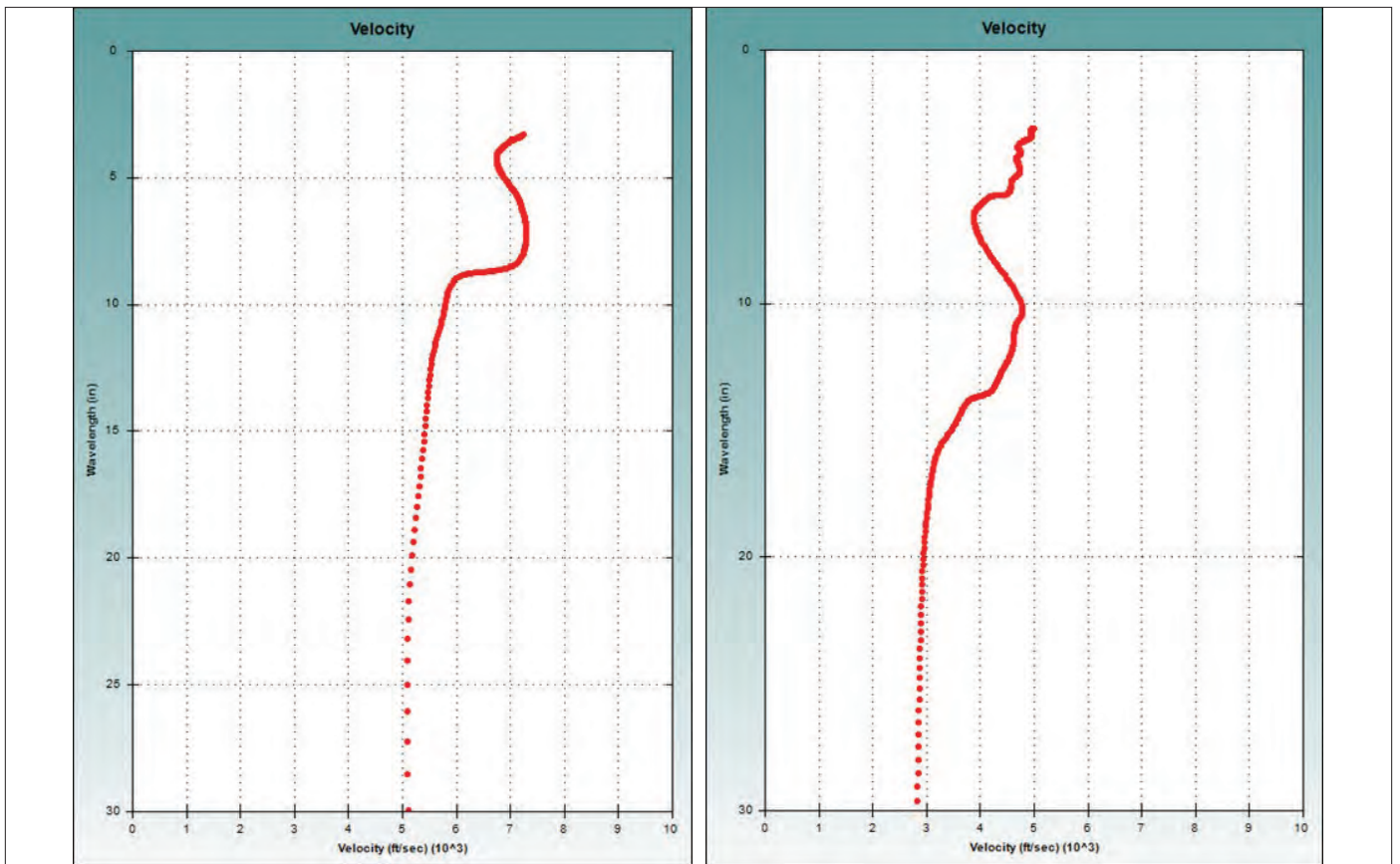


Fig. 10: SASW velocity vs. wavelength results on sound (left) and visibly cracked (right) girder areas. The backside of the sound 7.5 in (190 mm) thick web section is shown by the drop in surface wave velocity from approximately 7,000 ft/s from 4 to 8 in (100 to 200 mm) to approximately 5,500 ft/s at a wavelength of 8 in (200 mm) (left). The SASW test across a crack on a girder end indicates a crack depth from the surface to approximately a 7 to 8 in (175 to 200 mm) depth where the surface wave velocity increases (right)

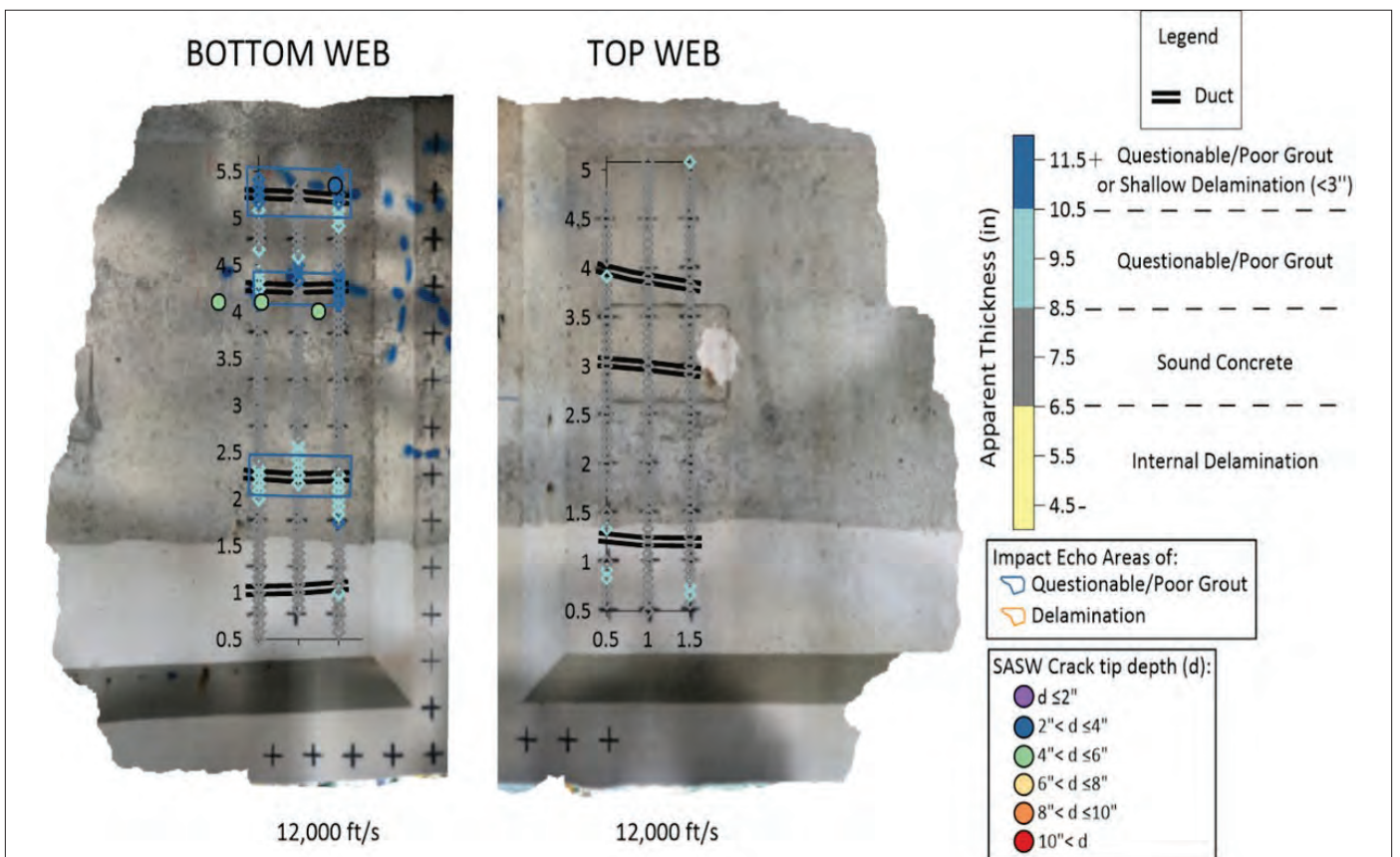


Fig. 11: Data fusion of photogrammetric images, impact echo scanning, SASW and GPR results for duct grouting, crack tip depth and duct locations for web walls

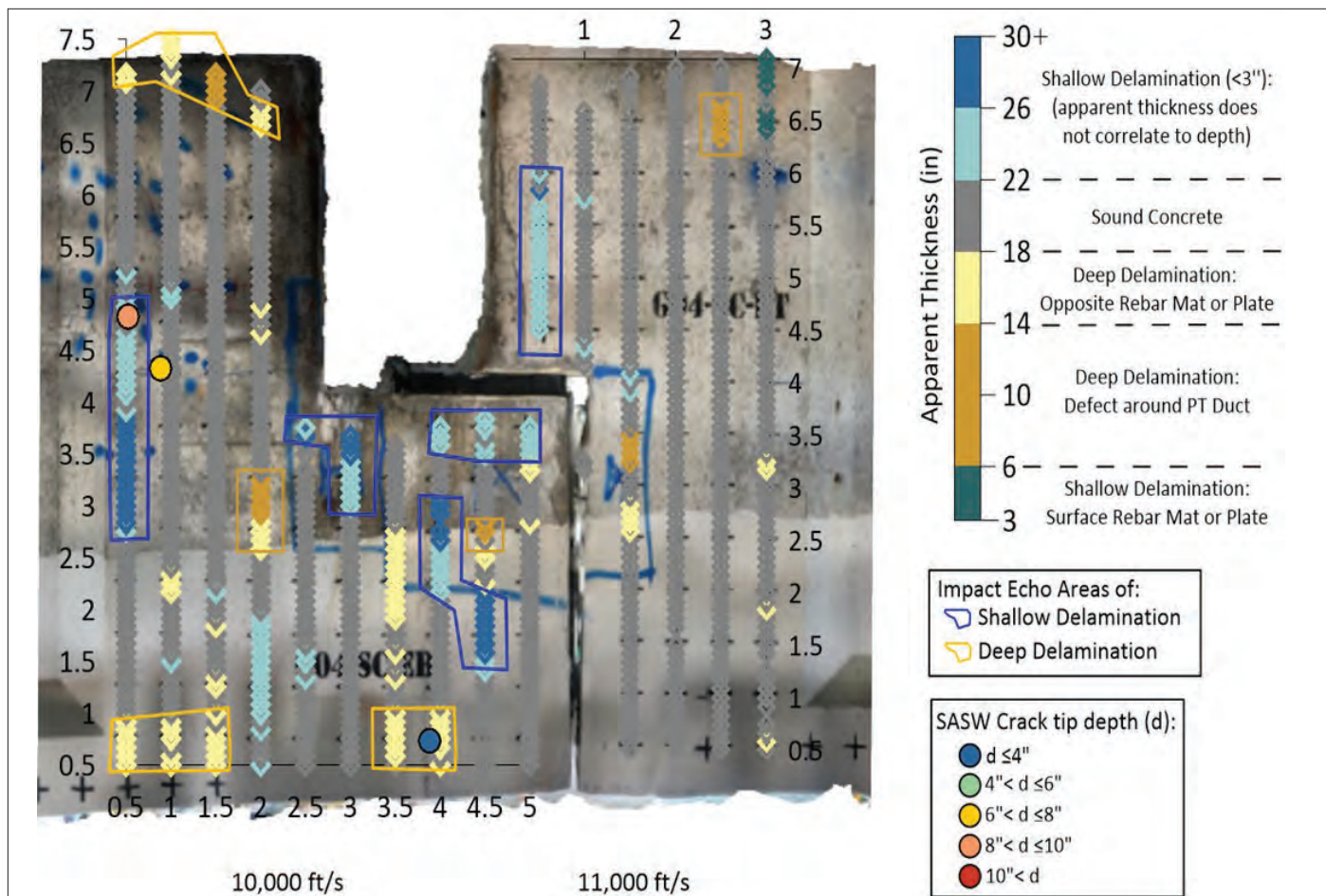


Fig. 12: Data fusion for girder end walls of photogrammetric images, impact echo scanning, SASW and GPR results for duct grouting, crack tip depth and duct locations

on depth of cracking and concrete integrity as well as one-sided velocity measurements. Impact Echo Scanning (IES) identifies grouted vs. voided Post-Tensioning Duct conditions and delamination/cracking in concrete. Finally, data fusion integrates internal concrete conditions from NDE with photogrammetric surface concrete images for clearer structural assessment. 🗨️

## REFERENCES

1. ICRI 210.4, *Guide for Nondestructive Evaluation Methods for Condition Assessment, Repair, and Performance Monitoring of Concrete Structures*, International Concrete Repair Institute, St. Paul, MN, 2009.

