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NOTE FROM THE EDITOR

The concrete repair industry is finally starting to take off for the year. ICRI members have been returning to their offices and back to construction sites. ICRI is continuing to update our website by adding a new Learning Center and updating the bookstore. The technical presentations from the cancelled Spring 2020 Convention have all been uploaded to the ICRI website and are available for viewing.

ICRI has been holding meetings and presentations during the COVID shutdown by utilizing Zoom. This allowed committee meetings from the canceled spring convention to take place remotely. Several chapters have utilized Zoom or GoToMeeting to host meetings and events that have allowed ICRI members to stay in contact with friends and associates.

The theme of this issue of the Concrete Repair Bulletin is “Surface Preparation for Concrete Repairs, Sealers, and Deck Coatings.” There are several articles in this issue about repair projects on parking garages, fountains, and water treatment plants that use various methods of surface preparation.

Stay tuned to the Concrete Repair Bulletin and the ICRI website for upcoming announcements and information as the year continues. Please continue to send your ICRI chapter events and updates to Dale Regnier.

I hope you continue to have a safe 2020!

Jerry Phenney, Desman
Concrete Repair Bulletin Editor
Another month, another edition of the CRB—and another healthy dose of uncertainty coming your way.

If there is one thing I took away from the COVID-19 Panel Discussion held on June 19, it’s that there is not a single functioning crystal ball anywhere on planet Earth that can tell us when the pandemic will abate.

First, the big news: At the June meeting of ICRI’s Board of Directors, the very difficult decision was made to replace our live Fall Convention in Minneapolis with a virtual convention. Given where things stand, the risks are just too great. Despite this additional setback, ICRI’s leadership and staff are dedicated to providing the best possible virtual experience and ensure the continued networking and education that is so important for our members. Stay tuned for more details in the coming weeks!

This continued uncertainty brings me back to some lessons learned during the recent ICRI webinar on the state of the industry during COVID. (BTW—many thanks to our panelists, Elena Kessi, Brian Daley, Dave Erney, and Steve Lucy!) There were some very important points made during the discussion. My favorites were Brian and Elena telling us that, at the outset of the pandemic, they were contacting their fellow ICRI members to talk about the availability of materials and supplies they would need in the coming weeks. When Elena had difficulties finding PPE items to order for her workers, fellow members came to her aid. During my time as a member of ICRI, this type of fellowship has been exhibited on numerous occasions on both the local and national levels and, in my mind, is one of the hallmarks of our organization.

This highlights another aspect of membership in ICRI that many of us at the international level have come to realize—the advantage of having a greatly expanded network of people and resources! We understand that many members are content remaining with their chapter’s network, and we hope you take full advantage of networking with your local members. However, if you find your company expanding its reach, performing work outside local confines, I hope you will consider volunteering on one of ICRI’s technical or administrative committees. A Volunteer Opportunity Board has been created and posted on the ICRI website to inform you of openings on these various committees. Volunteering to assist on the Coatings and Waterproofing Committee is how I became involved in ICRI on the international level, and it has turned out to be one of the most rewarding experiences of my professional life! As I have mentioned previously, all ICRI members have different experiences in the various aspects in the concrete repair industry—be it in design, in the field, or in support roles such as finance, sales, marketing, or business development. Contributing your knowledge and expertise to our committees is an excellent way to “give something back” to the industry and, at the same time, develop relationships with ICRI members beyond your localized network.

If you happened to catch my video message back in June, I called out my boss and my company for the support they have provided to me regarding my involvement in ICRI. Our organization’s Supporting Members and Company Members play a vital role in supporting the educational endeavors and accomplishments of ICRI. As we begin our new fiscal year on July 1, new benefits are being rolled out to our Supporting and Company Members. If you are already a Supporting or Company Member of ICRI, we thank you very much for this investment in our organization! (Current Supporting Members – your new perpetual plaques are being mailed to you.) If you are on the fence about joining as a Supporting or Company Member, please review these updated benefits, and consider upgrading your membership! What better way to show your commitment to the concrete repair industry!

Please continue to be vigilant about your safety and the safety of those around you!

Sincerely,

Mark D. LeMay, AIA, LEED AP, CCSRT
2020 ICRI President
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PROTECTS RECAP FROM MOISTURE FOR UP TO 8 MONTHS.
As noted in a previous TAC Talk article, all members of the Technical Activity Committee (TAC) and the individual ICRI technical committees are committed to creating relevant technical offerings to meet the needs of today's construction professionals. While we continue to promote our written technical guidelines, ICRI is also evolving to create alternative offerings such as webinars, video presentations, tech notes, certification programs, and online training modules. We are looking at all possible vehicles to promote the effective transfer of knowledge within the repair industry.

Here are a few of the alternative technical offerings currently running through ICRI technical committees:

- **Webinars**—Jim Spiegel, chair of the Education Webinar Subcommittee and member of 710 Coatings and Waterproofing Committee, has recently created a webinar based on the Chemical Grouting guideline currently being developed in the 710 Committee. Each of our previous ICRI webinars had over 200 attendees, and we expect the same for Jim's upcoming event. Also, the ICRI technical committees look forward to creating additional webinars this year.

- **Crack Training Modules**—Mark Kennedy, chair of the 320 Repair Materials and Methods Committee, has led the committee's effort to create a number of educational and training modules for defining and understanding cracks in concrete.

- **Rebar Surface Preparation**—David Rodler and Charles Mitchell, co-chairs of the 210 Evaluation Committee, are leading the committee's effort to create a guideline and physical samples to illustrate the levels of rebar surface cleaning.

As an ICRI member, it is not necessary to attend national conventions to join an ICRI technical committee. One thing we have learned from being locked down is that we can move ahead with our committee efforts using Zoom meetings.

The ICRI technical committees have been meeting via video conferencing for the past few months. Participation is simple—you need only request a link to the next meeting.

As always, if you want to join an ICRI technical committee, please feel free to contact me directly at mnelson@nelson-testing.com. In addition, visit the Volunteer Job Opening Board available on the ICRI website for committee needs.

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

ICRI committees are open to all and they are looking for your involvement. Lend your expertise and help improve the industry!
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With the continuation of COVID-19 and as States and whole countries continue to open for business, I have heard the terms “essential business” and “non-essential business” quite often in the local news and over the phone in conversations with customers and counterparts. These terms used for identifying business sectors that could or could not stay open can also be used to identify the Secretariat’s choices on the ideas presented to ICRI.

On a monthly basis, we identify if ideas submitted to the Secretariat are “essential” or “non-essential” to the growth or awareness of our beloved Institution, individual committees, or documents, etc. Not all ideas received are considered essential or ICRI cannot support such a project, and it may be rejected or tabled for future consideration. However, for most ideas submitted, the Secretariat discusses and votes on the viability of the proposed idea and may get the involvement of one or more committees to get it started in the process of fruition. Some ideas are approved quickly, and others move slower as committees ponder and discuss if the idea fits ICRI’s strategic plan and can even be implemented. In these cases, an idea can sit idle if committee members are not involved or if the committee is missing key volunteers such as subcommittee chairs, secretaries, or co-chairs, or if there is little activity outside of the conventions.

For these reasons, an idea that was submitted and deemed “essential” was a volunteer job board for Committee Chairs to utilize if they have open roles on their committee roster. The Volunteer Job Opening Board is now active on the ICRI website www.icri.org and was discussed in detail in the last issue of the CRB.

As we move toward the Virtual Fall Convention, take advantage of this new tool and get involved with this wonderful organization.

Keep your ideas coming in and stay safe during these times!

Andrew Fulkerson is a member of the ICRI Secretariat and a member of Committees 310 and 320, past chair of Committee 310; past member of TAC (2 terms) and Committee 710, and past VP of the Northern Ohio Chapter.

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ICRI Mission and Strategic Plan Benefit Members and the Industry

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

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

**ICRI Mission:** ICRI will be the state-of-the-art, trusted and reliable source of delivering best industry practices and professional networks in the repair industry.
- Develop industry professionals
- Professional networks
- Champion innovation and safety

**Professional Development**
- ICRI will develop and deliver programs, products, and services that provide knowledge, build skills, and validate expertise.
- Expand certification
- Quality programs and products
- Enhanced product program services

**Organization Strength**
- ICRI will have the resources, staff, and structures to fully support its strategic priorities.
- Engage members
- Strengthen chapters
- Grow staff capacity and capabilities
- Serve members

**Organization Credibility**
- ICRI will be a well-connected organization backed by a recognized and respected brand locally, nationally, and globally.
- Strengthen strategic partnerships
- Strengthen brand
- Engagement of diverse participants

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

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WWW.ICRI.ORG JULY/AUGUST 2020 CONCRETE REPAIR BULLETIN 9
Production of potable water requires functional infrastructure. Administrators of aging water treatment facilities often face difficult budgetary decisions associated with structural and operational needs and upgrades. Rebuilding infrastructure when unnecessary is energy intensive, disruptive, and creates a large economic burden to taxpayers, but uncomprehensive maintenance and repair strategies can lead to disruption and economic burden due to increased frequency of required actions. Sustainable rehabilitation using innovative and flexible strategies can significantly extend service life at lower overall costs in an environmentally responsible way.

Mitchell Water Treatment Plant (Fig. 1), constructed in the 1950s and 1960s and located in Greensboro, NC, can produce 24 MGPD of potable water and is a critical component of the city’s infrastructure. Based on findings of a condition assessment and prioritized owner initiatives, a multi-phased approach was undertaken to repair deteriorating concrete and extend service life of the filter house and basin concrete components. This article discusses the rationale and approach for structural repairs during the US $2.4M Phase I filter house rehabilitation completed in 2016 and the US $6.2M Phase II exterior basin rehabilitation completed in 2020. Topics and key aspects of the phased work include historical durability aspects of existing concrete, the use of high-performance concrete for structural replacement, hydrodemolition for surface preparation, spray applied mortar for overlays, and tensile bond testing.

**MOTIVATION AND OWNER INITIATIVE**
City officials had been noticing increasing deterioration of exterior reinforced concrete basins, bridges, and walking surfaces; building façade lintels; and interior reinforced concrete slabs and encased steel beams at and around the hypochlorite storage room. This led to growing concerns about the remaining service-life of the facility and the resources that would be required to rebuild or move operations if the plant became unserviceable. Thus, the City commissioned an engineering study to evaluate the current condition of the structure and obtain options for...
service-life extension with the primary goals of protecting the city’s critical asset, significantly extending service life and minimizing overall life-cycle costs.

**CONDITION ASSESSMENT**

**Age Considerations**

In regard to concrete materials, construction documents dated 1955 (original) and 1963 (northern expansion) did not contain specifications or code references. Though construction pre-dated the initial ACI 350 Committee Report¹ and the first edition of the ACI 350-01 code,² other historical codes provide perspective on industry standards for planning and assessment. Local building codes³, ⁴ active at the time of original construction referenced ACI 318-51 as "generally accepted good practice in reinforced concrete construction." ACI 318-51 lacked meaningful durability requirements for potential durability issues, including sulfate resistance, alkali-silica reaction resistance, freezing and thawing resistance other than a modest limit of water content, and corrosion protection other than reinforcing steel cover requirements. The benefits of entrained air for freezing and thawing durability in concrete were discovered by the late 1930s and researched and implemented by some entities by the 1940s.⁶, ⁷ However, mandatory provisions were not incorporated into ACI codes until ACI 318-63.⁸ Thus, it was suspected that there would not be entrained air in the subject concrete. Greensboro’s climate frequently cycles above and below freezing, which subjects critically saturated non-air entrained concrete to distress, particularly above water lines.

**Chemical Exposure Considerations**

Chemicals in use at the time of the assessment included sodium hypochlorite for disinfection and ferric sulfate as a coagulant. Historical pH/composition of basin water and other plant chemicals that can affect leaching and deterioration were not known. Deicing chemicals were used on horizontal walking surfaces around the basins. Thus, chemicals and conditions that can contribute to deterioration of concrete and steel were present.