2. ICRI 210.1R, *Guide for Verifying Field Performance of Epoxy Injection of Concrete Cracks*, International Concrete Repair Institute, St. Paul, MN, 2016.
3. ASTM C1383, *Standard Test Method for Measuring the P-Wave Speed and the Thickness of Concrete Plates Using the Impact-Echo Method*, ASTM International, West Conshohocken, PA, 2015.
4. ACI Committee 228, *Report on Nondestructive Test Methods for Evaluation of Concrete in Structures (ACI 228.2R-13)*, American Concrete Institute, Farmington Hills, MI, 2013.



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# Nondestructive Testing of Fatigued Concrete in a Crusher Foundation

by Alfred Gardiner

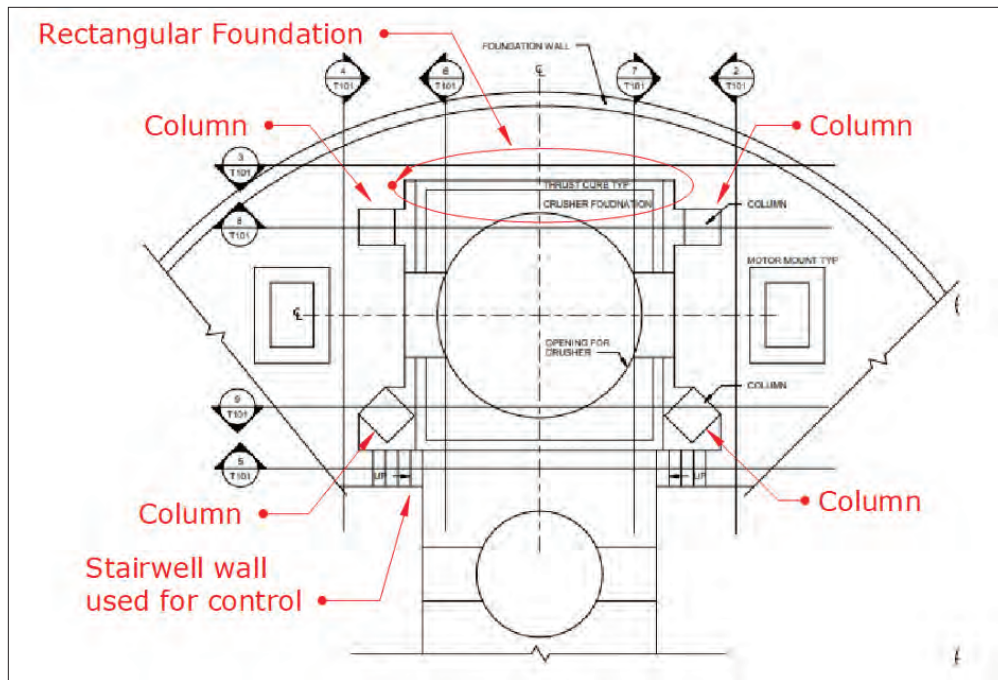


Fig. 1: Structural elements at crusher foundation

Keeping the end in mind is the most critical step in any nondestructive evaluation. The techniques and computing capabilities are constantly evolving, providing more and more methods to evaluate concrete. Cost, timeline, potential outcomes, and repair options should all be considered before you start the evaluation.

This article discusses a 60-year-old crusher foundation in a mining operation. The crusher was scheduled to be replaced and an in-depth review of the foundation was needed. Repairs had already occurred on the columns and additional repairs, or a complete replacement, could be accomplished during the installation of the new crusher equipment. Initial concerns were raised regarding fatigue damage of the concrete over 60 years of vibration.

## NDT METHOD SELECTED

The NDT method utilized on the project was ultrasonic pulse velocity (ASTM C597)<sup>1</sup> to assess possible fatigue issues in the concrete. This method uses sound waves transmitted through the concrete to measure the speed of the sound. This pitch and catch method is ideal when you have

access to two sides of the structure as was the case on this project.

Fatigue after 60 years of vibration can cause cracking, especially around the aggregates, which would slow the sound wave as it passes through the concrete. Most published research recognizes 3000 to 3500 meter per second (m/s) as an acceptable threshold for velocity in sound concrete.<sup>2</sup> Below these velocities, the concrete is of questionable quality. Keep in mind that this technique measures soundwaves through concrete and anomalies in the velocity are due to unknown causes. Without Superman's x-ray vision, other ways of determining the reason for lower velocity are required. On this project, strategic cores and petrographic analysis were conducted to determine the root cause of reduced velocities.

## NDT EVALUATION

The NDT evaluation could only be conducted during an 8-hour down time that occurred on a weekly schedule. The plan was developed to conduct the pulse velocity testing and observations during one of the weekly 8-hour periods.

The data from this site visit were analyzed and a second trip was performed a week later to extract cores from the locations selected during the analysis.

The structure consisted of a rectangular foundation and four columns (Fig. 1). On the columns, access was available to opposite parallel sides, therefore the pulse velocity testing was conducted through the width of the columns (Fig. 2). For the rectangular foundation, access was only available on perpendicular sides, therefore the pulse velocity testing was conducted on angles rather than directly through the structure. Although the velocities for sound concrete are provided in research papers, a calibration of the velocity for the concrete being tested is recommended. To calibrate, pulse velocity testing was conducted on concrete placed at the same time as the foundation and columns, although it had not been exposed to vibration. This location was the stairs indicated in Figure 1. The average velocity measured at this location was 3786 m/sec.

Some test locations in column areas provided no signal transmission and other column locations provided variable velocities. Examples of good signals and non-signals are presented in Figures 3 and 4. The foundation yielded similar results with variable velocities. A sample of the velocities measured is provided in Table 1. The table was color formatted to provide easy identification of areas of concern.

### CONCRETE CORING TO SUPPLEMENT NDT

NDT revealed many areas of concern with the concrete in the columns and foundation. Signals could not be collected in some areas and in other areas the pulse velocity provided significant variability in the measured velocity. Multiple cores were extracted from the five structural elements to correlate the NDT to the physical condition of the concrete. The cores confirmed the concrete was cracked from what appeared to be 60 years of vibration applied from the operating crusher above. Figures 5, 6, 7, and 8 show the coring operation, view in a core hole, an extracted core, and the polished section of a core.


On this project, the NDT provided an effective way to quickly test the columns and the foundation in a grid pattern covering a large area quickly. The result of the NDT allowed for the coring locations to be selected strategically instead of randomly. Additionally, the number of cores required to evaluate the structure was dramatically reduced as only six (6) cores were extracted.

The cores provided information that the NDT could not provide. Visual review of the cores indicated the concrete did not contain microcracking, and the macrocracking observed in the core holes and extracted cores were limited to the concrete over the reinforcing. The concrete at a greater depth than the reinforcing steel was in good condition and structurally sound.



Fig. 2: Column layout for pulse velocity testing

### CONCLUSION

Nondestructive testing techniques are effective for evaluating concrete structures—although they should always be coupled with extracting cores and physically observing the concrete. The cost and potential outcome of the evaluation should always be considered when planning an evaluation. In this case, the evaluation provided sufficient data to direct the client to conduct repairs rather than already planned removal and replacement. Repairs focused on removal and replacement of the concrete over the reinforcing steel and installing a carbon fiber wrap on the columns to help encapsulate the concrete for greater resistance to the vibrations induced from the new crusher. Keeping the end in mind, the evaluation saved the client time and money in the installation of the new crusher equipment. 

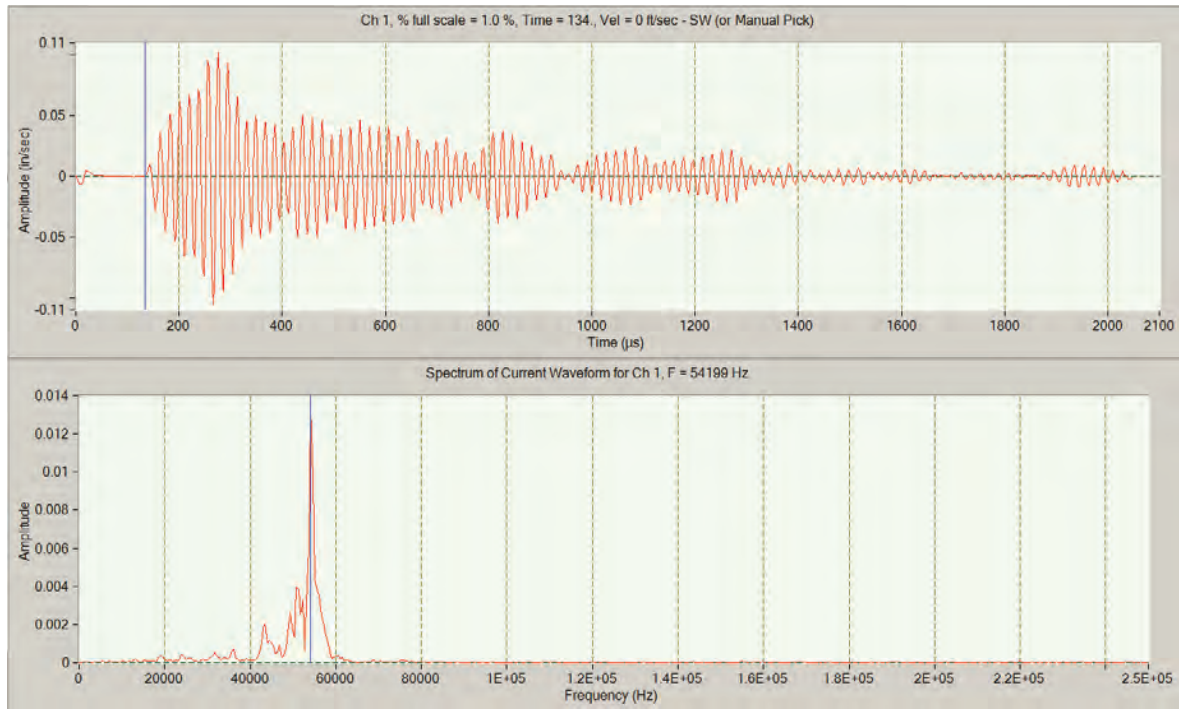


Fig. 3: Good signal through concrete



Fig. 4: Poor signal through concrete

**Table 1: Pulse Velocity Results in Foundation (m/s)**

0	2 ft	4 ft	6 ft	8 ft	10 ft	12 ft	14 ft	16 ft	18 ft	20 ft
1 ft	2655	2843	2172	1718	2201	2380	3693	3610	3693	4016
2 ft	3679	1913	3839	2109	3377	2848	3511	3723	2888	3679
3 ft	2805	2805	1933	5444	2958	3539	5444	3036	2135	3580
4 ft	2512	2544	2713	3719	2762	2216	1961	3696	2654	3361



Fig. 5: Coring operation at side of column



Fig. 6: Core hole showing delaminations in the concrete

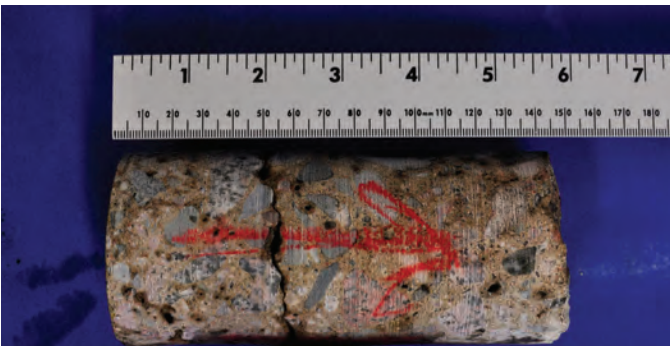


Fig. 7: Extracted core from rectangular foundation showing concrete delamination

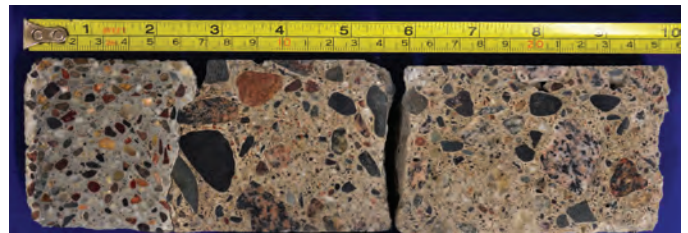


Fig. 8: Extracted core from column which was previously repaired showing delamination in original concrete

## REFERENCES

1. ASTM C597, *Standard Test Method for Pulse Velocity Through Concrete*, ASTM International, West Conshohocken, PA, 2016.
2. Malhotra, V. M., and Carino, N. J., *Handbook on Nondestructive Testing of Concrete*, CRC Press, 2004.



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# Responding to Crisis— A Rational Approach for Structural Engineers

by Charles Hammond and Anirudh Goel



Fig. 1: Emergency shoring

It is Friday afternoon and as you are about to head home for a relaxing weekend, the phone rings. It is the owner of a facility who is panicked because a piece of concrete has spalled from their structure and struck a vehicle, or potentially worse, a user of the facility. Scenarios like this involving compromised structures are far too common and, until recently, were of no great concern to an owner, contractor, attorney, or individuals who maintain responsibility for the facility and the safety of its users/occupants.

Structural engineers are needed by the industry to evaluate the built environment when things go wrong. Their competency, as demonstrated by examination, education, and experience, qualifies them to provide opinions regarding the condition of structures of all types. These individuals are often needed to be on site the very same day as the communication is received. Essentially, they are the First Responders for the Built Environment.

Responding to these types of situations requires knowledge and expertise rarely taught in a classroom environ-

ment during formal engineering education. It requires knowledge and expertise gained through years of conducting evaluations of existing structures and providing repair schema appropriate for the conditions at hand. While new design experience is often helpful for structural engineers, additional experience is needed for responding to structural issues competently at a moment's notice. The value that a forensic structural engineer brings to the table is often the ability to address the issue effectively and promptly, allowing the owner of the facility to return to business, a contractor to get back to work, and the users to be safe.

## COMMON EMERGENCY SCENARIOS

Common emergency scenarios for concrete structures include spalling, cracking, and partial/full collapses. These are often symptoms of unfortunate events, which can occur rapidly (vehicular impact, fire, etc.) or develop slowly over longer periods of time (corrosion of the embedded reinforcement, deleterious reactions in the concrete materials, etc.). The true expertise needed for re-



sponding to these situations comes not from the ability to repair the crack or spall, but to identify the root cause of the distress that often may not be obvious. Like a detective, the First Responder for the Built Environment needs to look for clues to determine the underlying cause(s).

## **STRUCTURAL ENGINEERING EMERGENCY RESPONSE (SEER)**

When a structural emergency occurs, usually there is chaos at the owner's end. Forensic structural engineers must be prepared for such scenarios and bring a method to the madness, knowing what to do when that phone call is received from a facility owner, such as what to be prepared for, how to plan, and what to do once onsite.

### **Initial Communication**

First, as much information as possible needs to be gathered from the owner/operator during the initial communications. One should expect that the client is likely to be overwhelmed with the situation at hand and that future communications may be difficult. Use this opportunity to get as much information as is available. No matter how insignificant the information seems now, it may prove to be useful in the future. A good reminder at this point is to not prejudge the causation for failure based on the information gathered or speculation of interested parties. It is easy and tempting to make assumptions and reach conclusions. However, it is critical that all relevant information gathered from the investigation be given appropriate consideration before reaching conclusions.

### **Temporary Shoring**

Limiting access to or temporarily stabilizing a structure by shoring/bracing (Fig. 1) is required if the structural integrity is in question. The stabilization is almost always a temporary fix that will mitigate further damage while simultaneously allowing for the investigation to continue. It is important that the temporary nature of the stabilization be clearly communicated to the client.

Shoring can be made from a variety of materials, but wood, steel, and aluminum are the most common. Shoring relieves stress from a structural member by providing an alternative load path in the structure. For example, rather than a girder load being supported by a compromised corbel, it can be taken directly to the ground with shoring. Like any structural member, the shoring needs to be designed by a qualified engineer to accommodate the anticipated loading specific to the area to be shored. Special care needs to be taken to gain an understanding of the alternative load path from the point of application down into the ground. Supporting a load off an elevated level or questionable subgrade may not be sufficient. It is easy to shut down a site, but it is usually in the best interest of the client to maintain some level of normal operations while the investigation and repairs take place. Forensic structural engineers must recognize that maintaining business operations is often critical for the client and that this will

often be an additional goal of the temporary stabilization. However, this goal should not compromise protecting the health, safety, and welfare of the users of the facility.

### **Document Review**

With the structure stabilized, the investigation into the origins of the problem can now begin. Reviewing all available documentation is often the first step. The document review includes the review of original construction documents (design drawings, shop drawings, specifications, communications, etc.), any documentation that has been produced since the facility was originally constructed (condition assessment reports, repair documents, photographs, etc.), and relevant industry codes/standards. Document review is a very valuable step that is too often overlooked. Understanding the original design intent can go a long way in ensuring that any repairs are harmonious with the original construction. However, if no drawings are available, this is not an insurmountable barrier but rather an additional obstacle to overcome. Utilizing non-destructive evaluation (NDE) techniques, and perhaps selective demolition, a good idea of how the structure was originally built can be attained. Discovery of latent conditions often requires more invasive testing.

### **Field Investigation**

The next step in the investigation is the field work. An important onsite priority is understanding the hazards that may be present when planning field work. Damaged utilities, chemicals stored on site, questionable structural integrity, and any other hazards should be considered. The field investigation frequently includes taking extensive photographic documentation of the structure, meticulous measurements, interviews of people familiar with the facility, and field testing. Detailed notes should be taken that document the locations of distress, photograph numbers, testing locations, quantities, and the locations of any samples that were collected. Seemingly innocuous information, such as the name of the engineer collecting the data, the date, and the weather conditions should also be collected as these may prove to be valuable pieces of information later in the investigation. While still on-site, the information collected should be reviewed to ensure completeness. When in the field, avoid the temptation to provide opinions too early in the investigation based on an incomplete assessment of the situation at hand.

### **Final Assessment**

With the investigation complete, it is now time to organize, review, and analyze the information collected. Search for patterns in the distress that could help point to the true underlying cause rather than the symptoms. For example, perhaps most of the distress is on the side of the building facing an ocean. Patterns in the distribution of distress are often great indicators as to the actual underlying cause. The final step of the investigation is reporting. Reports are generally created to document the investigation and its findings. The report should be well organized and tar-

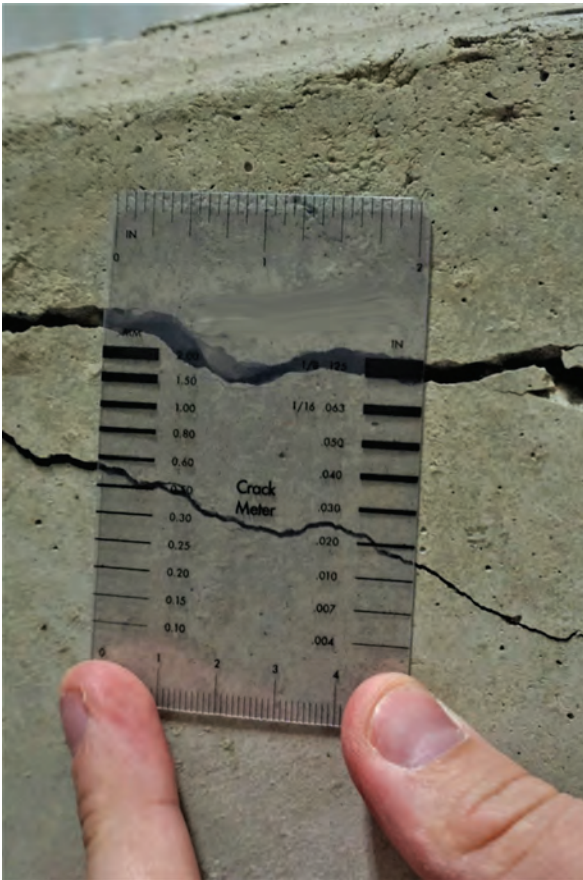


Fig. 2: Crack comparator used to identify crack width



Fig. 3: Concrete coring

geted to the intended reader. Identifying a crack pattern as being typical of a pretensioned member afflicted by alkali-silica-reaction may be sufficient if the intended reader is a fellow forensic structural engineer; however, additional background is often needed to convey the information to readers who are not informed about the nuances of structural engineering.

### FIRST RESPONDER'S "TOOLBOX"

Like an EMT in an ambulance, forensic structural engineers providing emergency response services need to have an array of items in their "toolbox" for assessing the condition of existing structures. Some of the more commonly used tools include:

- Personal protective equipment;
- Camera for taking photographs;
- Business cards for establishing methods of communication;
- Measuring devices for taking field measurements (tape measures, laser distance measurers, calipers, crack comparators (Fig. 2), angle gauges, etc.);
- Clipboard for taking field notes;
- Knowledge of shoring for developing shoring plans;
- Knowledge of relevant industry standards and codes; and
- Knowledge of NDE techniques.

There are a variety of NDE methods for concrete including visual, stress-wave, nuclear, magnetic/electrical, infrared thermography, and radar. ACI 228.2R<sup>1</sup> reports on the subject and is a good reference for more detailed information on these methods. Commonly used methods for assessing existing concrete structures include:

- Visual (ACI 201.1<sup>2</sup>) – the most used method of NDE. It is generally fast to perform, does not require expensive equipment, and can identify a wide range of distress types;
- Ground penetrating radar (GPR)—typically used in concrete structures to identify the characteristics of embedded objects, such as reinforcing steel, but can also be used for thickness measurements;
- Concrete coring (ASTM C42<sup>3</sup>) (Fig. 3) – used to remove samples for testing such as for strength (ACI 562<sup>4</sup>) and petrography (ASTM C856<sup>5</sup>);
- Acoustical impact testing – typically hammer sounding or chain dragging (ASTM D4580<sup>6</sup>) used to find concrete delaminations; and
- Chloride testing (ASTM C1152<sup>7</sup>, ASTM C1218<sup>8</sup>, AASHTO T260<sup>9</sup>) – used for measuring penetration of chlorides into concrete which increases the probability of corrosion.

Less common but still prevalent methods include:

- Infrared thermography (ASTM D4788<sup>10</sup>);
- Ultrasonic pulse velocity (ASTM C597<sup>11</sup>);
- Rebound hammer (ASTM C805<sup>12</sup>);
- Impact-echo (ASTM C1383<sup>13</sup>); and
- Half-cell potential (ASTM C876<sup>14</sup>).

Each scenario requires different tools, and the Emergency Responder for the Built Environment needs to have sufficient knowledge to select the most appropriate tools for the job. For example, fire damage often necessitates coring to ascertain the depth of concrete that is adversely affected by the elevated temperatures.

## RISK AWARENESS AND MANAGEMENT

When dealing with SEER situations, the environment might not seem conducive to discuss contracts, but a dispassionate approach with trust in the process of handling a SEER scenario helps protect us and our firms from unwarranted risks and future liabilities.

### Written Contract

It is best to have a written contract and/or authorization from the client in place before going onsite. It is also important that the scope of services and expertise be clearly defined and that the forensic structural engineer remain within those parameters while investigating or performing the assessment. For example, commenting on utility lines onsite while contracted strictly to look at the structural issues may be problematic in the long run. However, it is prudent to have a network of forensic experts in other areas to refer to and assist the client, if needed.