**Testing Program**

Methods to evaluate concrete and reinforcing included visual review and the following tests at representative areas throughout the building, basins, and other exterior areas:

- Test excavations;
- Audible soundings;
- Compressive strength (ASTM C 39);⁹
- Petrography for potential materials distress (ASTM C 856);¹⁰
- Chemical testing at various incremental depths for acid-soluble chloride concentration (ASTM C 1152)¹¹ and concentrations of bromide (EPA 9211),¹² fluoride (EPA 9214),¹³ and iodide (ASTM D 3869);¹⁴
- Non-destructive cover testing; and
- Half-cell potential (ASTM C 876)¹⁵ and 4-pin Wenner probe for embedded steel corrosion.

The average and 10 percent fractile compressive strength of 17 samples using the principles of ACI 214.4R-10¹⁶ were 5,420 psi (37.4 MPa) and 3,620 psi (25.0 MPa), respectively.

**Concrete Materials-Related Distress (MRD)**

Paste erosion, pH reduction and paste deterioration from leaching to a depth of ¼ to ½ in (approx. 6 to 13 mm) were characteristic of submerged basin surfaces sampled (Fig. 2). Freezing and thawing distress from lack of entrained air was characteristic of many exterior components sampled at or above the waterline (Fig. 3). Concrete was deteriorated up to 5½ in (approx. 140 mm) deep at horizontal surfaces and through the entire width of an 8 in (200 mm) thick baffle wall. MRD other than that associated with corrosion of embedded metals was not identified for concrete within the building.

**Embedded Steel Corrosion**

Severe corrosion of embedded reinforcing and encased steel I-beams was identified in and around the sodium hy-

---

Fig. 2: Typical condition of interior basin prior to repair (insets show paste erosion at surface and corrosion-related distress)

Fig. 3: Examples of freezing and thawing distress at horizontal surfaces (left) and near water line at a baffle wall (right). Insets of petrographic cross-sections show 2½ in (64 mm) distress at the horizontal surface and full depth at the baffle wall surface (inset photos courtesy of Dipayan Jana, PG, PhD)
pochlorite room where spills had reportedly occurred (Fig. 4), requiring shoring. Reinforced concrete columns supporting the sodium hypochlorite room exhibited limited corrosion-related distress. Chloride contents were variable and ranged from trace to above 4,000 ppm at the depth of embedded steel, the higher values being well above the amount expected to initiate corrosion.17 Other halide concentrations were identified only in trace or slightly elevated amounts, suggesting that these were not likely contributors to distress.

Low concrete cover (within the carbonation zone) and corrosion of reinforcing steel (as identified visually and via half-cell testing) were characteristic of many exterior bridges and structural components within channels, and at some submerged and above-water basin wall surfaces (Fig. 3). Chemical testing revealed relatively low contamination of chlorides or other halides at submerged basin surfaces, but up to approximately 1,500 ppm at a depth of 1½ in (38 mm) below horizontal surfaces.

REPAIRS
Surface treatments, concrete repairs, cathodic protection and strategic replacements were considered for the rehabilitation program. To meet the City’s expectations of long-term service life extension, a general approach included replacement of the heavily deteriorated hypochlorite room concrete slab, localized repair with cathodic protection at adjacent and lower-risk areas; exterior concrete resurfacing with cementitious bonded overlays and localized repairs with cathodic protection, and other essential and ancillary repairs. The project was separated into two phases to address budgeting and operational impact. Phase 1 addressed the filter house and Phase 2 addressed exterior basins. Refer to Figure 5 for a schematic showing phasing and some of the primary structural repairs.

PHASE 1—FILTER HOUSE
Project Coordination and Scope of Work
Structural, concrete and façade repairs included the following:

- Replacement of the hypochlorite room floor and concrete at encased steel beams within the contaminat-
ed and severely deteriorated area (primary aspect of Phase 1 repairs);
- Repairs and localized galvanic cathodic protection at reinforced concrete columns;
- Strengthening of the elevated ferric sulfate room floor slab for new higher capacity storage tanks;
- Architectural repair of cast stone components over windows; and
- Flashing repairs and coating of corroded lintels at windows requiring brick replacement, temporary wall support, and dust protection of interior basins.

Phase 1 also included HVAC and operational and architectural upgrades including new walls, coatings, and rearranging of interior spaces. This required significant coordination between trades. A requirement of the project was that the plant had to remain functional during all work.

**Design Considerations for Replacement of the Sodium Hypochlorite Room Slab**

Removal and replacement of the elevated continuous reinforced concrete floor slab included the following special considerations:

1. **Supplemental support of steel columns supported on the elevated slab:** This required steel columns be captured for support by collars that were encapsulated during concrete placement.

2. **Connection to the adjacent slab sections:** Structural continuity was required between the new and remaining sections of elevated floor slab and included mechanical splicing, supplemental anchors at slab edges and preservation of existing reinforcing steel.

3. **Concrete considerations:** Low permeability, low shrinkage, durable concrete with similar strength to the existing concrete was used to provide protection to reinforcing steel, reduce shrinkage stresses and cracking from adjacent slab restraint, mitigate potential alkali-silica reaction (ASR), and provide structural compatibility. Specifications provided performance and prescriptive options. Prescriptive options included requirements for supplementary cementitious materials, admixtures, cementitious materials contents and w/cm. Performance options included:
   - Shrinkage: 250 microstrain maximum at 28 days after 7 days curing per modified ASTM C 157[18]
   - Chloride penetrability: 1000 Coulombs maximum at 28 days per modified ASTM C1202[19] (7 days standard cure followed by 21 days at 100°F)
   - ASR: 0.10% maximum at 14 days per ASTM C1260[20] or ASTM C1567,[23] or 0.04% maximum at 1 year per ASTM C1293[22]

Some key aspects of the concrete mixture are provided in Table 1.

<table>
<thead>
<tr>
<th>Material</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cementitious materials</td>
<td>630 lbs/yd³</td>
</tr>
<tr>
<td>Class F fly ash</td>
<td>25%</td>
</tr>
<tr>
<td>w/cm</td>
<td>0.45</td>
</tr>
<tr>
<td>Corrosion inhibitor</td>
<td>2.5 gal/yd³</td>
</tr>
<tr>
<td>Shrinkage-reducing admixture</td>
<td>1.5 gal/yd³</td>
</tr>
<tr>
<td>Trial compressive strength (avg. @ 28 days)</td>
<td>4,520 psi (31.2 MPa)</td>
</tr>
<tr>
<td>Fine aggregate ASR (ASTM C1260 expansion @ 14 days)</td>
<td>0.05%</td>
</tr>
<tr>
<td>Coarse aggregate ASR (ASTM C1260 expansion @ 14 days)</td>
<td>0.08%</td>
</tr>
</tbody>
</table>

**Construction of Sodium Hypochlorite Floor Slab**

Demising walls were installed to isolate the repair area and provide dust control for the functioning plant. Shoring and falsework, as well as collars to support columns, were installed prior to existing slab removal. Bearing areas were extended into walls and supplemental support angles were installed at boundaries. Adhesive anchors and mechanical splices were installed to provide additional continuity where needed in addition to existing preserved reinforcing. Galvanic anodes were installed at selected repair perimeters for supplemental corrosion protection at adjacent areas. Concrete was pumped for slabs, beam encasements, and containment curbs monolithically, and wet cured (Fig. 6). New walls and equipment pads were subsequently installed. Interior remodeling and coatings occurred after slab and walls were constructed (Fig. 7).

![Fig. 6: Construction of replacement floor. Note demising wall at left to separate construction activities from daily operations and vertical reinforcing for masonry walls (inset shows collar on second floor column to transfer loads)](image-url)
PHASE 2—BASINS

Design Considerations

A cementitious bonded overlay and deeper localized repairs with galvanic cathodic protection were included to extend the service life of approximately 100,000 sf (9,000 sm) of basin, bridge, and exterior walking surfaces. The intent was to replace deteriorated and contaminated concrete, provide corrosion protection where necessary, and provide long-term functional protection of the underlying concrete from the environment. Slab sections with severe deterioration and contamination were replaced.

Prior to bidding, a mock-up was conducted with testing to confirm the demolition method, depth of demolition, application materials and procedures, and expected achievable material bond strength. Hydrodemolition was specified for removal of deteriorated concrete and surface profiling for bonded overlays. Advantages of hydrodemolition include mitigation of residual microcracking, relatively easier replication over large areas, and uniform production and dust control. The goal was to remove all deteriorated and unsound concrete and achieve an ICRI CSP-823 surface profile to optimize bond between the prepared surface and overlay.

A proprietary prepackaged cementitious bonded overlay repair material with fibers and silicate-based technology was used due to chemical resistance, NSF 61 certification, and previously demonstrated suitability. Specifications required tensile bond strength evaluation per ASTM C158324 and ICRI Technical Guideline 210.3R.25

Basin Overlay Repairs

One side of the basins was repaired at a time to maintain plant functionality. Work occurred during low water production demand times, which extended from the beginning of October to the end of April. This required cold weather protection for repair material placement and curing. Containment tents and heaters were used to maintain appropriate temperatures (Fig. 8). Residual emissions from heating were piped outside enclosed areas. Erecting and maintaining safe temporary enclosures required consideration for wind, snow, and rain loads.

Considerable variation was realized in the surface profile based on deterioration and the typical variation in depth at peaks and valleys from the very aggressive surface profile obtained from hydrodemolition (Fig. 9). Distance from the peaks and valleys of extending aggregate often ranged from $\frac{3}{8}$ to $\frac{3}{4}$ in (approx. 10 to 20 mm). While aggressive surface profiles increased mechanical interlock between substrates and the new overlay, they also presented challenges with respect to thickness, material overages, and obtaining saturated-surface dry (SSD) conditions at horizontal surfaces.

Where corroded or undermined reinforcement was encountered, galvanic anodes embedded in the parent con-
Concrete were used for corrosion protection. Reinforcing bars with shallow surface corrosion were frequently exposed near water lines inside basins and sporadically at exposed horizontal and submerged vertical surfaces. A mock-up was performed at the beginning of construction to review installation criteria including applicable conditions, reinforcement preparation, anode spacing, and steel continuity requirements within excavations.

Prior to repair material application, surfaces were prepared to a clean SSD condition by pre-wetting for a day and pressure washing to remove bond-inhibiting debris. Water pockets were commonly encountered at prepared horizontal surfaces from pre-wetting, requiring removal with blowers and oil-free air compressors. Quality assurance tensile bond testing identified isolated horizontal repair areas where bond lines were weakened from standing water left at the time of overlay application. Petrographic evaluation at representative samples demonstrated higher water content in the mortar at the bond line (Fig. 10). In these situations, the bonded overlay was removed and reinstalled.

Utilization of low-pressure spray was considered critical to achieving consistent material consolidation. Use of a scrub coat was evaluated with bond testing (ASTM C1583) as part of a pre-project mock-up. No particular benefit was identified for the scrub coat application and was not required in the specifications. Mock-ups attended by manufacturer’s representatives, the engineer, and installers during the project served to verify conformance with specifications and certify nozzlemen for the project. Due to the dependence of bond on proper spraying and finishing, only certified personnel were permitted to spray and finish repair mortar. Critical aspects of spraying included maintaining consistent velocity, perpendicular alignment with application surface, and spray distances. Where perpendicular spray was not feasible due to restricted access, spray angles were required to match the demolition profile to ensure that voids were filled.

Surfaces were screeded to uniform profiles using magnesium screeds and floats. Broom finishes were specified at horizontal surfaces for slip resistance, while smooth finishes were specified within the basins to prevent trapping of flocculation particles. As evidenced by an initial failed mock-up, troweling and over-finishing were noted as potential risks to be avoided. Certified finishers were directed to work material just enough to form a level, uniform surface appearance. Horizontal surfaces were wet cured with burlap and vertical surfaces were cured using atomizing foggers hung within the basins (Fig. 11). Improperly finished surfaces and feathered transitions required correction in isolated areas.

**Other Work**

Other work included:
- Sectional replacement of some walkway areas to ad-
dress distress and permit access to lower channels;
• Coating of submerged metal components with NSF 61 approved coatings; and
• New aluminum bridges and stainless-steel ladders at basins.