### Safety

Planning for eventualities onsite and safeguarding against them is the foundation for SEER services. A forensic structural engineer should be mindful of the equipment and logistical requirements that may be required onsite. For example, typical personal protective equipment used by a structural engineer may not be enough depending on the situation expected onsite. Some sites can require respirators or hazmat suits if a chemical or nuclear hazard is expected. This may even warrant the engagement of an expert to assess the environmental quality onsite beforehand. For instance, the risk of exposure to asbestos, lead, mixed chemicals, and the like should be considered prior to performing the investigation. It would be wise to advise the client to engage other experts to address items not included in the scope such as the assessment of environmental hazards and site security.

Finally, when conducting investigative actions, be it taking photos, up-close observation of the structure or NDE, it is critical to be mindful to not lead ourselves or others into harm's way. It is often possible to maintain business operations, depending on the level of distress/failure, but safety should not be compromised to do so.

### Good Samaritan Laws

Emergency scenarios in unexpected circumstances may present an unfortunate situation. It is very important to know that because forensic structural engineers are usually not volunteering their services, they will likely NOT be covered under "Good Samaritan Laws." Each state law is different, and one needs to understand the applicable laws in the location where the site visit is required.

## CASE STUDY

Some of the concepts discussed above were practiced while providing a client with solutions to problems that occurred on an ongoing construction project. The structure was an eleven-story precast structure (Fig. 4) with precast

columns, walls, and girders supporting double-tees with a cast-in-place topping slab. The precast contractor required emergency response services when the owner expressed concerns about cracking observed in the corbels (Fig. 5) and at ends of girders supporting the garage ramps. The first step included asking the client to provide pictures of the observed conditions and asking for any design drawings that might be available for review.

With the required safety protocols in place, a visual inspection was performed. The cracks identified by the client were observed and it was determined that there was a potential life safety concern with the structural integrity of the compromised corbels and girders (Fig. 6). A recommendation was made to immediately install shoring. Shoring plans were quickly developed, and a shoring contractor



Fig. 4: 11-story precast structure



Fig. 5: Corbel cracking

was engaged to install the recommended shoring. Once the shoring was in place (Fig. 7), the cracked and spalled concrete was removed from the corbels and nondestructive ultrasonic-pulse velocity (UPV) tests were conducted on the girder ends to estimate the extent of cracking and/or spalling of the concrete section. Testing on the girder ends was carried out along a 2 in (50 mm) by 2 in (50 mm) grid (Fig. 6) covering the extent of the visible crack, to map the crack geometry within the concrete section.



Fig. 6: Girder cracking/faulting near support



Fig. 7: Shoring of L-shaped girder

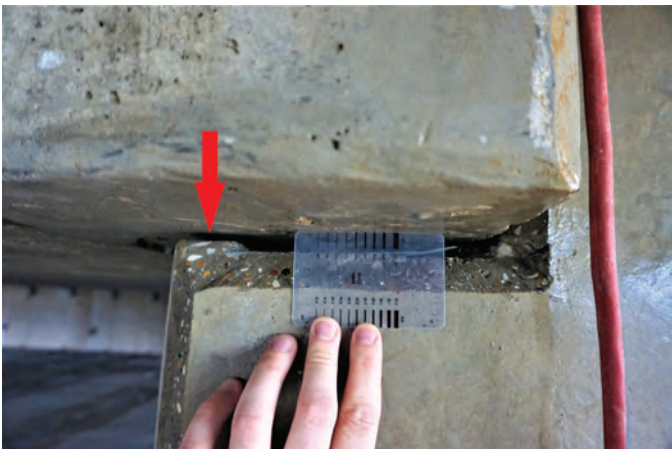


Fig. 8: Concrete projecting above bearing plate surface

It was easy to assume that either the structural design was flawed, or that the contractor had made a mistake while fabricating/erecting the structural elements, which are fair possibilities. However, by not prejudging the causation and continuing the investigation, it was found that the embedded steel bearing plates were recessed into the corbels and/or the surrounding concrete was raised above the embedded bearing plates and the installed elastomeric bearing pads at many locations (Fig. 8) were not thick enough to overcome this. This resulted in the inverted-tee and L-girders bearing directly on the corbel concrete rather than the bearing plate, effectively altering the intended load path. The concrete-on-concrete bearing caused high localized stresses which resulted in the observed cracking and spalling.


The spalling in the corbels was addressed using a form-and-pour technique that included typical recommendations from ICRI guidelines such as cutting the repair perimeter, removing concrete behind the reinforcing, etc. The spalled girders supporting the garage ramps were inclined and resting on corbels and thus needed to be lifted using hydraulic jacks to perform similar repairs. To address the underlying issue of the raised concrete surrounding the embed plates, the projecting concrete was ground down to the level of the bearing plates where feasible and steel shims and/or thicker elastomeric bearing pads were installed where grinding was not feasible. These solutions were effective in restoring the intended load path.

In summary, construction on the structure was halted due to the observed cracking. A timely forensic structural engineering assessment resulted in the shoring of the affected portions of the structure thereby allowing construction to continue and mitigating further financial damages to the client.

## CONCLUSION

As First Responders for the Built Environment, forensic structural engineers must possess specialized knowledge of failure mechanisms, temporary stabilization design, and experience in conducting field investigations and performing nondestructive evaluations. Additionally, they need to be proficient writers who can document and present clear and concise findings. Unfortunately, this expertise is rarely taught in the classroom during formal engineering education. The responder should maintain a “toolbox” that contains not only tools of the trade, but also specialized knowledge such as the ability to recognize when temporary stabilization is needed so that others are not led into harm’s way.

SEER is a mature field with vast resources available on every aspect of the subject. Institutions like ICRI, ACI, NCSEA, ASCE, BOMA, FEMA, and a variety of SEER committees provide helpful guidelines so practitioners can better understand the problems most often encountered with concrete structures and to make forays into the field of

SEER services. The competency of professionals skilled in the built environment helps provide clients with effective solutions in an aggressive time frame, getting them back in business, and not letting a roadblock to their success turn into a dead end. 

## REFERENCES

1. ACI Committee 228, *Report on Nondestructive Test Methods for Evaluation of Concrete in Structures* (ACI 228.2R-13), American Concrete Institute, Farmington Hills, MI, 2013.
2. ACI Committee 201, *Guide for Conducting a Visual Inspection of Concrete in Service* (ACI 201.1-08), American Concrete Institute, Farmington Hills, MI, 2008.
3. ASTM C42/C42M, *Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete*, ASTM International, West Conshohocken, PA, 2020.
4. ACI Committee 562, *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures and Commentary* (ACI 562-19), American Concrete Institute, Farmington Hills, MI, 2019.
5. ASTM C856/C856M, *Standard Practice for Petrographic Examination of Hardened Concrete*, ASTM International, West Conshohocken, PA, 2020.
6. ASTM D4580/D4580M, *Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding*, ASTM International, West Conshohocken, PA, 2018.
7. ASTM C1152/C1152M, *Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete*, ASTM International, West Conshohocken, PA, 2020.
8. ASTM C1218/C1218M, *Standard Test Method for Water-Soluble Chloride in Mortar and Concrete*, ASTM International, West Conshohocken, PA, 2020.
9. AASHTO T260, *Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials*, American Association of State Highway and Transportation Officials, Washington, D.C., 1997 (R2016).
10. ASTM D4788, *Standard Test Method for Detecting Delaminations in Bridge Decks Using Infrared Thermography*, ASTM International, West Conshohocken, PA, 2013.
11. ASTM C597, *Standard Test Method for Pulse Velocity Through Concrete*, ASTM International, West Conshohocken, PA, 2016.
12. ASTM C805, *Standard Test Method for Rebound Number of Hardened Concrete*, ASTM International, West Conshohocken, PA, 2018.
13. ASTM C1383, *Standard Test Method for Measuring the P-Wave Speed and the Thickness of Concrete Plates Using the Impact-Echo Method*, ASTM International, West Conshohocken, PA, 2015.
14. ASTM C876, *Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete*, ASTM International, West Conshohocken, PA, 2015.



### **Charles Hammond, PE, SE, CWI, RRO, LEED AP**

is a Senior Restoration Consultant in Walker Consultants' Austin office. Charles received his BS and MS in Civil Engineering from Texas Tech University and the University of Texas at Austin, respectively. His diverse international and domestic background has included restoration projects, new design projects,

forensic investigations, and litigation work. Charles has over 14 years of design and forensic experience that has included various structure types constructed from a wide range of materials. Charles is a licensed professional and/or registered structural engineer in 13 states and maintains membership in ICRI, ACI, AWS, and SEAoT, among other organizations.



### **Anirudh (Ani) Goel, EIT**

is a Restoration Engineer II in Walker Consultants' Houston office. Ani received his BE and ME in Civil Engineering from Manipal University, India, and Texas A&M University at College Station, respectively. Ani performs evaluations, non-destructive testing, feasibility studies, designs repairs, and prepares construction documents for a

variety of structural, architectural, and material distress related projects. His experience includes computer modeling, analysis and design of steel, concrete, masonry, and timber structures and retrofits. Ani has over 4 years of experience in the field of structural engineering with forays in the oil and gas industry, and traditional structural engineering consultancies.

## WE ARE HIRING



ICRI Technical Director Ken Lozen, FICRI, has announced his intention to retire in early 2022.

Managing ICRI's technical activities is a crucial role in the organization. Therefore, we are launching a campaign now to fill this important position and allow ample time for our future Technical Manager to gain from Ken's wisdom and insights.

Contact ICRI Executive Director Eric Hauth at [erich@icri.org](mailto:erich@icri.org)

## Technical Manager

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## CONCRETE REPAIR CALENDAR

**JULY 8-9, 2021**

**ICRI Concrete Slab Moisture Testing (CSMT) Program**

**NWFA Wood Flooring Expo**

Orlando, FL

Website: [www.icri.org](http://www.icri.org)

**OCTOBER 11-13, 2021**

**2021 ICRI Fall Convention**

Minneapolis, MN

Website: [www.icri.org](http://www.icri.org)

**OCTOBER 17-21, 2021**

**ACI Concrete Convention - Fall 2021**

Atlanta, GA

Website: [www.aciconvention.org](http://www.aciconvention.org)

**JANUARY 17-20, 2022**

**World of Concrete 2022**

Las Vegas, NV

Website: [www.worldofconcrete.com](http://www.worldofconcrete.com)

**APRIL 4-6, 2022**

**2022 ICRI Spring Convention**

Vancouver, BC, Canada

Website: [www.icri.org](http://www.icri.org)

### INTERESTED IN SEEING YOUR CONCRETE INDUSTRY EVENT LISTED HERE?

Events can be emailed to [editor@icri.org](mailto:editor@icri.org). Content for the September/October 2021 issue is due by August 1, 2021 and content for the November/December 2021 issue is due by October 1, 2021.

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](http://www.icri.org).

## INDUSTRY NEWS

### UK & U.S. COLLABORATE TO IMPROVE THE BUILT ENVIRONMENT

A memorandum of understanding (MoU) has been announced between representatives for the United Kingdom and the United States of America, cementing a pledge to work together on the development of the U.S. National Building Information Management (BIM) Program.

Marking the next step in a two-year collaboration, the MoU will see the National Institute of Building Sciences work with experts from the UK's Centre for Digital Built Britain (CDBB) on the development of a National BIM Program for the U.S., supporting international alignment on technical standards for the built environment. The US-UK collaboration has been enabled through the support of the UK's Construction Innovation Hub.

NIBS will work with CDBB to adapt the UK program model and materials as a guide to developing a U.S. national roadmap aligned with the international standard for BIM-ISO19650. The MoU also will support and encourage the public and private sector in both countries to learn from each other and exchange of best practice creating benefits to both economies and growing trade opportunities by increasing the sector's productivity and performance. The U.S. National BIM Program will foster a productive and more collaborative international digital construction sector for the public good, facilitating innovation to drive increased value and be an engine for long-term sustainable growth.