Bond Testing
Long-term performance of bonded overlays is heavily dependent on bond strength between the parent concrete and repair material. Tensile bond strength testing was conducted in accordance with ASTM C1583 at repair areas. Measured bond strengths were evaluated against specified minimum criteria determined during mock-ups. Minimum acceptable average and individual tensile bond strengths were 200 psi (1.4 MPa) and 160 psi (1.1 MPa), respectively. Figure 12 shows bond testing performed during pre-construction mock-ups and examples of core failure modes during construction.

Non-conformant bond tests were identified as those failing within the overlay or interfacial failures between the overlay and parent concrete below specified minimum bond strength criteria. Partial interfacial failure modes were common and required close evaluation. Additional testing for confirmation was performed where results were suspect or non-compliant. As shown in Figure 13, average bond strengths routinely exceeded specifications. For confirmed cases where bond strength requirements were not met, petrographic samples were taken for evaluation. A number of lower results were associated with retests at four horizontal areas, three of which were confirmed low, and two vertical areas that passed requirements upon retest. As shown in Figure 13 and expected, averages are higher when retest areas are removed from the dataset. Note in Figure 13 that overhead results were lower than other orientations. This was attributed to the likely incomplete consolidation under reinforcing steel. Some of the lower results were associated with the baffle wall. In areas where petrographic testing identified bond or material deficiencies, bonded overlays were removed and replaced after additional surface preparation. Strategies for delineating extents of deficient areas included additional bond strength tests around defective test areas and auditory soundings.

![Fig. 13: Tensile bond strength results (ASTM C1583) includes data for results without an epoxy bond failure or test error and all retests at suspect areas](image-url)
SUMMARY

Structural rehabilitation of deteriorated concrete at a wastewater treatment plant was implemented to achieve long-term service life extension. Viable repair options were determined based on a condition assessment that identified materials-related distress, contamination, and corrosion. High-performance concrete was used to replace a hypochlorite room slab in a cooperative approach with other upgrades as the plant remained functional. A bonded cementitious overlay and concrete repairs with cathodic protection were used to restore and enhance exterior components in a phased approach. Surface preparation, testing, and inspection were critical aspects of the bonded overlay installation as shown in Figure 14. 

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International Concrete Repair Institute
A Tale of Two Fountains
by David T. Ford and Fatemeh Shirmohammadi

Kansas Citians call their city the Paris of the Plains for reasons unknown to most of the world. The City of Kansas City, Missouri was planned much like Paris, with miles of boulevards and parkways connecting parks and green spaces. Kansas City’s first fountains date back to the late 1800s and the community’s love affair with fountains has flourished ever since. Today, you will find over 200 aquatic showpieces—large and small, artistically intricate and cleverly simple—gracing nearly every courtyard, parkland, and tree-lined boulevard throughout the area, including the Delbert J. Haff Circle Fountain and Meyer Circle Sea Horse Fountain.

DELBERT J. HAFF CIRCLE FOUNTAIN
In the 1890s, Delbert J. Haff rose as an essential figure for the city’s Parks and Recreation Board, influencing the community’s approach to preservation, beautification, and neighborhood-building, even today. In 1937, the city designed a circle entrance to the west side of Swope Park and at the east end of Meyer Boulevard, dedicating it to Mr. Haff and honoring his contributions to the local parks system (Fig. 1). Originally, the fountain pool measured 180 ft (55 m) long by 60 ft (18 m) wide, with depths that varied from 28 in (0.7 m) on the east end to 42 in (1.1 m) on the west end, and a low retaining wall of coursed stone.

Existing Condition
Aside from periodic maintenance, the fountain pool never underwent significant renovation or improvement over the years. By the 2010s, the concrete structure was crumbling with numerous cracks and spalls. The original concrete floor (Fig. 2 and 3) and walls (Fig. 4) showed numerous locations of concrete distress and the original filler in the concrete basin joints or wall-to-floor transition joints had not been replaced during its lengthy service life. Significant deterioration was observed at various locations within the perimeter architectural capstones. The original limestone masonry capstone on top of the basin walls was installed flat and the lack of slope had allowed rain and snow to collect on the stones, damaging the masonry substantially over time.

Most disturbing, the basin floor slab had settled and cracked. This considerable structural distress, however, was not the Kansas City Parks & Recreation Department’s (KC Parks) motivation for repair. Their primary concern was that the fountain did not actually work and had been increasingly plagued with active leaks, creating unnecessary operational expenses. Ultimately, KC Parks sought to completely repair the leaks, but more importantly, to modernize the fountain pool and ease the burden of future maintenance by decreasing its volume capacity.
**Condition Assessment**

First, the source of water leaks was identified: cracks, joints, piping connections, or all three. To do that, the fountain’s manual fill line was shut off and the water depth was periodically measured and recorded to determine if the basin itself, or valves in the water service line, were leaking. Over two consecutive days, the basin water depth was measured at approximately 8:30 a.m. and 5 p.m., noting no water at the fill line outlet after the fill line valves were closed. Downstream gate valves in the meter vault appeared to be completely seal closed. Deducting the average regional standard for water evaporation from the gross volume water loss, a significant water loss of 7,500 gallons (28,390 liters) per day was recorded.

Next, three concrete cores were extracted from the fountain’s basin. While the compressive strength and chloride content of the cores were favorable, the quality of the internal microstructure—internal cracking caused due to past freeze-thaw—had and would continue to damage the concrete.

The assessment revealed that the bulk of water was lost due to failed filler within large control joints/gaps within the slab, but extensive deterioration of the concrete in various locations also increased its permeability, thus creating additional sources/paths for water to escape the fountain.

**Repairs**

Considering the condition of the basin slab and walls, the original slab-on-grade needed to be removed while the concrete walls of the fountain could be salvaged. A 6 in (150 mm) thick, heavily reinforced concrete slab-on-grade was designed with water stops and expansion/control joints to limit cracking (Fig. 5). To further ensure water-tightness, a two-coat, cementitious waterproofing system was applied to the new basin slab and original fountain walls, which were sounded and partially repaired as needed. The new, cementitious waterproofing system also created a protective layer to expand the service life of the concrete slab. To finish, the design added a new dolomite capstone with a sloped surface on top of the
original walls. In the end, the fountain’s volume was cut in half—from 223,000 gallons (844,150 liters) to 111,500 gallons (422,075 liters)—and created a more sustainable water feature that retains all of its original beauty (Fig. 6).

In addition, a new subgrade concrete vault was designed to replace the existing, deteriorated vault, housing the fountain’s new mechanical and electrical equipment. To avoid any future concrete deterioration or water infiltration and expand the service-life of the concrete vault, a permanent, subgrade dewatering system with pump stations was installed to drain the ground water around the vault.

MEYER CIRCLE SEA HORSE FOUNTAIN
The Meyer Circle Sea Horse Fountain is one of Kansas City’s most popular and most visible water features. Located in the traffic circle at Ward Parkway and Meyer Boulevard, nearly 40,000 vehicles pass by the fountain every day. The fountain itself—measuring 100 ft (30 m) in diameter with a depth of 30 in (0.8 m)—was originally constructed in 1925 and has since evolved into an iconic Kansas City landmark. The ornamental sculpture resting on top of the masonry pedestal traces its roots to 17th Century Italy (Fig. 7). It was purchased by J. C. Nichols in Venice in the early 1920s and gives the fountain its whimsical name, with the three mythological sea horses perched atop the stone pyramid.

Existing Condition
The fountain had gone through three major renovations/improvements during its service life. In 1960, a 4 in (100 mm) thick, concrete topping slab was installed on top of the original basin floor. In 1966, the jets and portions of the statue that had been stolen or vandalized were replaced. And in 1992, a new fiberglass pump vault was installed at the south side of the fountain. Somewhere along the way, KC Parks upgraded lighting features in and around the fountain and increased the height of its retaining walls, but subsequently lowered them again after public backlash. Most recently, the water feature had experienced increasingly disruptive malfunctions that led to a lengthy operational shutdown in 2015. These disruptions stemmed from excessive flooding within the underground mechanical and electrical vault located on the south side. Additionally, excessive leaking required KC Parks to install water inlets to maintain operability by continuously supplying water.

Compared to the Haff Fountain, the concrete structure of the Meyer Fountain was in much better shape. The Meyer Fountain was originally constructed using concrete slab and walls and finished with limestone masonry for the exterior veneer, matching the center masonry pedestal supporting the sculpture. The concrete floor was in fair condition, with localized spalls and freeze-thaw damage at the east side of the basin. KC Parks’ restoration plan for the Meyer Fountain aimed to repair all leaks and waterproof the mechanical vault, while maintaining the feature’s original materials and aesthetics.
Condition Assessment

To identify the source of water leakage in the vault, members of KC Parks' facility maintenance management team were interviewed. They indicated that the vault didn’t flood when the fountain was empty, and thus, partially attributed the source of leaking to deficiencies below the central pedestal. After water-spray testing the pedestal and other locations of the basin, the source of the leak was identified at the joint between the basin floor and the perimeter walls on the south side (Fig. 8). To remedy this issue, sealing the joint and adding a cementitious waterproofing system on the top was recommended.

Three concrete cores were extracted from the area of most concrete spalling on the east side of the fountain floor. Significant freeze-thaw damage and ettringite—an expansive, secondary deposit—were reported. Ettringite can lead to internal cracking and diminish the concrete’s durability by increasing freeze-thaw susceptibility. It was concluded that the concrete deterioration likely resulted from water infiltrating the microstructure.

Repairs

The 4 in (100 mm) thick concrete slab topping was partially removed along the east side of the floor and replaced with a new concrete infill.

To finish, the existing capstones on top of the basin walls were installed flat. Because the existing capstone was in fair condition—unlike that of the Haff Fountain—the adjustment could be done on top of the wall. The existing capstones were removed and re-installed after creating a slope on top of the wall using a concrete overlay (Fig. 9). To support maintenance efforts, a new subgrade concrete vault was designed to house upgraded mechanical and electrical equipment, replacing the existing fiberglass vault (Fig. 10). Views of the fountain after renovation are shown in Figures 11 and 12.
SUMMARY
Weather and water are harsh elements for any material to withstand over time. For both the Haff and Meyer Fountains, the structural concrete of each feature began to show signs of that struggle, leaking water and eventually losing function. KC Parks, understanding the importance of these two landmarks, stepped in to facilitate their restoration before the damage was too great to correct.

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INTERNATIONAL CONCRETE REPAIR INSTITUTE
PROJECT HISTORY
The Market Centre Parkade (Fig. 1) was constructed in 1986 during an economic downturn in the City of Brantford, Ontario, Canada. Brantford was once the third-largest industrial center of Canada, specializing in agricultural machinery and settlers’ goods. However, the arrival of urban sprawls and the collapse of the main economic drivers in the latter half of the twentieth century resulted in an economic decline for the city.1

This parking space, along with the Market Square Mall, was introduced in efforts to revitalize the downtown to its former glory. The parkade is a 3-story reinforced cast-in-place concrete structure approximately 344,500 sf (32,000 m²) in area, to accommodate up to 950 vehicles. It features wide ramps, a column free design and several pedestrian links connecting it to the public library and the downtown core.

SCOPE OF THE WORK
Like all building structures, the Market Centre Parkade is not exempt from deterioration over time (Fig 2). As a large unheated outdoor structure, it was exposed to weathering, salts, and freeze-thaw cycles. In addition, the parkade was found to be under-reinforced, resulting in concrete delamination at many locations within the parkade. The City of Brantford rectified some of these deficiencies in the mid-2000s using carbon-fiber reinforced polymers (CFRP). In September 2017, the City of Brantford issued a request for proposal to upgrade the parkade to accommodate increased demand as the result of a new YMCA building that was to utilize the parking space. The scope of the work included rehabilitation of concrete columns, beams, and suspended decks, new expansion joints and traffic coatings, and LED lighting upgrades. The project was completed in December 2018.