The new agreement was announced during a Digital Construction Week Connect series webinar.

### INTERESTED IN SEEING YOUR NEWS IN THIS COLUMN?

Email your 150-200 word industry news to [editor@icri.org](mailto:editor@icri.org). Content for the September/October 2021 issue is due by August 1, 2021 and content for the November/December 2021 issue is due by October 1, 2021. ICRI reserves the right to edit all submissions.



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## New and Recently Updated! ICRI Technical Guidelines

**NEW!** Guideline 510.2-2019  
*Use of Penetrating Surface Applied Corrosion Inhibitors for Corrosion Mitigation of Reinforced Concrete Structures*

**UPDATED!** Guideline 320.1R-2019  
*Selecting Application Methods for the Repair of Concrete Surfaces*

These and all ICRI guidelines are available from the ICRI online store. AND... most ICRI guidelines are free to ICRI members as PDF downloads!

[www.icri.org](http://www.icri.org)

# ICRI CHAPTER NEWS

## CHAPTER CALENDAR

As the global pandemic begins to ebb, chapters are starting to host events. Be sure to check with individual chapters by visiting their chapter pages for any chapter events planned after publication of this *CRB* issue.

### CHICAGO

September 2, 2021  
LEE SIZEMORE MEMORIAL GOLF OUTING  
And Scholarship Fundraiser  
White Pines Golf Club  
Bensenville, IL

### CINCINNATI

July 21, 2021  
CHAPTER SUMMER SOCIAL OUTING  
Location TBD

September 22, 2021  
23rd ANNUAL GOLF OUTING  
Mill Creek Course at Winton Woods  
Forest Park, OH

### FLORIDA WEST COAST

August 4, 2021  
CHAPTER TECHNICAL MEETING  
Red Mesa Cantina  
St. Petersburg, FL

### GEORGIA

August 26, 2021  
CHAPTER LUNCH 'N' LEARN  
Maggiano's Perimeter  
Atlanta, GA

September 30, 2021  
CHAPTER LUNCH 'N' LEARN  
Maggiano's Perimeter  
Atlanta, GA

### INDIANA

September 2, 2021  
ANNUAL GOLF EVENT  
Plum Creek Golf Course  
Carmel, IN

### MINNESOTA

July 20, 2021  
GOLF SCHOLARSHIP FUNDRAISER  
Bunker Hills Golf Club  
Coon Rapids, MN

### NORTH TEXAS

October 1, 2021  
Save the date!  
JESSE POINTS MEMORIAL GOLF CLASSIC  
20th Annual NTX ICRI Golf Tourney

### PITTSBURGH

July 16, 2021  
CHAPTER GOLF OUTING  
Birdsfoot Golf Club  
Freeport, PA

### ROCKY MOUNTAIN

July 2021  
VIRTUAL LUNCH AND LEARN  
Speaker: Ed Nagel



# ICRI CHAPTER NEWS

## CHAPTER ACTIVITIES

### FLORIDA WEST COAST HOSTS FIRST EVENT AT NEW CIGAR BAR

The Florida West Coast Chapter helped inaugurate a new local establishment by having their first in-person event since the pandemic on June 2, 2021. This Social Networking Event was the chapter's 3rd Annual Cigar Tasting but the first time they combined it with a Whiskey Tasting. They met from 6-9 pm at Cigars International in Tampa, Florida. They had 30 sign up in advance and more than 40 members and non-members show up at the event! The chapter invited a local distiller, Horse Soldier to give a presentation. They proved to be a draw as they are a local company that started in Tampa and are rapidly growing. Everyone enjoyed the opportunity to be out, network, and socialize.



Florida West Coast Chapter members gathered for their first in-person event of 2021 at a local establishment called Cigars International where everyone tasted whiskey, enjoyed cigars, networked, and socialized

[WWW.ICRI.ORG](http://WWW.ICRI.ORG)



### GEORGIA CHAPTER VIRTUAL LUNCHEONS

The Georgia Chapter of ICRI had several successful virtual luncheons to start the year. In January attendees learned about the structural advantages of, code provisions for, and practical applications of, headed bars for repair and strengthening with Robbie Hall of the Headed Reinforcement Corporation. The February presentation by Joshua Lloyd, PE, of SGS TEC Services, covered the problems, evaluation, and solutions of building repurposing. In March Brian MacNeil, Kryton International, Inc., presented on waterproof and abrasion-resistant concrete. The last lunch and learn before the chapter's summer hiatus was a successful transition from the virtual luncheons back to in-person events. This April luncheon covered effective waterproofing methods and was presented by Kyle Henscheid with W.R. Meadows of Georgia. The winter into spring luncheons were a success and the Georgia Chapter looks forward to resuming these luncheons in the fall.

### QUEBEC PROVINCE CHAPTER HOSTS SPRING WEBINAR SERIES

The Quebec Chapter's Regional Committee organized a 2-part webinar series—May 19 and June 16, 2021—each part featuring 2 presentations.

On May 19 the Quebec Chapter hosted Part 1 of this webinar series. The first speaker was Martin Pharand from Polytechnique Montréal who was one of the winners of the local chapter scholarship program. Martin presented on his doctoral research results. The main objective of the doctoral project was to offer tools for simple and fast calculations with regards to the hardening behavior in traction of UHPC in accordance with the philosophy of Canadian standards for structural repairs, slab reinforcements, or for prefab applications.

The second speaker in Part 1 was Richard Cantin with Simco Technologies. Richard's presentation addressed misconceptions with practices and techniques which have evolved considerably over the last few decades. It is now possible to carry out more durable repairs than in the past and even make structural repairs more durable than in the original structure. The concepts of conformity and acceptability of materials and structures were also discussed in order to distinguish between the two, particularly in the case of new construction.

On June 16 the Quebec Chapter hosted Part 2 of this webinar series. The first speaker was Samuel Bernier-Lavigne with Université Laval. He presented on the case study of the get-away called "Passerelle Éternelle" using an Ultra-High Performance Fiber Concrete structure (UHPC) on the St-Charles river in Quebec. Following that was Ahemd El Refai, also with Université Laval who presented research results when using Fiber-Reinforced Cementitious Matrix (FRCM).



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# ICRI CHAPTER NEWS

## CHAPTER ACTIVITIES

### NORTH TEXAS HOSTS 7TH ANNUAL SPORTING CLAY CLASSIC

On the spectacular morning of Friday, May 14, 2021, the North Texas Chapter hosted their 7th Annual Sporting Clay Classic at Dallas Gun Club in Lewisville, Texas. The tournament featured some tight competition, which was due in part to the participation of 79 shooters from 21 teams, the most ever in the history of the event.

After a safety briefing by Dallas Gun Club, the shooters made off like bandits in their golf carts and proceeded to blow away the clay pigeons and rabbits throughout the 13 stations on the course. After all points were tallied, Jeff Lungrin held onto his first-place title for a second year with a tally of 90 targets hit. The Master Builders team of Mr. Lungrin, Patrick Jorski, Glen Turner, and Ray Dickerson finished in first place in the team category with an combined score of 334 targets hit.

Following the shooting, the group met under the pavilion at Dallas Gun Club for boxed lunches and beverages. The event was our most successful clay shoot to date, and raised thousands for NTX Chapter Scholarships. The North Texas Chapter thanks all of the participants and sponsors for their support!

#### Individual Awards

- 1st Place—Jeff Lungrin
- 2nd Place—Trevor Pedigo
- 3rd Place—Glen Turner

#### Team Awards

- 1st Place—Master Builders Solutions: Jeff Lungrin, Patrick Jorski, Glen Turner, Ray Dickerson
- 2nd Place—Chamberlin Roofing & Waterproofing: Alden Wagner, Tim Hooper, Dustin Parkinson
- 3rd Place—Master Construction & Engineering: Don Weempe, Casey Wright, Jon Grimes, Jane Weempe



The 1st place Master Builders Team with Chapter President Eddie De Haro (far left) and Chapter Treasurer Pete Haveron (second from right).



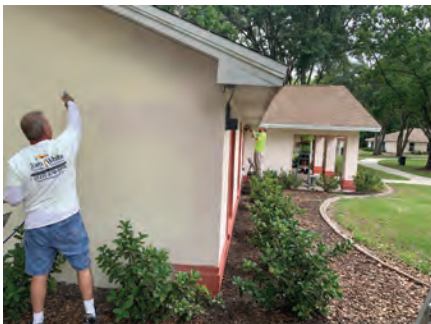
Ken Allen of Southwest Construction Services, ready for the pull.



Chapter President Eddie De Haro sells raffle tickets while the shooters enjoy lunch after the event.

### FLORIDA WEST COAST HOSTS VOLUNTEER DAY

The Florida West Coast Chapter of ICRI organized a volunteer day for general membership to paint several houses for the Joshua House Foundation, Inc. The Friends of Joshua House provides a safe haven for abused, abandoned, and neglected children, while offering therapeutic residential group care program providing a protected, nurturing, family-like environment. The efforts and donations from the chapter and especially C&N Renovations, Tom White Painting, RL James, Florida Paints, Biscayne, SIKA, Sentry Management, CPR-Concrete Painting and Restoration, Coloristic, Coastal Construction Products, Wooster, MAPEI and Michelle Nobel gave many kids in need the opportunity to move into the Joshua House several weeks early. The Chapter sincerely thanks all of those who participated and donated. This incredible event took weeks of preparation by our Community Outreach Committee headed by Karrie McMillan and Tom White along with several days of labor, which will impact the youth in the community in the most positive ways.



Tom White (foreground) uses paint sprayer on the house with Thomas Garguilo of SIKA (background) cutting in



Some of the Chapter volunteers taking a short break with just two of the painted houses in the background.



Volunteers are enjoying some of the good generously donated by CPR for those working in the hot sun!

# ICRI CHAPTER NEWS

## CHAPTER ACTIVITIES

### CAROLINAS HOSTS TOPGOLF SOCIAL EVENT

Thanks to everyone who came out to the ICRI Carolinas Topgolf outing in Charlotte on April 15, 2021 and thanks to all the companies who helped sponsor the event. On an absolutely beautiful night, the chapter's members and guests enjoyed seeing familiar and new faces in person and spending time with each other. Add in a little friendly competition and a few cold ones and the event was a real success. And finally, congratulations to our two Top Golfers: David Cline of Stone Restoration of America and Chuck Weiss of Applied Building Sciences.



John Ammons of Green Mountain International (left) and Chuck Weiss of Applied Building Sciences (right)



John Ammons of Green Mountain International (right) and David Cline of Stone Restoration of America (left)



Carolinas Chapter Board Members John Ammons of Green Mountain International (left), John Lambert, Jr. of Stone Restoration of America (center) and Jeff Welty of High Rock Waterproofing, Inc. (right).



Nothing like a little friendly competition and being cooped up for more than a year to get people out to Topgolf for a social outing.

### BALTIMORE-WASHINGTON HOSTS SPRING GOLF OUTING

With 2021 providing continued challenges for meeting indoors, the local Baltimore-Washington Board brainstormed different ways to get the members together this year for an in-person gathering. It didn't take long to decide that hosting a spring golf tournament would be the perfect venue to achieve just that. This additional ICRI Baltimore-Washington Chapter Golf Outing was held on Thursday, May 6, 2021, at Westfields Golf Club in Clifton, Virginia. The course was in beautiful shape and was a nice change of pace geographically speaking from our annual fall golf outing held further north. It was great to see so many familiar faces, and that was backed up by our tee sheet that had 106 golfers signed up! A quick morning continental breakfast and snacks on the course hopefully held everyone over before boxed lunches were served post-round. The awards presentation and some words from our Chapter President wrapped up the day, in which many of us got our first sunburn of the year. Keep an eye out for info regarding the Fall Golf Tournament, which will still be hosted later this year.