RESTORATION PROGRAM
Structural Strengthening of Columns and Walls
Two types of structural strengthening methods were necessary to address the under-reinforced sections: flexural strengthening and column confinement. CFRP was selected and had its share of surprises on the project. Sounding of the concrete revealed extensive delamination at 16 of 34 south-facing columns and at various walls throughout the parkade. Before the repair could proceed, shoring systems were installed to distribute loads to supports (Fig. 3).

Delaminated areas were saw cut and chipped to achieve a Concrete Surface Profile (CSP) 7-9² with an appropriate repair geometry. Exposed rebar was given a corrosion-inhibiting coating that had an open time of 14 days to allow the repairs to be completed in sections. Finally, due to the high density of rebars in the columns, a form and pump application was selected utilizing a highly flowable self-consolidating concrete to ensure full encapsulation without the need of vibrating the concrete (Fig 4). Areas with excess material were grinded to provide a flat, uni-
form surface for the CFRP installation. Sharp corners on the columns were also rounded using a grinder as they can act as stress concentrators for the CFRP fabric.

The CFRP application was completed in multiple lifts. Most columns had two layers of the CFRP plates to increase flexural strength, and were then wrapped with the CFRP fabric to increase the axial capacity (Fig. 5). One of the challenges of doing multiple lifts is the verification that each layer is well bonded to its subsequent layer. To address this, manufacturer representatives and engineers gave weekly site visits to sound these layers to detect voids or bubbles in either the CFRP plates or fabric.

Finally, an elastomeric waterproof paint coating was applied to conceal the fabric. Three (3) separate mock-ups were done for the selection of the paint color, and the City of Brantford decided to go with Stonehenge. In addition, wooden guardrails painted yellow were installed in locations where the CFRP would be exposed to vehicular traffic and potential damage (Fig. 6).

**Parking Deck Membrane and Expansion Joints**

The existing parking deck membrane and expansion joints were at the end of their service life and needed to be replaced. The removal process consisted of a combination of coating strippers and grinding to remove the existing membrane (Fig. 7), and the concrete was then shotblasted to achieve a prepared surface of CSP 3-4. Then, a new elastomeric deck coating was installed (Fig. 8).
Fig. 6: Columns after CFRP and elastomeric paint coating

Fig. 7: Existing parking deck membrane removal

Fig. 8: New deck membrane installed on upper level

Fig. 9: Concrete deterioration at floor slabs

Fig. 10: Expansion joint replacement

Fig. 11: New column caps and LED lighting
Concrete delamination was also discovered once the membrane was removed. These areas were chipped to sound concrete and the exposed rebars treated with a corrosion protection coating (Fig. 9). For these repairs, conventional concrete was used to save on cost.

The new expansion joints were a little higher than the previous ones, so certain measures had to be taken to address this situation. First, to increase the longevity of the repair, multiple saw-cuts were made at the perimeter of the existing expansion joints approximately ½ in (13 mm) deep, giving the repair material a thicker build and a proper slope. The saw-cuts were then chipped out using jackhammers to achieve a substrate of CSP 5-7. A high compressive strength concrete (up to 9500 psi [65 MPa]) was then placed and sloped to the new expansion joint (Fig 10).

**LED Lighting and Column Caps**

New LED lighting was implemented on the top floor of the Market Centre Parkade in efforts by the City of Brantford to save electricity. All existing single low-efficiency light fixtures were removed from the columns and replaced with LED lights installed at the center of the parkade (Fig. 11). The new design incorporated a taller lighting fixture post at 20 ft (6 m) to illuminate larger areas.

Because the old column caps were damaged and non-reusable, new ones were installed to give a uniform look. The new column caps were attached using a non-shrink grout to ensure full contact between the concrete column and the caps.

**CONCLUSION**

Over time, every structure eventually requires some form of rehabilitation and repair, and in many projects like these, the path to a successful one is not always straightforward. Attention to installation details, procedures, and project conditions are equally important as speed and schedule and are key to a long-lasting solution.

**ACKNOWLEDGEMENT**

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Specification Guidelines for Surface Preparation of Concrete Prior to Repair

by Luc Courard, Benoit Bissonnette, Andrzej Garbacz, Alexander M. Vaysburd, and Kurt F. von Fay

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To achieve a durable repaired concrete structure, the specifier of a repair project should require the use of equipment, techniques, and procedures that are appropriate for the project objectives, deterioration mechanism(s), environmental conditions, structural circumstances, and other local conditions and limitations that exist for the specific structure or part of the structure.

Success will be dependent on determining the cause and extent of concrete distress or deterioration, establishing realistic repair objectives, and developing a repair strategy to address the problem. Ultimately, the project team must achieve:

• The required condition of the substrate regarding cleanliness, roughness, cracking, tensile and compressive strength, chlorides and other aggressive agents, depth of carbonation, moisture content, and temperature;
• Compatibility of the existing concrete and reinforcement with the repair and protection materials and systems, and compatibility between different repair and protection products, including avoiding the risk of creating conditions that may cause acceleration of corrosion;
• The specified characteristics and properties of repair materials and systems and the composite repair system regarding the fulfillment of their purpose to prolong the useful service life of the structure; and
• The required repair application conditions, such as ambient temperature, humidity, wind force, precipitation, and any temporary protection.

Concrete surface preparation deals with the various operations needed to fulfill these requirements. This article summarizes the results and outcome of a research project titled “Development of Specifications and Performance Criteria for Surface Preparation Based on Issues Related to Bond Strength.” The work was sponsored by the ACI Foundation’s Concrete Research Council, Farmington Hills, MI, and the U.S. Department of the Interior’s Bureau of Reclamation (USBR), Denver, CO. The research was also supported by Laval University, Québec City, QC, Canada; the University of Liège, Liège, Belgium; and Warsaw University of Technology, Warsaw, Poland.

CONCRETE SURFACE PREPARATION

General considerations

Concrete preparation is the process by which sound, clean, and suitably roughened surfaces are produced in areas to be repaired. It includes delineating the repair boundaries by sawcutting; removal of unsound and, if necessary, sound concrete and bond-inhibiting foreign materials from the exposed concrete and reinforcement surfaces; opening the concrete pore structure; and repairing reinforcement damage, if required. Concrete must be removed if it is affected by spalling, delamination, or disintegration, or if it is in an area with severe cracking due to active corrosion of reinforcing steel.

In addition to unsound concrete with reduced mechanical integrity and/or contamination, some sound concrete must also be removed as needed to provide adequate repair geometry, to repair embedded reinforcement, and to allow structural modifications. The effectiveness of various concrete removal techniques may differ for unsound and sound concrete, and a combination of techniques may be necessary. However, the methods used to remove the deteriorated or contaminated concrete and prepare the concrete and reinforcement to receive the repair material must not weaken the surrounding sound concrete and reinforcement.

Bond strength of concrete repairs depends on several parameters. It has been shown that when substrate-induced damage is prevented or kept below a certain level, tensile bond strength increases with the substrate surface coarseness. Still, one of the most important parameters apparently remains the mechanical integrity of the substrate. In that regard, it must be stressed that impacting tools such as chipping hammers may significantly damage the surface, and this can completely outweigh the benefits of an increased roughness. When using such equipment, extra steps should be taken during removal of the weakened superficial layer.
Concrete removal

Concrete removal methods are categorized by their type of action: impacting, blasting, cutting, milling, presplitting, and abrading. “Guide to Concrete Repair (ACI 546R-14)” describes these categories, lists the respective removal techniques, and provides a summary of information on each. Among the various concrete removal methods, only breakers (chipping hammers and jackhammers) and high-pressure water jets (hydrodemolition) are addressed in the following sections because they are the main options for removing a significant depth of concrete. Most of the other methods are intended to remove the skin concrete and/or to texturize the surface.

Breakers: The most commonly used removal systems, which generally employ the repeated striking of a concrete surface with a high-energy tool to fracture and spall the concrete. Impacting devices include handheld chipping hammers and large, machinery-mounted hydraulic breakers.

The handheld breakers (Fig. 1) are available in various sizes with different levels of energy and efficiency. Small breakers (12 to 20 lb [5.5 to 9 kg]) are commonly specified for partial removal of unsound concrete or concrete around reinforcing steel because they cause little damage to surrounding concrete. Larger handheld breakers (30 to 90 lb [13 to 40 kg]) are used for complete removal of large volumes of concrete. Care should be exercised when selecting the size of breakers to minimize the damage to existing concrete and its bond to embedded reinforcing steel.

While a variety of cutting tools are used in handheld breakers, the Shank end—the end of the tool that is inserted into the tool-retaining mechanism—is common to all. The cutting or working end can vary from a broad spade-like blade to a sharp, well-honed point. Most concrete removal work is done with a pointed tool, although a relatively narrow (3 to 4 in. [75 to 100 mm]) blade-type tool is sometimes used to remove cracked and deteriorated concrete.

The effects of the breaker operation must be monitored to ensure minimal disruption of the surrounding environment by noise, dust, and flying debris. Also, breakers should be operated at less than 45 degrees from the vertical. Removal near the repair boundaries must be completed with spade bits, as gouge bits can damage sound concrete.

High-pressure water jets: This type of system (Fig. 2) employs a small jet of water driven at high velocities, commonly producing pressures of 10,000 to 45,000 psi (69 to 310 MPa). Water jetting may be used as a primary technique for removal of concrete when it is desired to preserve and clean the steel reinforcement for reuse and to minimize damage to the concrete remaining in place (Fig. 3). Water jetting literally disintegrates concrete to sand and gravel-sized pieces, working preferentially on unsound or deteriorated concrete and leaving a rough profile. However, care must be taken not to punch through thin slabs or decks. Further, water jetting should not be allowed if there is a possibility that unbonded post-tensioned systems are within the removal zone (the only viable method of concrete removal in such a situation is using lightweight chipping hammers).

Two trial areas, one of sound concrete and one of deteriorated concrete, should be used to determine the appropriate water-jetting speed, pressure, and number of overlapping passes. Once properly calibrated, these operating parameters should not be changed unless the concrete changes (for example, if it is found that a harder aggregate has been used in one portion of the structure).

As with sawing operations, the debris and slurry that result from the water-jetting operation must be removed using a low-pressure water stream before the slurry dries and hardens at the surface of the cavity.
not fail prematurely. The first step is removing deteriorated or chloride-contaminated concrete surrounding the reinforcement. Sufficient care should be exercised to avoid further damage to the steel. Workers have to be aware of the location of reinforcement, they should use light (13 to 15 lb) chipping hammers to remove the concrete in the vicinity of the reinforcement, and they should take the necessary precaution to avoid vibrating the reinforcement or otherwise causing damage to the bond of reinforcement to concrete adjacent to the repair area.

All unsound concrete should be removed. If reinforcing steel is exposed, then enough concrete must be removed to provide a minimum clear space between the bar and the surrounding concrete of 3/4 or 1/4 in. (19 or 6 mm) larger than the maximum size aggregate in the repair material, whichever is greater.

Additional concrete removal must be carried out along corroded exposed bars until a continuous length of at least 2 in (50 mm) of bar free from corrosion is exposed. An additional length of uncorroded reinforcing bar must be exposed if couplers or lap splices are to be used for replacement or supplemental reinforcement. Again, the concrete removal area should have neat vertical faces at the perimeter, and the extent of concrete removal must be agreed upon by the licensed design professional.

Final step in the concrete removal operation
The dynamic loads imposed by removal operations can result in subsurface cracking within the substrate. This damage, typically on the order of 1/8 in. (3 mm) deep, is generally referred to as bruising (Fig. 4). Extensive bruising may result in very low bond strength, with the failure plane running entirely through the substrate. This can be evaluated by conducting pulloff tests on the prepared substrate, as described subsequently.11 Bruising can be further identified conclusively and quantified through a petrographic examination of concrete cores.12 Bruising can be minimized by exercising care in the removal process and, where possible, by avoiding the use of more detrimental techniques such as scabblers, bush hammers, or large pneumatic hammers (especially hammers equipped with wide chisel tools). Where these tools must be used to increase production and/or reduce costs, the damage can be mitigated by carrying out a final step with a less aggressive method to remove a layer of concrete about 0.10 to 0.20 in (2 to 5 mm) in depth. This is typically performed with one of the following abrading techniques:

- **Sandblasting**—the most commonly used method for both concrete and reinforcing steel surface preparation, in which common sand, silica sand, metallic sand, or slag (also known as Black Beauty10) are propelled at high velocity against the surface to be abraded;

- **Shotblasting**—in which metal shot is propelled at a high velocity. In this method, the rebounding shot and pulverized concrete are vacuumed into the shotblasting

The advantages of water jetting include:
- Fewer workers are required than with other procedures;
- Only weak concrete is removed when water jetting is performed by an experienced operator using appropriate operating parameters;
- It produces well-controlled but rough and irregular cavity surfaces that enhance bonding; and
- It eliminates manual hauling of rubble from the repair area.