The Chapter appreciates all the golfers who joined in for this special day and are thankful for the continued support of the generous sponsors. Please be sure to say thank you when you see these sponsors: Murat Seyidoglu, PE, SE; Kaveh Afshinnia, PhD; Vector Corrosion Technologies; Freyssinet; TB Philly; Tremco Sealants; Garvin Construction Products; PPSI; Henry; Neogard; SK&A/ETI; Concrete Protection & Restoration, Inc.; ECS; Aquafin; Metro Sealants; Consolidated Waterproofing Contractors; CA Lindman; and Emseal.



Chapter President Brian Radigan (left) is here with Rony Paredes from SK&A. Brian is presenting Rony with his 3rd Place award from the Chapter's Outstanding Project Award program.



Ed Kluckowski from Freyssinet, Inc. (left) is receiving his 1st Place award from the Baltimore-Washington Project Awards from Chapter President Brian Radigan.

INTERNATIONAL CONCRETE REPAIR INSTITUTE

# ICRI CHAPTER NEWS

## CHAPTER ACTIVITIES

### GEORGIA HOSTS ANNUAL SPRING GOLF TOURNAMENT

On Monday, May 10, the Georgia Chapter of ICRI held its annual Spring golf tournament. With states beginning to ease COVID protocols and people eager to take advantage and get out of the house, the tournament went off spectacularly. The golfers ascended in number to take advantage of the nice weather and the goodies provided by various hole sponsors. Tables set up by sponsors at the holes provided everything from drinks and brisket to taking a picture with Bigfoot. The day of golf was followed by a BBQ lunch at the clubhouse, presenting the trophies, and a raffle for the Chapter's scholarship fund. The tournament set the chapter record for golfers attended with a total of 108 "athletes," and generated enormous support for our scholarship fund. The Georgia chapter appreciates everyone who attended and helped to make this tournament a success. Special thanks to all of our sponsors that helped provide so much support.



Thank you to our sponsors



Take a photo with Bigfoot



Teeing off!



The Board of the Georgia Chapter



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### INTERESTED IN SEEING YOUR CHAPTER NEWS & EVENTS LISTED HERE?

#### Chapter News & Event Deadlines

SEPTEMBER/OCTOBER 2021  
Deadline: July 10, 2021

NOVEMBER/DECEMBER 2021  
Deadline: September 10, 2021

Send your Chapter News by the deadlines to  
Director of Chapter Relations Dale Regnier at [daler@icri.org](mailto:daler@icri.org).



ICRI has 39 chapters, including two student chapters, in metropolitan areas around the world. Chapters hold technical presentations, educational meetings, symposia, and local conventions on repair-related topics.

Chapters also provide an outstanding opportunity to meet and build relationships with repair specialists in your area. In addition to the technical meetings, chapters also host golf outings, social evenings, dinner cruises, and other networking events.

# ICRI CHAPTER NEWS

## CHAPTERS COMMITTEE CHAIR'S LETTER



MICHELLE NOBEL  
Chapters Chair

We're halfway through the year, which means the holidays are right around the corner! During these extraordinary times we're living in, and as things continue to get back to normal, remember all the people you love and care about. In the enlightened, sagacious words of **Maya Angelou**, *"Try to be a rainbow in someone's cloud."* A positive influence can brighten someone's day and it's not hard to do if you focus on the positives instead of the negatives.

I hope everyone is as excited as I am to see everyone in person at the 2021 ICRI Fall Convention, October 11-13, in Minneapolis, Minnesota. Since last year was a mulligan to many of us, this can be a year to reunite with old friends, or the start of new friendships that you can only find at ICRI Conventions. Mark your calendar and plan on attending! The details and registration information will be coming out soon, so check your emails for updates.

The Women in ICRI Committee is always looking for women to join this great committee. While we're scattered across North America and around the world, we have one common thread—supporting each other in this great organization. Please join us in applauding the women that won the ICRI 40 under 40 Award, as we highlight members in the *Concrete Repair Bulletin*.

If you would like to join the Women in ICRI group, reach out to Tara Toren-Rudisill, TTorenrudisill@ThorntonTomasetti.com; Monica Rourke, MRourke@mapei.com; or me at mnobel@mapei.com.

Another benefit of your ICRI membership is the Certification and Education programs offered by ICRI. The information is on the Certification and Education tab on the ICRI.org website. Hosting a certification event at your local chapter can benefit your chapter. Explore the same tab to learn about the CSRT program, CSMT program, webinars, training, tips on the learning center, and all that ICRI has to offer.

In April the members and supporters of the ICRI Florida West Coast Chapter organized a volunteer event to paint several houses for the Friends of Joshua House Foundation,

Inc. The Friends of Joshua House provides a safe haven for abused, abandoned, and neglected children while offering a therapeutic residential group care program providing a protected, nurturing, family-like environment. It was a great event for the chapter and it was nice to work alongside all the contractors, manufacturers, and engineers.

Dates to mark on your calendar are:

- 2021 ICRI Fall Convention—October 11-13, 2021, in Minneapolis, Minnesota
- World of Concrete 2022—January 17-20, 2022, in Las Vegas, Nevada
- 2022 ICRI Spring Convention—April 4-6, 2022, in Vancouver, British Columbia

As we get back to traveling, don't forget to send in your ICRI chapter meetings and events to be posted on the ICRI website. Find out what's happening in an area you're traveling to. What's better than being with like-minded individuals and making new friends? It beats eating alone! Here's a link to the calendar on the ICRI website for more information:

[https://www.icri.org/events/event\\_list.asp](https://www.icri.org/events/event_list.asp)

You can reach out to ICRI staff, the Executive Committee, your Region Director, or the leaders of your local ICRI chapter for help. ICRI will be sending out more details of upcoming events as they develop.

In the encouraging words of **Socrates**, *"The secret of change is to focus all of your energy not on fighting the old, but on building the new."*

Let's focus on building new friendships that may one day last a lifetime!

Please be safe, be kind, and I will see you all this Fall!

Sincerely,

Michelle Nobel  
2021 ICRI Chapters Committee Chair  
MAPEI Corporation

*"As someone relatively new to the concrete restoration industry, one of the very first things I did after starting my new job was join my local ICRI chapter. It immediately gave me access to best-in-class training documents (especially the ICRI Guidelines). ICRI also offered informational videos and a peer network that accelerated my knowledge and confidence out of the gate. I highly recommend membership to anyone new thinking about entering the field."*

Jeff Konkle, MAK Construction Products Group

# ASSOCIATION NEWS

## CONCRETE INDUSTRY MANAGEMENT PROGRAM HOLDS SUCCESSFUL AUCTION AT 2021 WORLD OF CONCRETE

The National Steering Committee (NSC) for the Concrete Industry Management (CIM) program—a business intensive program that awards students with a four-year Bachelor of Science degree in Concrete Industry Management—is pleased to announce they raised more than \$1.150 million in gross revenue at its annual auction, held in conjunction with the World of Concrete on Wednesday, June 9.

The 2021 CIM Auction featured a 2021 Mack® Granite® donated by Mack Trucks and equipped with a McNeilus® FLEX Controls™ Bridgemaster® mixer. Other big-ticket items included a Line Dragon® donated by Somero Enterprises, Inc., a Load and Go Ready Mix Truck Wash® system donated by Shumaker Industries and a COMMAND-batch System donated by Command Alkon.

In addition to the above-mentioned big-ticket items, they received donations from industry leaders like CEMEX, LaFarge-Holcim, Lehigh Hanson, Inc., Argos Cement, St. Marys Cement, Inc., Roanoke Cement Company, GCC, Martin Marietta as well as admixture donations from CHRYSO, Inc., Master Builders Solutions, Sika USA, Euclid Chemical, GCP Applied Technologies and CarbonCure Technologies, Inc.,

“Once again, we had incredible support from the World of Concrete show management, Informa and Ritchie Bros. Auctioneers,” said CIM Marketing Committee Chairman Brian Gallagher. “We thank the many companies such as Mack Trucks, McNeilus, Somero Enterprises, Inc., Shumaker Industries, Command Alkon, Volvo Construction Equipment Con-Tech, Beck Industrial, Multiquip, Inc., Allen Engineering and the numerous companies that donated items to the Auction to make it a complete success.”

The Auction was conducted entirely using Ritchie Bros. Auctioneer’s Timed Auction System.

In addition to the live auction, a silent auction was also held with record proceeds. Auction items included cement, concrete saws, drills, mixers, vibrators, safety equipment, screeds, decorative concrete tools, water meters, pumps, generators, training sessions, refer-

ence books, iPads and laptop computers, sports travel packages and golf and vacation travel packages.

The CIM program has, and continues to provide, future leaders for the concrete industry. To learn more about the program, visit [www.concretedegree.com](http://www.concretedegree.com).

## WISCONSIN READY MIXED CONCRETE ASSOCIATION RECOGNIZES EXCELLENCE IN CONCRETE DESIGN

The Wisconsin Ready Mixed Concrete Association has recognized the winners for the 39th Annual Concrete Design Awards.

The awards are a part of a prestigious program showcasing best uses of ready-mixed concrete in Wisconsin and Michigan’s Upper Peninsula (UP). The Wisconsin Ready Mixed Concrete Association (WRMCA), Acuity, Carew Concrete & Supply, County Materials Corporation, Euclid Chemical, Mapei, Master Builders Solutions, Oshkosh Corporation, Premiere Concrete Admixtures, Riv/Crete Ready Mix, Sika Corporation & the Wisconsin Chapter of the American Concrete Institute cosponsored the annual award program, now in its 39th year. Award winners were determined by a distinguished panel of Wisconsin/UP educators and construction professionals.

The award program recognizes excellence in the ready-mixed concrete industry in the following categories: Agricultural, Commercial, Concrete Overlay, Decorative, ICF, Industrial, Municipal Facility, Parking Lot, and regional projects.

This year’s award-winning projects exemplify innovative design in concrete for a diverse range of projects in Wisconsin and Michigan’s Upper Peninsula.

For the 39th Annual Concrete Design Awards, projects showcased represented winners that included owners, architects, engineers, contractors, and ready mixed producers.

To view the individual project’s, visit <https://wrmca.com/2021-wrmca-concrete-design-awards>

## ACI FOUNDATION ANNOUNCES ELECTION OF TRUSTEES

The ACI Foundation is pleased to announce the election of a new trustee—Jeffrey Coleman, and the re-election of two existing

trustees—Michael J. Paul, and William E. Rushing. The ACI Foundation is honored to have these outstanding individuals continue the work of the ACI Foundation. They join Michael J. Schneider, current Chair of the Board of Trustees, and Ronald G. Burg, Joseph M. Bracci, Robert Frosch, Antonio Nanni, Charles K Nmai on the ACI Foundation Board of Trustees.



The ACI Foundation is a non-profit organization established by the American Concrete Institute (ACI) to promote progress, innovation, and collaboration by supporting research and scholarships, while also serving as an independent resource to provide thought leadership and strategic direction for the concrete industry.

Learn more at [ACIFoundation.org](http://ACIFoundation.org).

## ACI ADOPTS THREE NEW POSITION STATEMENTS

The American Concrete Institute has recently approved three new position statements on the topics of construction volume, public good, and workforce development. The Institute now has a total of twelve position statements on various topics supporting policy positions along with state, federal, and international programs, rules, and regulations.

The three new position statements include:

- **Construction Volume:** Creates a favorable environment, domestically and internationally, for increased construction; and more specifically encouraging or creating an environment for increased use of concrete in construction.
- **Public Good:** Establishes appropriate levels of design, construction, repair, and maintenance criteria that provide for life safety, health and welfare of the public, and property protection; and to encourage, where appropriate, engaging ACI and/or the ACI Foundation to facilitate programs and activities related the role of concrete technology in improving the built environment to achieve appropriate



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levels of life safety, health, and welfare of the public and property protection.

- *Professional and Workforce Development:* Support professional development including but not limited to education and credentialing, and engage ACI and/or the ACI Foundation to facilitate professional and workforce development programs and activities related to concrete and concrete technology.

The Institute's position statements are focused on advocacy efforts related to code development and adoption; and future statements may focus on other ACI programs, services, and activities. The process of creating ACI position statements was created by the ACI Board to better allow ACI to actively engage in advocating for ACI code adoption.