The disadvantages of water jetting include:
- The finished surfaces are saturated, so repair placement may have to be delayed until the area dries unless the repair material is not moisture-sensitive;
- The fine slurry laitance remaining after the procedure requires careful attention during cleaning;
- A protective shield must be built around the repair area if the patch is next to occupied areas;
- Controlling the depth of removal can be difficult;
- Equipment rental is expensive;
- It can be difficult to obtain a good production rate—performance of water-jetting equipment may be variable; and
- The wastewater and debris must be handled in an environmentally acceptable manner, as prescribed by local regulations.

**Treatment of exposed reinforcing steel**
The most common cause of concrete deterioration is the corrosion of embedded reinforcing steel. Adequate evaluation and treatment will ensure that the repair will

![Fig. 4: Average total length and average number of cracks for different surface preparation techniques on a 0.32 m² concrete surface (Ref is without preparation; P is polishing (grinding); SB is sandblasting; SC is scarification; WJ is high-pressure water jetting; J07 is jackhammering 7 kg (15 lb) + sandblasting; J14 is jackhammering 14 kg (31 lb) + sandblasting; J21 is jackhammering 21 kg (46 lb) + sandblasting)7](image)
machine, which separates the shot from the concrete so the shot can be reused; and

- **Waterblasting**—suitable for vertical and horizontal surface preparation, this technique is similar to high-pressure water jetting, except that smaller, typically handheld equipment is used to spray water at pressures between 5000 and 15,000 psi (35 to 105 MPa). For increased efficiency, abrasive particles such as aluminum oxide or garnet can be introduced into the stream.

**Conditioning of the surface**

**Cleanliness:** The presence of oil, grease, dust, or laitance prevents intimate, continuous contact between the materials to be bonded, thus compromising the development of bonding forces in repairs. Concrete removal techniques usually yield surfaces with adequate levels of cleanliness. If grease or oil is still present, however, it may be necessary to use (suitable) chemical cleaning agents.

**Carbonation:** A long delay between surface preparation and the repair material placement may allow the freshly exposed substrate surface to carbonate. The carbonation depth will be a function of the extent of the delay, the concrete porosity, and the amount of ambient CO₂. Until recently, there was very little information on how carbonation will affect bond development of the repair system. Although carbonation products partially fill pores, we have recently completed tests showing that carbonation has little impact on the bond strength of a cement-based material placed on a sound, properly prepared concrete substrate surface. However, we also observed that the detrimental effects of bruising upon repair bond can be worsened if carbonation is allowed to occur prior to repair. Therefore, in unusual situations where a prepared concrete surface has been exposed for extended periods of times, the superficial layer should be removed using one of the aforementioned abrading-type surface preparation techniques.

**Moisture content:** We have observed that in many specifications, the required moisture condition of the substrate is generally ill-defined or is addressed without any due consideration to the given substrate characteristics. However, the substrate surface moisture content has a significant influence on the bond between existing concrete and repair material. The standard specification, if any, is to specify the saturated surface dry (SSD) condition of the substrate prior to application of cementitious repair materials. This widespread approach derives from the following rationale: on the one hand, superficial porosity of the concrete substrate to be repaired should allow some penetration of the repair material to promote a strong mechanical bond and, on the other hand, it should not absorb too much of its water, as it may alter the hydration process.

SSD means that the porosity immediately under the surface is saturated, with no film of liquid water standing on the surface. This condition is typically achieved in practice by soaking the substrate for a while and then allowing the surface to dry out prior to repair material placement, long enough to eliminate water accumulations in the lower points. This does provide an intuitive solution to avoid problems but has never been rigorously defined, measured, or tested. After all, there is no qualitative or quantitative physical meaning of the SSD condition, and there is no strict definition for the degree of saturation, the depth of saturation, or how it is measured.

Nevertheless, there is experimental evidence that SSD is not the optimum moisture condition for bond development in all situations. For example, the influence of the substrate moisture content upon bond strength is illustrated for a polymer-modified repair mortar in Fig. 5.

Overall, for the repair systems considered in the test program, the optimum saturation levels for repair bond strength would lie somewhere between 55 and 90 percent. It seems that unsaturated pores below the surface can be beneficial. This observation is consistent with the results yielded in one of the very few in-depth experimental studies reported on the subject. The nonuniversal character of the optimum moisture condition of concrete prior to repair has been highlighted in a recent study by the USBR. For the conditions and materials investigated, it was found that for normal- and higher-strength (about 5000 psi [35 MPa] and higher) concrete elements repaired with portland cement-based materials, prewetting of the substrate is not necessary for optimum bond strength. Conversely, for the repair of lower-strength concrete elements, higher bond strength was obtained with the so-called SSD condition achieved after water ponding for 6 hours.

In any case, it is fundamental to avoid the presence of standing liquid water on the surface.

![Fig. 5: Relationship between mortar bond strength and the concrete substrate saturation level of a polymer-modified repair mortar cast over concrete substrates at various saturation levels, with dry or wet consistency polymer-modified slurry](image-url)
Bonding agents: The primary reason for using a bonding agent prior to the placement of a repair material is to enhance the contact between the latter and the existing substrate profile. In some projects, the quality of the concrete surface preparation for repair has been neglected, based upon the false assumption that a poor surface quality can be compensated for by using a bonding agent. In other cases, bonding agents are being specified and used as a “belt-and-suspenders” measure.

With the technology available today, cement-based repair materials having the rheological characteristics to properly wet the existing concrete substrate can easily be designed, eliminating the need of a bonding agent. Furthermore, a bonding agent may act as a bond breaker when used inappropriately.

Hence, bonding agents are generally not recommended for repairs and overlays employing cement-based materials, except when it is recommended by the manufacturer of a proprietary material. In any case, standing water must be removed prior to the bonding agent application. Moreover, application of a bonding agent requires a meticulous management of time—it is indeed necessary to apply the repair product on the bonding agent “fresco” to avoid the creation of a second interface.

QUALITY CONTROL
Evaluation of roughness
Many techniques have been developed for accurately describing surface roughness at various scales. For instance, mechanical and laser lab profilometers allow microroughness (high-frequency waves) characterization, while the interferometric (optical) method is useful for describing the shape of the surface profile. Nevertheless, investigations made using precise laser and mechanical profilometers have clearly indicated that the surface treatment technique does not have much influence on microroughness. This indicates that only the waviness parameters need to be determined for assessing surface roughness prior to repair.

Because surface preparation essentially influences waviness, the optical method based on the Moiré pattern interferometry, which offers significant advantages in terms of production rate and surface area treatment capability, could be used alone to perform surface roughness characterization. While the method directly yields reliable quantitative data, the equipment available today is not adapted to daily field applications. Nevertheless, with the rapid technological development in that field, suitable optical devices, likely automated, may soon be available.

This would allow even more rapid and objective assessment. Among the methods available today, the most suitable method for field assessment appears to be the Concrete Surface Profile (CSP) developed by ICRI. The CSP system is easy to use and rapidly yields reliable information, regardless of the surface orientation. Its use was originally limited to surface profiles with a maximum height (vertical distance between the lowest and the highest point of the profile) of 6 mm, consistent with the type of applications for which it was actually designed—that is, surface treatments such as sealers, coatings, and thin overlays (Fig. 6[a]). With the addition of a tenth plate (no. 10), the CSP characterization range now extends to the medium range of roughness for surface repairs. However, rougher profiles such as those obtained with rotomilling, high-pressure water jetting, or use of a heavy breaker are not yet characterized. It can be seen in Fig. 6(b) that above a detection threshold of the optical device of about 0.15 mm, the profile meso-waviness half-amplitude \( A_{mw} \) determined by interferometry increases linearly with an increase in the CSP number.

On-site assessment of the profile can be achieved with the use of the replica putty test method, in accordance with ASTM D7682. After being applied against the prepared substrate and cured, the testing putty is removed, providing a negative image of the surface profile, which may be examined (Method A) and/or measured (Method B). The peaks and valleys of the surface can be measured using a customized thickness gauge and the data analyzed to determine the surface profile characteristics.

The sand patch test method (ASTM E965) is another rapid method that can be used in the field. The average surface texture (macrotexture depth) is determined by measuring the area covered by a known volume of sand or other fine grain material spread uniformly over the surface to be assessed. The most significant limitations include a bounded range of validity (heights of 0.25 to 5 mm can be characterized, so high-amplitude surface profiles are excluded) and conditions of use (horizontal surfaces only, dry, no wind). Nevertheless, within the range of use, the data it yields show good
correlation with surface profile characterization parameters such as average $A_{max}$.\textsuperscript{15}

**Evaluation of mechanical strength of the concrete substrate**

There are numerous examples of repair and overlay projects where the specified bond strength is greater than that of the concrete substrate. Clearly, it is pointless to expect the bond value to be greater than (or even equal to) the tensile strength of the substrate concrete. Many specified testing criteria for bond strength of completed overlays and surface repairs are based on documented recommendations from organizations such as ACI, ICRI, and RILEM and are seldom based on considerations related to the strength of the given concrete to be repaired. In cases when such criteria are not being met based on the tensile pulloff test results of the completed repair or overlay, it is very difficult to establish what went wrong—surface preparation, repair material quality, workmanship, environmental conditions, or a combination of some of these.

The benchmarks for the bond criteria are also often taken from the repair materials data sheets and relate to laboratory tests. The expectations to meet these benchmarks at the jobsite, often under difficult working conditions, can be unrealistic. Therefore, sound engineering judgment is necessary. The specifications for a repair project must not be blindly copied from other specifications or a material manufacturer’s data sheet because this may result in situations where it is not physically possible to achieve compliance with the specified criteria. Thus, more consideration needs to be given to the requirements of the project in defining the specifications. To allow the specifier to establish realistic bond strength requirements and test criteria, the condition evaluation should include tensile strength testing of existing concrete.

To provide assurance that the surface preparation procedures have been performed as specified, the tensile pulloff tests should be performed on the prepared surface prior to repair application.\textsuperscript{1,8} The pulloff test should be done in accordance with the applicable provisions of ICRI Guideline No. 210.3R-2013.\textsuperscript{19}

In cases where the tensile strength of the prepared substrate significantly deviates from the tensile strength of the existing concrete documented in the condition evaluation report, the data should be analyzed by the licensed design professional. Additional surface treatments may be necessary.

**Evaluation of reinforcing steel**

Exposed reinforcement should be examined carefully to make sure it is free of loose concrete, rust, oil, and other contaminants. Where reinforcing steel bars show signs of deterioration due to corrosion or mechanical causes, the percentage of section loss can be assessed in accordance with the method described in ACI 364.14T-17.\textsuperscript{20}

**Evaluation of concrete surface cleanliness**

Prior to repair, it is essential to make sure that the concrete surface is free of contaminants, dust, laitance, fragments of concrete, or a bruised concrete layer. In the wake of the newly developed ICRI Concrete Surface Repair Technician (CSRT) certification program, a TechNote is being developed by ACI Committee 364, Rehabilitation, to provide guidance on how to carry out a cleanliness evaluation adequately as part of a rigorous quality control program for repair works.

**Evaluation of moisture**

In-place evaluation of the moisture content of concrete remains a challenge. ICRI has recently developed a Concrete Slab Moisture Program for training and certification of personnel involved in the evaluation of the moisture condition in concrete slabs prior to flooring. The program covers five ASTM International test methods, among which ASTM F2170\textsuperscript{21} and F2659\textsuperscript{22} cover in-place evaluation of concrete substrates prior to repair.\textsuperscript{23,24}

With the availability today of simple, affordable embedded relative humidity probes, ASTM F2170 can be used to reliably monitor relative humidity within the concrete cover (depths of 1 to 2 in). It is not suited, however, to make rapid measurements on multiple areas of an element to be evaluated.