Learn more and view all position statements at [concrete.org/positions](http://concrete.org/positions).

### ACI FOUNDATION ESTABLISHES BURG-COLEMAN IOWA STATE '77 FELLOWSHIP

The ACI Foundation has established the Burg-Coleman Iowa State '77 Fellowship. This new fellowship is funded through a

generous \$75,000 donation from Ronald G. Burg, ACI Executive Vice President, and Jeffrey W. Coleman, ACI President, 2020-2021.

Burg and Coleman are both 1977 graduates of Iowa State University College of Engineering: Coleman with a degree in civil engineering in '76 and a master's in structural engineering in '77, and Burg with a degree in civil engineering degree in '77.



BURG COLEMAN

The fellowship will be administered by the ACI Foundation and awarded annually to students who are studying an advanced degree in civil engineering with a focus on concrete structures or materials. Preference will go to candidates who study at Iowa State, and subsequently to students who are full-time residents of Iowa at the time of application for the Fellowship. This new fellowship will be open for student applicants in mid-2021 for the ACI Foundation's 2022-2023 awards cycle.

To learn more about the ACI Foundation and its councils, visit [ACIFoundation.org](http://ACIFoundation.org).

### NEW ACI REINFORCED CONCRETE DESIGN HANDBOOK AVAILABLE

The American Concrete Institute has released the new ACI Reinforced Concrete Design Handbook as a three-volume handbook providing guidance to professionals engaged in the design of reinforced concrete structures. The ACI Reinforced Concrete Design Handbook is available in print, as a digital download, and as part of the new ACI 318 PLUS subscription.



The ACI Reinforced Concrete Design Handbook is published in three volumes: the first volume covers introductory chapters, structural analysis, durability, and member design. More specialized topics including retaining walls, serviceability, the strut-and-tie method, and anchoring to concrete in chapters 12 through 15 are published in the second volume. A third volume containing

design aids and a moment interaction diagram Excel spreadsheet are available as free downloads.

The ACI Reinforced Concrete Design Handbook was developed using the provisions in ACI CODE-318-19, Building Code Requirements for Structural Concrete, and serves as a helpful companion to ACI CODE-318-19. The handbook provides many design examples of various reinforced concrete members based on a fictitious seven-story building.

The ACI Reinforced Concrete Design Handbook is also fully integrated and included with ACI 318 PLUS. ACI 318 PLUS is an entirely new annual subscription that provides users with convenient digital interactive access to ACI CODE-318-19, Building Code Requirements for Structural Concrete and Commentary, along with in-document access to related resources, robust digital notetaking, and enhanced search.

To learn more and purchase visit [concrete.org](http://concrete.org).

## ACI HOSTS WORLDWIDE 24 HOURS OF CONCRETE KNOWLEDGE CONFERENCE

The American Concrete Institute (ACI) along with ACI international chapters and partners will host “24 Hours of Concrete Knowledge,” a free conference that will bring the worldwide concrete community together. The conference is for everyone interested in learning more about concrete, from everywhere in the world. The event starts on July 13, 2021 at 3:00 PM EDT and will complete a trip around the world with visits to 12 Chapters and 12 Partners to learn from their concrete experts for 24 continuous hours.

Visit [concrete.org/24hourconcrete](http://concrete.org/24hourconcrete) for more information.

## ACI FOUNDATION'S STRATEGIC DEVELOPMENT COUNCIL TO HOST VIRTUAL TECHNOLOGY FORUM

The ACI Foundation's Strategic Development Council (SDC) will host its next virtual Technology Forum on August 24-26, 2021. This 50th forum will include technology showcases that highlight new materials, industry research needs and examine collaborative research models that have the potential to advance the industry. Showcases include

- The World's First Concrete Bridges Made with Glass Powder

- Eliminating Pour Strips with the PS=Ø® Mechanical Rebar Splicing System
- Automated Quality Control of Poured & Placed Concrete

## THREE GENEROUS DONORS FUND NEW ACI FOUNDATION AWARDS

Master Builders Solutions, the ACI Georgia Chapter, and the ACI Ontario Chapter have generously funded three new awards through the ACI Foundation.

Master Builders Solutions Concrete Materials Scholarship will be awarded to graduate students pursuing an advanced degree related to the concrete industry with a focus on material science. Applications will be considered from candidates who are studying the use of admixtures (fibers, water reducers etc.) to advance the use of concrete.

Nicholas F. Maloof, Jr. ACI Georgia Chapter Fellowship will be awarded to graduate or undergraduate students studying an advanced degree related to the concrete industry with a focus on construction or building material sciences. Applications will be considered from candidates who are graduates of a Georgia school (high school or undergraduate). Further preference will be given to candidates who are a dependent of a Georgia resident.

ACI Ontario Chapter Graduate Scholarship will be awarded to any student who has completed a bachelor's degree from an accredited higher education institute. At the time of acceptance of this award (but not necessarily at the time of application) the applicant must have been accepted for graduate study. The graduate program must be in concrete research or concrete construction at an accredited university in Ontario, Canada. Application details are available at [acifoundation.org/scholarships](http://acifoundation.org/scholarships).

## INDUSTRY LEADERS SHARE GROWTH PROJECTIONS AT THE TEXAS AGGREGATES & CONCRETE ASSOCIATION'S ANNUAL MEETING

The Texas Aggregates & Concrete Association (TACA)—the leading state trade association for the aggregate, concrete, cement and associated industries—welcomed more than 450 attendees to its 67th Annual Meeting, June 16-18, at the JW Marriott San Antonio Hill Country Resort & Spa.

A highlight was the Texas and National Economic Report presented by Jon Hockenyos, president of TXP, Inc. He noted that Texas' dramatic growth—the state is currently 8.9 percent of the nation's population and accounts for 32.4 percent of net national population growth in 2020—has created a huge demand for housing, industrial and warehouse construction, but a slower demand for office, lodging, entertainment and medical facilities, which is largely due to societal changes during the COVID-19 pandemic.

Abbott Lawrence, chairman of the board of the National Ready Mixed Concrete Association (NRMCA), told TACA Annual Meeting participants that in 2019, Texas was No. 1 in spending on roads and highways of all the states (New York and California were next in line), which is not surprising given the level of population growth the state has experienced in the past few years. Of the top 20 aggregate demand regions in the U.S., he said four are in Texas—Dallas, Houston, Austin and San Antonio—three are in Florida and two are in California.

Michael Johnson, president & CEO of the National Stone, Sand & Gravel Association (NSSGA), warned that America's economic competitors are investing strategically in infrastructure as a means to try to take our status as the No. 1 economy in the world just as the quality of our infrastructure continues to decline. Johnson is optimistic about Congress passing legislation that will make significant investment in infrastructure this year and cautioned that when that investment does come, regulations He cited policies that put aggregates, sand and cement facilities further and further away from population areas as counterproductive to growth and infrastructure investment as of particular concern.

For more information on how TACA member companies enhance our daily lives, please visit <https://www.tx-taca.org/>.

## INTERESTED IN SEEING YOUR NEWS IN THIS COLUMN?

Email your 150-200 word association news to [editor@icri.org](mailto:editor@icri.org). Content for the September/October 2021 issue is due by August 1, 2021 and content for the November/December 2021 issue is due by October 1, 2021. ICRI reserves the right to edit all submissions.



# PEOPLE ON THE MOVE

## WALKER CONSULTANTS CONGRATULATES JARED WRIGHT



Walker Consultants congratulates Jared Wright, PE, PhD, Forensics, Restoration, and Building Envelope Consultant, in our Pittsburgh, PA office for recently obtaining the degree of PhD in Civil Engineering from The Pennsylvania State University. His dissertation focuses on increasing the durability of concrete infrastructure and reducing early-age concrete cracking and alkali-silica reaction (ASR).

Since joining Walker, Jared has gained niche knowledge of the design, construction, and in service problems associated with post tensioned high-rise structures – performing both destructive and nondestructive (NDE) testing evaluations. When repair is necessary, Jared ensures the owner understands the true cause of the problem, provides material and structural design advice for proper restoration, and works with the owner and contractor during the construction phase to confirm condition and repair are safe.

Jared's work focuses on forensic studies related to the durability and structural integrity of the built environment. Jared routinely performs condition assessments and appraisals of high-rise building facades, parking structures, plazas, and steel structures to investigate material related defects/deterioration, building leakage, and corrosion deterioration. He has particular interest and expertise in the fresh, hardened, mechanical, and durability properties of concrete.

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## KLEIN & HOFFMAN ANNOUNCES CAITLIN MAGGIANO AS SENIOR ASSOCIATE II



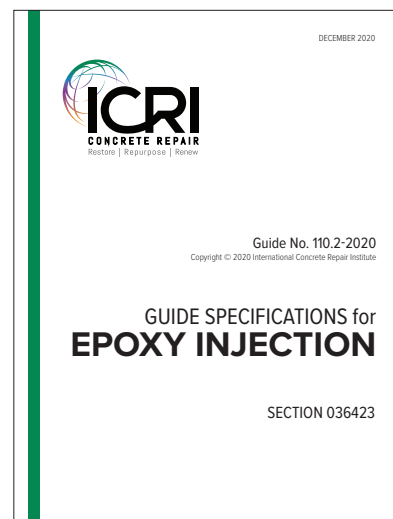
Klein and Hoffman, a Chicago-based structural and architectural engineering firm, announces that Caitlin Maggiano, PE, will join the Philadelphia office as Senior Associate II

Maggiano comes to K&H with over 12 years of experience working in the repair and restoration field where she has been responsible for projects concerning buildings in distress and routinely developed thoughtful solutions to unique problems. She is active in many industry-based organizations including the International Concrete Repair Institute (ICRI) in which she was recently selected as one of the '2021 Top 40 Under 40'. As an engineer, she has extensive knowledge in assessing existing structures and developing repair programs specifying appropriate materials and systems with clients' needs in mind.

Maggiano brings an exceptional set of skills to the firm, having completed dozens of projects with notable Philadelphia-based clients, including the Marriott Reading Terminal Headhouse, University of Pennsylvania, and luxury Condominium Associations. She specializes in the repair and restoration of building exteriors (roofing, windows, concrete and masonry, and waterproofing) while servicing residential and higher education markets, amongst others. In her new role as Senior Associate II, Maggiano will oversee several areas of operation in the Philadelphia market.

# NEW!

## The First Complete Epoxy Injection How-To Guide



Available at  
[www.icri.org](http://www.icri.org)

The purpose of this guide specifications is to aid the Design Professional in the preparation of technical specifications for inclusion directly into a project manual for the repair of cracks in structural concrete using epoxy injection materials and methods that are in line with the state-of-the-art practices used in the concrete repair industry. Its primary focus is to provide an outline for developing the three parts of the specification through suggested text, references, and commentary for evaluating alternatives.

# PRODUCT INNOVATION

## NEW INCONSPICUOUS RUST PREVENTATIVE GENERAL EQUIPMENT COMPANY INTRODUCES SECOND GENERATION FCS10 FLOOR COVERING STRIPPER

General Equipment Company introduces the FCS10 Gen 2 RIP-R-STRIPPER® floor covering stripper. The redesigned unit offers new features for improved productivity, operator comfort and ease of transport. It is an ideal solution for removing a wide range of floor covering materials found on both commercial and do-it-yourself projects.



The Gen 2 FCS10 is compatible with a variety of straight and scoring type blades up to 10 inches wide for use on wood and concrete surfaces. A small, lightweight design makes the FCS10 especially productive in hard-to-reach areas, such as bathrooms, closets, foyers and other areas that are too restrictive for larger floor covering strippers to work effectively. Anti-Vibe® caster wheels add to the maneuverability of the unit in small spaces, while minimizing the amount of vibration experienced by the operator.

Weighing only 44 pounds (19.6 kg) without a blade, the FCS10 is highly transportable due to the new detachable handle design. The locking button and release lever have been eliminated making the process of detaching the handle simpler. The easier attachment method also improves flooring material flow over the front of the unit for greater productivity. Additionally, the ergonomic steel handle has been widened to provide greater comfort and control to the operator and no longer requires assembly of the handle to the shaft, which saves time and effort. Further, the handle material has been upgraded to an all-steel construction for maximum durability and the ability to withstand jobsite abuse.