Used in accordance with ASTM F2659, electrical impedance devices can be implemented to determine when the concrete substrate surface has dried out sufficiently for concrete placement after prewetting. Obviously, such meters have precision limitations and require some calibration, but they are well suited for field testing, allowing the performance of multiple measurements in a short period of time without much effort.

**Evaluation of bond**

The pulloff test is a convenient method for evaluating both the mechanical integrity of the concrete surface prior to repair and the repair tensile bond strength.\textsuperscript{2,25-28} A reliable evaluation of these characteristics can be obtained, provided that a minimum number of tests are performed with adequate equipment. The potential bias due to testing misalignment, below average naked-eye detection capability, was assessed to reach up to approximately 15 percent.\textsuperscript{29} However, this bias can only affect the pulloff strength evaluation on the conservative side.

ICRI Guideline No. 210.3R-2013\textsuperscript{19} arguably provides the most comprehensive technical guidance with regard to the specification and evaluation of bond for concrete surface materials. The document makes no recommendation for a universal acceptance value. Depending on the project, required bond strength values will typically range from 100 to 250 psi (0.7 to 1.7 MPa) and should not exceed the existing concrete tensile strength. Whenever possible, the implementation of field trials is desirable. According to the ICRI Guideline,\textsuperscript{19} for all modes of failure, acceptance of pulloff test results should be based upon the following criteria:

- Where field trials (mockups) are carried out:
  - Average pulloff strength of the specimens is above the
required pulloff strength (90 percent of average field trial test
  - No specimen test result is below 75 percent of the average trial specimen test value.
• Where field trials (mockups) are not carried out:
  - Average pulloff strength of the specimens is above the required pulloff strength; and
  - No specimen tests below 75 percent of the required strength.

With a provision allowing single test values reaching 75% of the specified strength, the quality assurance procedure implicitly takes care of the variability of the test associated with misalignment, which was found in the research work carried out by some of the authors to reduce the recorded bond strength by up to 15% within a reasonable visual detection limit (±4 degrees).

It is important to keep in mind that bond strength between a repair or overlay material and a concrete substrate is in fact a subtle property or, more accurately, characteristic to specify. Ultimately, the key requirement for a successful repair is adequate bond between the repair and existing substrate, which will keep its integrity throughout its service life. At the present time, practical answers to the problems of bond may depend on short-term bond testing rather than on long-term performance. Bond strength achieved initially is only an indication of performance with the specified parameters. There is no well-defined relationship between initial bond strength and the lasting interfacial bond in a repair system. Longevity of the bond is influenced by many factors, including substrate surface preparation and texture, relative volume changes of the repair material, mass transport, service conditions, and quality and condition of the underlying concrete. To maximize bond quality and durability, proper consideration must be given to all repair compatibility requirements applicable in each situation.2,30,31

CONCLUSIONS

The recommendations issued herein generally ensure satisfactory results provided adequate quality control is implemented. It must be emphasized that results of the research project discussed in the article, as well as other reported work on the subject, are primarily dealing with “short-term” bond strength considerations, not with the mechanisms and issues related to long-term bond behavior and durability. The short-term bond strength typically specified and evaluated can be used as an indication of the quality of materials and workmanship (that is, concrete surface preparation for repair, material selection, application, and curing). Long-term bond strength, however, is usually influenced by various other factors, among them environmental, loading, and fatigue conditions. Therefore, it is desirable to pursue research efforts on those factors affecting long-term bond strength in concrete repair and overlay systems, notably the surface preparation parameters and characteristics. Ultimately, everything comes down to the overall compatibility between the repair system and the existing concrete with respect to deformations, permeability, chemical reactivity, and electrochemical behavior.

Development of comprehensive guidelines addressing compatibility issues—with special emphasis on the factors related to dimensional compatibility—is needed for repair and rehabilitation to evolve as an engineering discipline.2,30,31

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REFERENCES


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CHAPTER NEWS

CHAPTER CALENDAR

Due to the ongoing pandemic and the variety of shelter-in-place and stay-at-home orders, plus the mandated closing of almost all possible venues, the majority of ICRI Chapters have had to cancel or postpone events. You can check with individual chapters by visiting their chapter pages to determine if there are any exceptions, as this is a fluid situation that may have changed after this publication went to print.

Baltimore-Washington
October 1, 2020
CHAPTER GOLF OUTING
Timbers at Troy
Elkridge, MD

Central Ohio
October 8, 2020
CHAPTER CLAY SHOOT
Eagles Nest Sporting Grounds
Mount Gilead, OH

Chicago
September 3, 2020
CHAPTER GOLF OUTING
White Pines Golf Club
Bensenville, IL

Georgia
July 16, 2020
SUMMER SOCIAL
Bad Axe – Axe Throwing
Atlanta, GA

August 27, 2020
CHAPTER LUNCHEON
Maggiano’s Perimeter
Atlanta, GA

Minnesota
July 21, 2020
CHAPTER FUNDRAISING GOLF TOURNAMENT
Bunker Hills Golf Course
Coon Rapids, MN

New England
August 10, 2020
CHAPTER GOLF CLASSIC
Ipswich Country Club
Ipswich, MA

North Texas
September 10, 2020
MEMBERSHIP MEETING
Las Colinas Corporate Center
Irving, TX

October 2, 2020
JESSE POINTS MEMORIAL GOLF CLASSIC
Waterchase Golf Club
Fort Worth, TX

Rocky Mountain
August 17, 2020
ANNUAL GOLF TOURNAMENT
The Club at Pradera
Parker, CO

CHAPTER NEWS DEADLINES

NOVEMBER/DECEMBER 2020
Deadline: September 10, 2020

JANUARY/FEBRUARY 2021
Deadline: November 10, 2020

Send your Chapter News by the deadlines to Director of Chapter Relations Dale Regnier at daler@icri.org.

CHAPTER ACTIVITIES

North Texas Hosts Web Meeting
Although the COVID-19 pandemic prevented the North Texas Chapter from meeting in person, the chapter held a web-based membership meeting May 7, 2020. While the chapter missed out on the opportunity to share a delicious Tex-Mex or barbecue meal together like usual, we were glad that over 60 attendees were able to join us for the web meeting. During the meeting, Steve Bradway, Vice President, Aquafin, Inc., provided a very informative presentation titled “What lurks under your floors?” The presentation discussed flooring system failures due to excess moisture. Information for design professionals was presented to aid in selecting methods and products for moisture mitigation. Standard test methods for evaluating moisture in concrete were also discussed. The North Texas Chapter is very grateful for Mr. Bradway’s time and effort, and looks forward to getting together again as soon as we can!

Pittsburgh Hosts Façade Presentation
The ICRI Pittsburgh Chapter hosted a well-attended lunch meeting March 10, 2020 at the Hofbrauhaus Pittsburgh. In addition to networking with fellow repair industry colleagues, attendees were given an informative presentation on building façade inspection and restoration. Speakers David Green with the City of Pittsburgh’s Department of Permits, Licenses & Inspections, and Phil Elgin with Wiss Janney Elstner, Inc., discussed façade inspection from a building code and evaluation perspective. Kelly Morris with Prosoco Restoration Anchors Division then discussed retrofit anchor solutions available for the restoration of masonry and stone façades.

Members and guests gather for a building façade presentation
CHAPTER ACTIVITIES

NORTH TEXAS HOSTS 6TH ANNUAL SPORTING CLAY CLASSIC

North Texas Chapter President Clay Broyles welcomed participants to the chapter’s 6th Annual Sporting Clay Classic on Friday, June 12. Under sunny skies, with temperatures in the 80s, and with an obvious pent-up demand for networking, seventeen teams descended on the Dallas Gun Club to compete for top team and top shooter bragging rights. This was the first event held at Dallas Gun Club since the start of the COVID-19 pandemic, and precautions were in place to keep everyone safe and socially distanced. When the totals were tallied, the Master Construction & Engineering team took home top honors with a combined score of 351, followed by the Master Builders Solutions team led by Patrick Jorski scoring 344. The team from All-Tex Supply garnered the third place prize with a score of 330.

The “Top Gun” award went to Jeff Lungrin from the Master Builders Solutions team who scored a 93. A scorecard playoff had to be conducted among four individuals who scored 91. Second place went to Past Chapter President RW Smith from the Master Construction & Engineering team, followed by Glen Turner from the All-Tex Supply team.

Proceeds from the event help to fund the North Texas Chapter’s $8,000 scholarship fund, which annually contributes to the scholarship fund for University of Texas at Arlington’s Civil Engineering Department and provides individual assistance to deserving students.

“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
ICRI CHAPTER NEWS

CHAPTERS COMMITTEE CHAIR’S LETTER

The new normal, summer edition! There are so many changes going on in our world right now, and it can be very stressful. I hope that at the end of this pandemic and world crisis we will all be more respectful and tolerant of each other. The division in this country and around the world is unsettling and unnerving. In remembering the astute words of Lee Iacocca, "In times of great stress or adversity, it’s always best to keep busy, to plow your anger and your energy into something positive." So, with that said, let us direct our anger and energy to positive endeavors. We can bring about great change in this world if we put our minds to it. So, let’s get to work!

Have you had a chance to see the 2020 ICRI Spring Convention Presentations? ICRI has new technical content online because of the cancellation of the 2020 ICRI Spring Convention. There are 14 recorded presentations from the presenters of the canceled Vancouver convention that you can now view on-demand.

These world-class presentations are offered at no cost to ICRI members for 90 days, and at a low cost to our non-member colleagues. So, take advantage of this incredible resource that ICRI put together for you. The recordings are available on the ICRI.org website through the ICRI Learning Center.

I hope that in September we will have the ICRI Fall Roundtable in Philly. The Baltimore Washington, Delaware Valley, Metro New York, Connecticut, Greater Cincinnati, Northern Ohio, Pittsburgh, New England, Quebec, and Toronto chapters will all be invited to attend. Some of the best ideas come out of the ICRI Roundtable meetings, and I am looking forward to having one this fall. Dale and I learn something new every time!

Hopefully, you have already submitted your entry for the ICRI Project Awards. The deadline for the award submissions was extended, so there should be no excuse for not submitting your project. It is gratifying to be rewarded for all the hard work that we do in this industry. Make sure you get rewarded for your hard work!

The ICRI Fall Convention is scheduled for October 5-7, 2020 in Minneapolis, Minnesota this year. We will be making decisions about the convention in the next few weeks, and we will inform everyone as to what those decisions are. I know we all want to get together and see each other, and my hope is we can do it and stay safe at the same time.

When the announcement to sign up for the next convention comes out, remember to sign up your delegates. It brings new attendees into this great industry and it also helps you get points for the ICRI Chapter Awards. Mark your calendar and make plans to attend now, so you can find out who wins the prestigious "ICRI Project of the Year Award!"

Please remember to double-check and make sure an event is still scheduled due to the changing times in our country and around the world right now. Also, remember to turn in your chapter events so they can be listed on the ICRI website. At ICRI, it is more important now than ever, that we support each other. So, if you are still on the road traveling to an area, seek out the local chapter to find out if they are having a meeting while you are in town.

Please stay tuned for further developments from ICRI National to be in the know on the latest happenings. Remember to be safe and kind, and God willing, I will see everyone in Philly for the ICRI Fall Roundtable!

Sincerely,
Michelle Nobel
Chapters Committee Chair

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ICRI has 39 chapters, including two student chapters, in metropolitan areas around the world. Chapters hold technical presentations, 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.
PDA MOVES OCTOBER CONFERENCE ONLINE
The PDA Board of Directors recently voted to move forward with an online conference as opposed to an in-person conference for October 2020. During the Board teleconference, members discussed the current variables of the COVID-19 pandemic as well as feedback from surveys sent to previous conference attendees and current members.

PDA is excited to announce its first-ever virtual conference, beginning October 26, 2020. This first-ever virtual conference is an online learning experience that provides an important professional education opportunity to individuals in the polyurea and coatings industries. This virtual event will consist of approximately 20 total educational sessions throughout the week (four 30-minute sessions each day), including evening happy hours and virtual networking time. The five-day event will be held completely online via Zoom so participants can conveniently participate from anywhere they have access to a computer and the internet or a phone.

PDA and the Board of Directors are currently working on the schedule, and are working with speakers who were chosen because of their reputation and expertise in specific topics, and are also individuals who will make this online format as empowering, informative engaging and enlightening as the in-person conference.

The Association is requesting sponsorships for various virtual events to help alleviate attendee costs. Registration for attendees, exhibitors and sponsor opened the week of June 22. Visit https://www.pda-online.org/attendeeinfo for more information.

THE ACI CONCRETE CONVENTION, RALEIGH, NC, USA
Engineers, students, contractors, educators, manufacturers, and material representatives from around the world attend the ACI Concrete Convention. This year’s convention will be held at the Raleigh Convention Center, Raleigh Marriott, and Raleigh Sheraton, Raleigh, NC, USA, October 25-29, 2020, where attendees will collaborate on concrete codes, specifications, and practices. Technical and educational sessions will provide attendees with the latest research, case studies, best practices, and the opportunity to earn Professional Development Hours (PDHs).

ACI is proceeding with all committee meetings, sessions, student activities, special events, and exhibit hall programs. The sixth annual ACI Excellence in Concrete Construction Awards Gala presented by Advancing Organizational Excellence (AOE) will be held on the evening of October 26. ACI is also investigating new virtual participation options in addition to the face-to-face activities, and plans to announce details in the coming months. ACI continues to monitor the COVID-19 situation and will respond as more information becomes available.

The ACI Concrete Convention is an opportunity to showcase companies, projects, current events, and landmarks, and offers numerous networking events where you can expect to meet with many of the industry’s top engineers, architects, contractors, educators, manufacturers, and material representatives from around the world.

To learn more about the ACI Convention and to register please visit aciconvention.org.

SCA ANNOUNCES SLAG CEMENT WEBINAR SERIES
The Slag Cement Association (SCA) is pleased to announce its slag cement webinar series featuring four webinars presented by industry experts. These free webinars are a great opportunity to learn about the different inherent benefits of slag cement when used in concrete construction. The webinars started at the end of June.

The slag cement series will include:

Demonstrating Resilient Concrete Results with Slag Cement, presented by Shawn Kelyn, St. Marys Cement, June 18, 1-2PM EST;

The Role of Slag Cement in Creating Sulfate Resistant Concrete, presented by Ryan Betz, Argus USA, July 9, 1-2PM EST;

Ground Granulated Blast Furnace Slags: Rapid Reactivity Testing and Effects of Varying Replacement Levels on Cement Paste Properties, presented by Sivakumar Ramanathan, University of Miami, July 23, 1-2PM EST; and

Mitigating Alkali Silica Reaction in Concrete with Slag Cement, presented by Keith Maddrey and Clayton McCabe, Argus USA, Aug. 18, 1-2PM EST.

The SCA encourages participants to preregister for each webinar at https://www.slagcement.org/resources/news/article/257/webinar-series-slag-cement-in-concrete.aspx. For those who can’t attend the live webinars, the recordings will be archived on the SCA website to view on demand at www.slagcement.org/videos.

CSDA ELECTS 2020 OFFICERS & BOARD OF DIRECTORS
The Concrete Sawing & Drilling Association (CSDA) is pleased to announce new Officers and Board members, who were elected in April. The election took place via email and mail-in ballots and results were announced at the April 1, 2020 Board Meeting which took place through Zoom, as the association’s planned 48th Annual Convention was cancelled due to COVID-19.

Six Board members, whose terms expire in 2022, were elected. They are Bill Fisher, National Research Company, Chesterfield, Michigan; Donna Harris, Concrete Renovation, San Antonio, Texas; Jeff Keeling, Brokk Inc., Monroe, Washington; Ryan McBride, Polished Concrete Consultants, Woodstock, Georgia; David Perkins, Hilti, Inc., Plano, Texas and Kevin Warnecke, ICS, Blount Inc., Portland, Oregon.

Returning for the second year of their term as Officers are President Matthew Finnigan, National Concrete Cutting, Milton, Washington; Vice President Mike Orzechowski, DITEQ Corp., Lenexa, Kansas and Kellie Kimball, Holes Incorporated, Houston, Texas who will serve as Secretary/Treasurer. Jack Sondgard, Central Concrete Cutting, Edgar, Wisconsin serves as Past President and Erin O’Brien is the new Executive Director, having been appointed on January 1, 2020.

Returning for the second year of their term on the Board are Ty Conner, Austin Enterprise, Bakersfield, California; Dan Dennison, Diamond Tools Technology, Indianapolis, Indiana; Mark DeSchepper, Echo GPR Services, Paola, Kansas; Bruce Ferrell, PROSOCO, Lawrence, Kansas; Jami Harmon, GSSI, Nashua, New Hamp-
ASSOCIATION NEWS

shire and Greg Lipscomb, Diamond Products, Elyria, Ohio.

For more information visit csda.org.

2020-2021 ACI FOUNDATION FELLOWSHIP AND SCHOLARSHIP RECIPIENTS ANNOUNCED

The ACI Foundation is pleased to announce its 2020-2021 fellowship and scholarship recipients. The ACI Foundation is a non-profit subsidiary of ACI that promotes progress, innovation, and collaboration in the concrete industry through strategic investments in research, scholarship, and ideas.

All Fellowship recipients receive a $10,000 - $15,000 US educational stipend; paid travel expenses and attendance fees to two ACI conventions; and assistance in finding an industry mentor. All Scholarship recipients receive a $5,000 educational stipend.

The ACI Foundation strongly supports students joining the field of concrete—future designers, engineers, construction managers, and contractors—and has provided financial support, and mentorship and internship opportunities in the concrete industry to 175 students in the last decade.

2020-2021 Fellowship Recipients:

ACI Foundation Concrete Materials Fellowship: Madeleine Murphree, University of Florida

ACI Middle East Fellowship: Siham Al Shanti, United Arab Emirates University

ACI Presidents’ Fellowship: Laura Hernandez-Bassal, University of California, Davis

Baker Student Fellowship: Maya Cottongim, Northwestern University

Barbara S. and W. Calvin McCall Carolinas Fellowship: Jessica Thangjitham, North Carolina State University

Charles Pankow Foundation Student Fellowship: Andrew Witte, Valparaiso University

Daniel W. Falconer Memorial Fellowship: Zachary Coleman, Auburn University

Darrell F. Elliott Louisiana Fellowship: Matthew Upshaw, Louisiana State University

Don Marks Memorial Fellowship: David Orense, University of Florida

Elmer Baker Fellowship: Samuel Carper, University of Cincinnati

Richard D. Stehly Memorial Fellowship: Peyton Bailey, University of Louisiana Lafayette

Tribute to the Founders Fellowship: Nicholas Slavin, California Polytechnic State University, San Luis Obispo

Bertold E. Weinberg Scholarship: Erin McArtor, Oklahoma State University

Katharine & Bryant Mather Scholarship: Daniel Ibarra Davila, Instituto Tecnologico y de Estudios Superiores De Monterrey (ITESM)—Mexico

Richard D. Stehly Memorial Scholarship: Benjamin Steger, University of Missouri—Columbia

Schwing America Scholarship: Daniel Peabody, Middle Tennessee State University

Submit your 2020 Outstanding Shotcrete Project to ASA

Prepare your 2020 Award entries now!

DEADLINE: OCTOBER 1, 2020

Brag about your Outstanding Shotcrete Project on the application and you may be able to brag about your Project as one of this year’s Award Winners!

www.shotcrete.org/ASAOustandingProjects
ACI Foundation Fellowship and Scholarship awards are made possible through generous contributions by donors from the concrete community. Together, the Foundation and its supporters are strengthening the concrete industry by encouraging students to pursue a professional career in the field of concrete. The ACI Foundation is leading the way to ensure a sustainable, successful future of the concrete industry by intentional and focused investments in people, research and technology. More information about each fellowship and scholarship is available at acifoundation.org.

ACI FOUNDATION FUNDS RESEARCH PROJECTS

The ACI Foundation’s Concrete Research Council (CRC) selected eight research projects to receive grants this year. The ACI Foundation is committed to progress in the industry by contributing financially to necessary and worthy research.

The following research projects will receive funding from the ACI Foundation:

- Calibration of Simplified Creep and Shrinkage Models Developed Using Solidification Theory: principal investigator Brock Hedegaard, University of Minnesota Duluth; co-principal investigator Mija Hubler, University of Colorado, Boulder. Endorsed by ACI Technical Committee: 209Creep & Shrinkage.

- Validation of Service Life Prediction for a 28-Year-Old Parking Garage Constructed of Low Permeability Concrete: principal investigator Amanda Bordelon, Utah Valley University; co-principal investigator W. Spencer Guthrie, Brigham Young University. Endorsed by ACI Technical Committee: 234 Silica Fume in Concrete; 365Service Life Prediction.

- Determination of the Curing Efficiency of Externally and Internally Cured Concrete Using Neutron Radiography: principal investigator Mehdil Kanzadeh Moradillo, Temple University; co-principal investigator W. Jason Weiss, Oregon State University. Endorsed by ACI Technical Committee: 213 Lightweight Aggregate & Concrete; 308 Curing Concrete.


- Reliability Evaluation of ACI 318 Strength Reduction Factor for One-Way Shear: principal investigator Robert Barnes, Auburn University; co-principal investigator Andrzej Nowak, Auburn University. Endorsed by ACI Technical Committee: 318ESection and Member Strength.

- Durability of Anchorage Pour-backs: Evaluating the Link between Surface Preparation and Bond: principal investigator Natassia Brenkus, The Ohio State University. Endorsed by ACI Technical Committee: 301-ISpecifications for Post-Tensioned Concrete.

CRC seeks concrete research projects that further the knowledge and sustainability of concrete materials, construction, and structures in coordination with ACI Committees where possible. CRC recommended these eight projects for funding, based on impact to industry, ACI Committee engagement, and collaboration with other funders and organizations.

Additional information about each of this year’s awarded projects—including additional funding partners, research team, ACI committee involvement, project details, and more—is available at ACIFoundation.org.
2019 Slag Cement Research Award Winners include:

Bio-friendly Slag Cement Benefit to the Drainage Systems
Arash Rahmatian, University of Houston

Ground Granulated Blast Furnace Slag: Rapid Reactivity Testing and Effects of Varying Replacement Levels on Cement Paste Properties
Sivakumar Ramanathan, University of Miami

ACI FOUNDATION ANNOUNCES 2020 AWARD RECIPIENTS

Frank J. Vecchio (University of Toronto) received the Arthur J. Boase Award for outstanding contributions made in the field of structural concrete and in recognition of work leading to the advancement of concrete modeling procedures and their application within nonlinear analysis software.

John W. Wallace (University of California Los Angeles) received the Arthur J. Boase Award for outstanding contributions to earthquake-resistant design of tall reinforced concrete buildings that utilize shear walls as the primary lateral force resisting elements, and commitment to educating young structural engineers.

Kamal H. Khayat (Missouri University of Science & Technology) received the Robert E. Philleo Award for outstanding contributions to research, teaching, innovation, and leadership targeting the advancement of high-performance concrete with adapted rheology and self-consolidating concrete (SCC), and the relentless pursuit of knowledge transfer regarding the science, performance, design, and testing standards of SCC.

Visit www.acifoundation.org to learn more.

INTERESTED IN SEEING YOUR NEWS IN THIS COLUMN?

Email your 150-200 word association news to editor@icri.org. Content for the September/October 2020 issue is due by August 1, 2020 and content for the November/December 2020 issue is due by October 1, 2020. ICRI reserves the right to edit all submissions.
PEOPLE ON THE MOVE

WAMT LABS’ COURTNEY MURDOCK EARNs PRESTIGIOUS RECOGNITION FROM PROSOCO

PROSOCO and its sister company AMT Laboratories are proud to announce that Courtney Murdock, Director of Project Testing for AMT Laboratories, has earned the title of “APT Recognized Professional” from the Association for Preservation Technology International (APT).