Other features include a 2,300-watt power unit that operates from a standard 15-ampere circuit. Also, the on/off switch has been enhanced with the safety of the user and ease of use in mind. Its new location at the top of the operator handle now

offers greater visibility and is easier to access.

For more information, visit [www.generalequip.com](http://www.generalequip.com).

## HAND-HELD, INSTANT KETT MOISTURE METER ENSURES CONCRETE AND MORTAR QUALITY, SPEEDS PROJECT

For contractors working with concrete or mortar, using the instant, hand-held Kett HI520-2 concrete and mortar moisture meter at the jobsite safeguards critical infrastructure, enabling easy spot checking to account for seasonal variability and environmental factors.

Water is an essential element of concrete and mortar. However, at the jobsite, seasonal temperature, rain, humidity, groundwater, and circulating air can greatly affect concrete and mortar moisture content. This can impact setting and drying time – and incorporating the wrong moisture levels in concrete and mortar can be disastrous to quality, finish, longevity, and even safety.



The durable HI520-2 instant moisture meter allows anyone to spot check concrete and mortar at the jobsite to assure that it is properly mixed, set, and dry. It allows non-destructive, non-invasive testing on a digital display with no pin holes or discoloration. This facilitates construction work as soon as feasible, speeds project completion, and improves quality.

With the moisture meter, the worker selects the calibration (i.e.-concrete or mortar), presses it against the sample, and moisture is immediately displayed with accuracy of +/-0.5% (0-12% for concrete/0-15% for mortar). Automatic temperature compensation enhances measurement accuracy.

For more information visit [www.kett.com](http://www.kett.com).

## CONCRETE INDUSTRY: MOBILE SHOWROOMS PROVIDE MANUFACTURERS WITH A POWERFUL NEW WAY TO DEMONSTRATE PRODUCTS

Manufacturers in the concrete industry that have historically relied upon trade shows as a primary lead generation channel have had to find a new way to connect with prospects since trade shows were cancelled because of the COVID-19 pandemic. In response, many companies have chosen to deploy an experiential mobile marketing trailer that they can take directly to targeted customers to showcase and demonstrate their products.

Mobile showroom today—tradeshow booth tomorrow. When trade shows will return is still very much an unknown since it is largely dependent on the timing and effectiveness of the nationwide vaccine rollout.



Concrete industry equipment manufacturers cannot push pause and wait until trade shows come back. They need to get in front of their customers now and with a little foresight they can design a mobile solution that will also be a ready-made exhibit when trade shows come back. The incredible immersive experiences that can be created within these environments means that a manufacturer is going to really stand out from the standard traditional booths their competitors will be using.

For more info visit [www.craftsmenind.com](http://www.craftsmenind.com)

## ABB ROBOTICS ADVANCES CONSTRUCTION INDUSTRY AUTOMATION TO ENABLE SAFER AND SUSTAINABLE BUILDING

9 out of 10 construction businesses predict a skills crisis by 2030, with 81 per-cent saying they will introduce robots in the next 10 years, with safety and the environment also catalysts for accelerating investment in robotics

ABB Robotics is driving automation in the construction industry with new robotic automation solutions to address key chal-

# PRODUCT INNOVATION

lenges, including the need for more affordable and environmentally friendly housing and to reduce the environmental impact of construction, amidst a labor and skills shortage.

Robotic automation offers huge potential to enhance productivity, efficiency and manufacturing flexibility throughout the construction industry, including automating the fabrication of modular homes and building components off-site, robotic welding and material handling on building sites and robot 3D printing of houses and customized structures. As well as making the industry safer and more cost effective, robots are improving sustainability and reducing environmental impact by enhancing quality and cutting waste.

Robots can make construction safer by handling large and heavy loads, working in unsafe spaces and enabling new, safer methods of construction. Using robots for the repetitive and dangerous tasks that people increasingly don't want to do means automation can help support the industry's labor and skills crisis and make construction careers more appealing to young people.



The latest large scale ABB robotics 3D printing technology for the construction industry was showcased by the Austrian architectural bureau MAEID at the 17th International Architecture—La Biennale di

Venezia, to inspire architects about the possibilities of automation and 3D printing, driving innovation and enabling new ways of building.

For more information, visit [www.abb.com](http://www.abb.com).

## CONSTRUCTION CONTRACTORS USING HEAVY EQUIPMENT RENTALS INCREASE PROFITABILITY WITH GPS TRACKING

Construction contractors frequently rent heavy equipment for big jobs. When renting equipment, job profitability depends on efficiently renting out equipment, keeping it in good working order and returning it on time, whether that involves tractor-trailers, semi-trailers, or moving trailers; buses or RVs; backhoes, bulldozers, cranes, excavators, scrapers, graders, dump trucks, or all-terrain forklifts.

To maximize profitability, contractors need to keep track of the equipment to ensure timely return when the job is complete especially when multiple equipment is being leased with multiple jobs occurring in a variety of locations.

In order to protect and preserve these rented assets, contractors also must deter theft and reckless use as ultimately the responsibility for the equipment rests on their shoulders. On top of this, if the contractor name/logo is emblazoned on vehicles for the public to see, it is vital to prevent any dangerous actions, such as speeding, that could hurt their brand or even invite liability in the case of serious accidents.

As a proactive response, a growing number of contractors are turning to real-time, 24/7 GPS tracking of their heavy equipment rentals to ensure better fleet management and faster rental turnaround.

In addition, the same approach provides clear driver and operator accountability, which helps to reduce asset damage and prolong its usable life.

Compared with typical GPS tracking devices that may only update every few minutes, the ATTI's Shadow Tracker provides real-time location updates every 10-seconds, as well as location, speed and idle time alerts if something is amiss. This data is transmitted via satellite and cellular networks to a smartphone or PC on a 24/7 basis. The system has access to nationwide speed limits in its database.

Via a PC or smartphone app dealers can display the real-time location of the entire fleet on a map, and zoom in on any specific vehicle. At a glance, they can see if a vehicle is moving (displays green) or stopped (displays red). If they touch a vehicle icon, the app will display where the vehicle has been, where it stopped, and how long it has idled.

The ability to encourage greater user accountability can significantly enhance profitability, while prolonging the usable life of the fleet.

For a free demo, visit <https://www.advanttrack.com/free-demo/>.

## INTERESTED IN SEEING YOUR NEW PRODUCT IN THIS COLUMN?

Email your 150-200 word news to [editor@icri.org](mailto:editor@icri.org). Content for the September/October 2021 issue is due by August 1, 2021 and content for the November/December 2021 issue is due by October 1, 2021. One (1) high resolution product photo may be included. ICRI reserves the right to edit all submissions.

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[WWW.ICRI.ORG](http://WWW.ICRI.ORG)

# NEW MEMBERS

## SUPPORTING MEMBER COMPANIES

### **Ace Avant Concrete Construction**

Archdale, North Carolina  
United States  
*Zach Matson*

## COMPANY MEMBERS

### **51st State Construction**

West Palm Beach, Florida  
United States  
*Oleksii Bolduma*

### **Atlantic Building Restoration, Ltd.**

Dartmouth, Nova Scotia  
Canada  
*Kirk MacDougall*

### **CarboShield**

Tucson, Arizona  
United States  
*David Wilburn*

### **E-Z Construction Co., Inc**

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United States  
*Timothy Dues*

### **Fyfe Asia Pte Ltd**

Singapore  
*Jeslin Quek*

### **KJW Construction Group**

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United States  
*Kimberlee Ashley*

### **Klein and Hoffman, Inc.**

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United States  
*Alesha Shaw*

### **Leading Edge Building Engineers**

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Canada  
*Daniel Aleksov*

### **Linron Company**

Houston, Texas  
United States  
*Angela Adams*

### **Materials Testing & Inspection**

Portland, Oregon  
United States  
*Steve Griffith*

### **OXO H2O**

Calgary, Alberta  
Canada  
*Martin Herrington*

### **Platinum Specialty Services**

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United States  
*Stephen Swartz*

### **Reynolds Painting Group FL**

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United States  
*Chris Barno*

### **Seabee Contractors LLC**

Panama City Beach, Florida  
United States  
*Jon Griese*

### **Sherwin Williams**

Boynton Beach, Florida  
United States  
*Jessica Ocasio*

## ADDITIONAL INDIVIDUALS FROM COMPANY MEMBERS

### **Andrew Aarons**

Braun Intertec  
Bloomington, Minnesota  
United States

### **Rob Fritz**

Sherwin Williams Protective & Marine  
Saskatoon, Saskatchewan  
Canada

### **Albert Hanna**

Wiss, Janney, Elstner Associates Inc.  
Irving, Texas  
United States

### **Jonathan Johansmeyer**

Coastal Construction Products  
South Daytona, Florida  
United States

### **Kaid Millis**

John Rohrer Contracting Co., Inc.  
Kansas City, Kansas  
United States

### **Jamie Nalley**

Simpson Strong-Tie  
New York, New York  
United States

### **Jeffrey Owad**

Structural Technologies  
Columbia, Maryland  
United States

### **Michael Tolson**

RTC Waterproofing & Glass, Inc.  
Carrollton, Texas  
United States

### **Mark Turner**

Structural Preservation Systems, LLC.  
Pompano Beach, Florida  
United States

### **Audrey Wykes**

Western Specialty Contractors  
Kent, Washington  
United States

## INDIVIDUAL MEMBERS

### **Curtis Ardoin**

Conroe, Texas  
United States

### **Zachary Asmussen**

Blaine, Minnesota  
United States

### **Roger Bain**

South Elgin, Illinois  
United States

### **Gabriel Caballero**

Burlington, Ontario  
Canada

### **Esther Calle**

Bridgewater, New Jersey  
United States

### **Kevin Carter**

Chicago, Illinois  
United States

### **Bill Crawford**

Jacksonville, Florida  
United States

### **Charles Crowder**

Suwanee, Georgia  
United States

### **Adam Duffy**

West Des Moines, Iowa  
United States

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- 2** Expanding certification programs and services to educate and build skills
- 3** Building strategic partnerships to strengthen the relevance of ICRI and the concrete restoration industry
- 4** Serving the needs of members and customers with staff, volunteers, and our chapter network

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Bridgewater, New Jersey  
United States

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United States

**Philip Greer**

Harrisburg, North Carolina  
United States

**Adam Heckler**

Nashville, Tennessee  
United States

**Jose Jimenez**

Atlanta, Georgia  
United States

**Kenneth Jones**

Jamul, California  
United States

**WooSeok Kim**

Daejeon, Daejeon  
Korea, South

**Vivek Kummari**

Tampa, Florida  
United States

**Jenni Lee**

Minnetonka, Minnesota  
United States

**Dante Marimpietri**

Painesville, Ohio  
United States

**Matthew Midei**

Baltimore, Maryland  
United States

**Tomas Montemayor**

Melbourne, Florida  
United States

**Michael Ornellas**

Aiea, Hawaii  
United States

**Brandon Peterson**

Andover, Minnesota  
United States

**Bryan Ritacco**

Huntley, Illinois  
United States

**Justice Sagoe**

Dallas, Texas  
United States

**Steven Stewart**

Monroeville, New Jersey  
United States

**Othar Velasquez**

Mississauga, Ontario  
Canada

**Danny Welsh**

Kansas City, Missouri  
United States

**Joshua White**

Houston, Texas  
United States

GOVERNMENT MEMBERS

**Julio Morelos**

USACE  
Walla Walla, Washington  
United States

STUDENT/APPRENTICE MEMBERS

**Touhidul Alam**

Western Sydney University  
New South Walila,  
Australia

**Andres Aponte**

Florida International University  
Miami, Florida  
United States

**John Beasley**

The University of Alabama  
Tuscaloosa, Alabama  
United States

**Fei Cheng**

Lehigh University  
Bethlehem, Pennsylvania  
United States

**Roy Hoshmand**

Arad Engineering  
Tel Aviv, Tel Aviv  
Israel

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