This title, established in 2018 by APT and the APT College of Fellows, is a formal recognition of achievement by individuals of “expert skill levels... in various fields of preservation technology.”

In earning this honor, Murdock joins an elite group of APT Recognized Professionals, including only 18 selected this year. She is also the first person that APT has selected in the category of “Materials Testing.”

The acceptance criteria are rigorous: A minimum of 10 years of experience in the field of preservation, managerial experience and mentorship, a minimum of 10 significant preservation projects on a designated historic site, peer approval and awards, and continuous education.

According to David Boyer, CEO and President of PROSOCO, this recognition is an honor that matches the quality of work Murdock has consistently produced for 18 years.

Murdock began her career in preservation in 2002, when she went to work in the PROSOCO lab as its Project Testing Coordinator. Over the next four years, she worked under the mentorship of Fran Gale, a highly regarded preservation professional who was the Technical Director for PROSOCO from 2001-2006.

In 2005, Gale and Murdock together formed AMT Laboratories, a sister company to PROSOCO that conducts its project testing, as well as testing for architects, engineers, professors and contractors.

In her current role as Director of Project Testing for AMT Laboratories, Murdock conducts lab and field testing on historic buildings, develops test protocols, writes proposals and reports, and provides guidance to clients based on test results and previous experience.

An active member of the local APT Central Plains chapter and regular attendee of APT Annual Conferences, Murdock also regularly attends a variety of professional events and courses, including the “Conserving Modern Architecture” course at the Getty Conservation Institute. She will be formally recognized at this year’s APT Annual Conference, Oct. 3-7, 2020.

INTERESTED IN SEEING YOUR NEWS IN THIS COLUMN?

Email your 150-200 word news to editor@icri.org. Content for the September/October 2020 issue is due by August 1, 2020 and content for the November/December 2020 issue is due by October 1, 2020. One (!) high resolution headshot/individual may be included. ICRI reserves the right to edit all submissions.
THE GPS TRACKING OF CONSTRUCTION VEHICLE FLEETS IS INCREASING PROFITABILITY

For construction contractors, the Shadow Tracker Vision III from Advanced Tracking Technologies (ATTI), provides real-time, 24/7 vehicle tracking capability, enabling optimal resource allocation and profitability across jobsites for under $20 a month per vehicle.

The real-time location of the entire fleet can be displayed via a PC or smartphone app on a map, with “zoom in” on any vehicle. Zooming in or out on the map enables seeing where vehicles are in case reallocating equipment to other jobsites is required. At a glance, contractors can see if a vehicle is moving (displays green) or stopped (displays red). Touching a vehicle icon on the app will display where the vehicle has been, where it stopped, and how long it has idled.

Compared with typical GPS tracking devices that may only update every few minutes, the system 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, which can help deter driver speeding.

For a free demo, visit https://www.advantrack.com/free-demo/. For more information contact Advanced Tracking Technologies, 6001 Savoy Drive, Suite 301, Houston, TX 77036; visit www.advantrack.com; call 800-279-0035; email sales@advantrack.com

“POINT-AND-MEASURE” MOISTURE METERS SPEED CONSTRUCTION, ENSURE QUALITY

For concrete repair, instant lab quality, “point-and-measure” handheld analyzers can now be used wherever moisture is a problem or a specified moisture content needs to be known to proceed with work, whether that involves sand, aggregate, concrete mixes, or determining concrete drying/curing time. This is speeding project completion and improving building quality for as little as $20 a day with leased equipment.

The new tool uses Near-Infrared (NIR) light, a highly accurate, non-contact secondary measurement method that can deliver the moisture readings of solids, slurries, and liquids in seconds without sample preparation in portable handheld models. The meter reflects light off the sample, measures how much light has been absorbed, and automatically converts the result into a moisture content reading.

NIR meters can be used on anything where measuring surface moisture is important, so can be used to instantly check the moisture level of bulk “dry” goods such as sand or aggregate on receipt from suppliers. It can also be used to spot check the moisture content of materials mixed with water.

When measuring moisture content inside concrete at superficial or deeper levels is necessary, instant portable electronic, contact gauge testers are available.

For more info, contact Kett: call 800-438-5388; email support@kett.com; or visit www.kett.com.
WAGNER METERS OFFERS NEW WEBINAR

Wagner Meters is pleased to offer an all-new training webinar that gives contractors, flooring installers, and building inspectors who work with concrete all the essential information they need for accurate, reliable testing of moisture in concrete floor slabs.

This free hour-long online presentation, titled The Why, What and How of Concrete Moisture Testing, is designed to help industry professionals take advantage of the very latest technologies so that they can avoid a flooring disaster due to excess moisture in concrete.

The new webinar covers a wide range of topics and answers many key questions, such as:

- How big of an issue is concrete moisture for people working in the flooring industry?
- What influences the rate at which concrete dries?
- What is the ideal water-to-cement ratio?
- How do concrete moisture gradients affect the outcome of a flooring installation?
- What are today’s best options for concrete moisture testing?
- What is needed to comply with ASTM guidelines?
- Which are better, single-use or reusable relative humidity sensors?
- What are the advantages of using the new Rapid RH® L6 test system?

The highly informative webinar is presented by Jason Spangler, Flooring Division Manager for Wagner Meters. In addition to explaining the latest scientific information about concrete moisture and how best to test for it.

For more information, visit www.wagner-meters.com/webinar.

RAPID SETTING MULTI-FUNCTIONAL REPAIR MORTAR

ChemMasters, Inc., has announced the introduction of “SpeedPatch™ XL”, a versatile single component cementitous repair mortar for a wide variety of horizontal, vertical and overhead repairs to concrete substrates. SpeedPatch XL is specially formulated to produce a light color concrete mortar that blends well with surrounding concrete, with accelerated set and high early strength.

SpeedPatch XL features superior finishing characteristics and can be shaved, shaped and contoured to make a wide variety of repairs while reproducing the original substrate profile without the need for forms. It contains no gypsum for enhanced durability and exhibits superior resistance to damage caused by freeze/thaw cycles and deicing chemicals.

Use SpeedPatch XL for vertical, overhead and horizontal repairs to both interior and exterior concrete including precast panels, steps, columns, beams, concrete pipe and silos, or cracks and other surface blemishes in formed walls. Its multi-functional properties make SpeedPatch XL a versatile replacement for multiple products.

ChemMasters, Inc. is a 63 year-old manufacturer of specialty concrete chemicals used to improve, repair and protect concrete and masonry. A state-of-the-art research and development facility is operated by ChemMasters to advance the science of concrete improvement.

ChemMasters, Inc. is located at 300 Edwards Street, Madison, OH 44057. Telephone: 800-486-7866, Fax: 440-428-7091 Email: info@chemmasters.net Web: www.chemmasters.net.

MAR-BAL, INC. HIRES OF BLAK KAT GROUP, LLC TO PROMOTE COMPOSITES GROWTH OF INNOVATIVE DETECTABLE WARNING SURFACES SAFETY PRODUCT LINE

Continuing their growth trajectory for demanding and innovative solutions for customers in the growing ADA compliant tactile warning surfaces construction market, Mar-Bal, Inc. (Mar-Bal: Chagrin Falls, OH) is expanding its dedicated sales team with the addition of Blak Kat Group, LLC (Chagrin Falls, OH) for its proprietary Detectable Warning Systems® (DWS) safety product line.

The construction-focused rep group, headed by managing partners Kyle Torres and Brian Zak, will promote the line’s value-added innovation engineered for visually impaired pedestrians, and drive the market advancement for the growth and benefits of warning surface composites.

The addition of Blak Kat Group will allow DWS to penetrate deeper within both concrete and paving-focused entities at a very competitive cost to contractors, distributors, states, and municipalities. Market applications include: Public Rights of Way, Parking Structures, Health Care-Disability (including senior and assisted living facilities), Rail-Transport, Architecture, Infrastructure, Commercial Shopping Centers, Apartment Communities, etc. The key objective of the group will be promoting the benefits of both composite and flexible materials for either cast-in-place or surface applied applications including the following brands:

AlertTile®: Surface applied, rigid composite, truncated domes.

AlertCast®: Cast-in-place, rigid composite—“The industry’s best replaceable detectable warning.”

RediMat®: Surface applied, flexible, glass-filled polyurethane on existing asphalt (or concrete).

For more information visit www.detectable-warning.com.
GENERAL EQUIPMENT COMPANY’S NEW SG7 SURFACEPRO™ EDGE GRINDER OFFERS COMPACT SOLUTION FOR VARIETY OF JOBS
The new SG7 SurfacePro™ edge grinder from General Equipment Company is an ideal edge grinder for everyone from do-it-yourselfers to commercial contractors. Intended for smaller areas, it can accommodate a wide variety of surface preparation applications, such as leveling concrete and asphalt, with unmatched productivity and versatility.

The heavy-gauge steel frame is ergonomically designed to allow the operator to work in a fully upright position. This greatly reduces the potential for lower back pain, strained knees or other occupational-related health issues, all while increasing productivity over hand-held grinders.

The compact size of the SG7 provides a unique advantage over other edge grinders on the market. With a detachable handle and weighing only 27 pounds (12.3 kg) without a blade, it is easy to lift and transport, fitting in almost any size vehicle. It also provides the rigidity to remove materials with more accuracy and control than larger machines that lack the same agility and maneuverability.

Other standard features include Anti-Vibe™ caster wheels and a 1.5-inch (38.1 mm) diameter dust connection port and hose to handle applications with dust control requirements. The SG7 also comes with a flexible dust shroud that incorporates a flip-up edge for improved viewing of the grinder cup edge when operating near features such as walls. The edge grinder comes supplied with a 7-inch (178 mm) diamond cup wheel.

For more information visit www.generalequip.com.

LET CORTEC® KEEP YOUR IDLE EQUIPMENT FROM GOING RUSTY!
Protecting idle equipment from corrosion is a primary way to minimize loss and stay responsive in this unpredictable market. Cortec® Corporation is making it possible for industries to do so by providing a broad range of solutions to corrosion along with expert advice.

Basic Operating Equipment—boilers, cooling systems, and electricals—require purposeful application of Vapor phase Corrosion Inhibitors that protect full equipment internal volumes. In the case of water treatment, products such as Cortec’s Boiler Lizard® and Cooling Loop Gator® have revolutionized the traditional approach to layup. Protection of electricals is also easy—so much so, that it can warrant sticking a VpCI®-105 or VpCI®-111 Emitter inside all electrical cabinets even during operational times.

Industry-Specific Machinery—drilling rig components or custom-designed manufacturing equipment—are open to a variety of techniques and technologies to protect components. Using specialty VpCl® additives in oil and hydraulic systems, fogging internal voids with VpCl®-337, and/or wrapping exterior equipment parts with a heavy duty VCI film such as VpCl®-126 HP UV or MilCorr® VpCl® Shrink Film. For some equipment surfaces, VpCl® coatings may be ideal.

Heavy-Equipment Overstock—such as off-road vehicles—needs to be stored in harsh conditions, the results can be especially severe if extra protection is not provided. In one instance, overstock had to be stored near the ocean, and this harsh environment caused the paint to blister and crack, leading to corrosion on the exposed surfaces underneath. Conventional paint did not solve the rust problem. A trial of Cortec® VpCl®-386 coatings was much more effective, so the full equipment bodies were repainted with VpCl®-386 tinted to match the original paint colors.

Contact Cortec® today for assistance: https://www.cortecvci.com/contact-us/.

INTERESTED IN SEEING YOUR NEW PRODUCT IN THIS COLUMN?
Email your 150-200 word product information to editor@icri.org. Content for the September/October 2020 issue is due by August 1, 2020 and content for the November/December 2020 issue is due by October 1, 2020. One (1) high resolution product photo may be included. ICRI reserves the right to edit all submissions.

For the best in product manufacturers and industry professionals, visit ICRI’s online Buyers Guide at www.icri.org.
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