CONCRETE REPAIR
BULLETIN
A Bimonthly Publication of the International Concrete Repair Institute

January/February 2018
Vol. 31, No. 1

2018 ICRI PRESIDENT RALPH C. JONES

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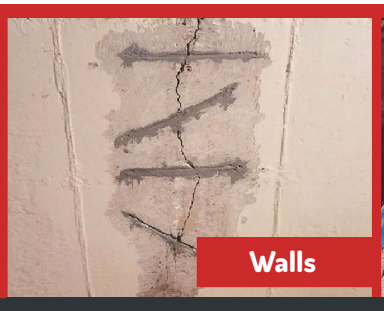
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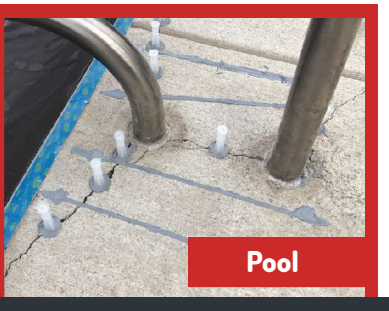
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CRB EDITORIAL DEADLINES

May/June 2018—March 1, 2018
Theme: *Health and Safety in Concrete Repair*

July/August 2018—May 1, 2018
Theme: *Sustainability and Re-purposing*

September/October 2018—July 2, 2018
Theme: *Seismic Solutions*

November/December 2018—September 4, 2018
Theme: *2018 ICRI Project Awards*

INTERNATIONAL CONCRETE REPAIR INSTITUTE

ON THE COVER: 2018 ICRI President Ralph C. Jones, PE. See page 4 for a special Q&A with Ralph.

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FEATURES

DEPARTMENTS

NOTE FROM THE EDITOR

The new year is now upon us and ICRI is starting 2018 with it's annual Kick-off Party at the Voodoo Lounge, Rio Las Vegas Hotel & Casino, on January 22, 2018. This will be the start of a busy year for ICRI Members.

This year's Spring convention will feature *Seismic Solutions*, April 11-13, 2018, at the Intercontinental Mark Hotel in San Francisco.

The 2018 ICRI Fall Convention topic will be *Resiliency: Above and Beyond Concrete Restoration*, November 7-9, at Omaha Marriott Downtown at the Capitol District, Omaha, Nebraska.

ICRI will continue to hold certifications classes for Concrete Surface Repair Technician and Concrete Slab Moisture Testing throughout 2018. Classes have already been scheduled in Surrey, British Columbia; Pompano Beach, Florida; Northbrook, Illinois; Biloxi, Mississippi; and McKinney, Texas. Check the ICRI website calendar for all dates and additional testing sites.

ICRI will continue to add educational videos to the website in 2018. Videos are available on the ICRI website to aid in the Concrete Surface Repair Technician and Concrete Slab Moisture Testing Certification programs. Also, a new set of videos have been developed to help members understand the new ACI 562-16 Repair Code and Guide.

2018 should be an exciting and busy year for ICRI Members throughout the world as the repair industry is showing no signs of slowing down. Please remember that ICRI is a great source for industry information and networking opportunities.

I hope that you have a successful and rewarding new year!

Jerry Phenney
Editor, CRB
MAPEI Corporation

PRESIDENT'S MESSAGE

The First Law of Thermodynamics


RALPH C. JONES

As the incoming ICRI president for 2018, I have been asking myself what is the one thing I want convey to the membership. The thought that kept coming to mind was energy. The first law of thermodynamics in simplified language states, "energy can neither be created nor destroyed." I am sure this law was established after considerable thought, research, extensive calculation and laboratory testing, but as I interact with the members of ICRI, I have reason to question the validity of the statement. Over and over again, I hear about the new energy in our organization. At the Fall convention in New Orleans I was fortunate enough to sit in on the Past Presidents' luncheon that included over 10 years of ICRI leadership. During the luncheon I heard the same statement, "I have never seen so much energy in this organization." What is equally impressive is how this new energy is being harnessed into new ideas and programs.

At the writing of this article, the Secretariat reports that they have 38 new (yes, new!) initiatives at the national level that are being considered and worked on within ICRI. These are initiatives that will ultimately improve our industry of concrete repair by providing better, more durable repair and restoration for our clients and communities. Equally impressive is the willingness of members to champion these initiatives to bring them to fruition.

If I could voice one thing to each member of this organization, whether at the national or chapter level, it would be that you are welcome in this organization. Your ideas and your involvement are welcome. For ICRI to achieve its mission of being the resource for concrete repair, restoration and protection, we need your help, your ideas, and your energy. If you are interested in contributing, ask someone in the organization how you can get involved. You can reach out to me, staff, any member of the executive committee, any of our board members, our technical activities chair or the Secretariat—almost 30 members of the organization that are officially interested in hearing your ideas and will help you get involved, as well as the dozens of committee chairs and members. ICRI is rapidly becoming the organization where your ideas can find a voice.

In retrospect I do accept the first law of thermodynamics as fact; however, ICRI is tapping into the energy that is within our organization and searching for new sources of energy to move our industry forward.

I must also acknowledge the efforts and accomplishments of ICRI Immediate Past President Brian Daley. As a result of his leadership, there have been many unique and positive advances in our organization, many of which were behind the scenes. In the several years I have known Brian and worked with him within ICRI, I have repeatedly been impressed with his leadership. He has been an inspiration to me. I find myself ill-equipped to fill his shoes—but will do my best. Thank you, Mr. Daley.

I would also like to express my gratitude to the board of director members who have fulfilled their terms on the board and will be passing the reins on to six new directors. Thank you to the outgoing board members and welcome to the new board members. I look forward to the continued contributions of our past board members and I look forward to working with each of the new board members.

I speak for the board of directors when I thank you for your contributions to this organization.

It is certainly an exciting time to be involved in ICRI.

Ralph C. Jones, PE
2018 ICRI President

UPCOMING DATES&INFORMATION

CERTIFICATION CLASSES

Concrete Slab Moisture Testing Certification Program

- January 24-25, 2018—Las Vegas, Nevada (World of Concrete)
- January 30-31—Las Vegas, Nevada (TISE West)
- March 12-13—Vancouver, British Columbia, Canada
- March 21-22—Biloxi, Mississippi
- April 25-26—Chicago, IL
- June 21-22—Pompano Beach, FL

Concrete Surface Repair Technician Live Performance Exam

- February 14, 2018—McKinney,Texas

2018 ICRI KICK-OFF PARTY
January 22, 2018
VooDoo Lounge
Rio Hotel & Casino, Las Vegas, Nevada

WORLD OF CONCRETE 2018
Exhibits: January 23-26, 2018
Seminars: January 22-26, 2018
Las Vegas Convention Center, Las Vegas, Nevada

2018 ICRI SPRING CONVENTION
April 11-13, 2018
Theme: *Seismic Solutions*
InterContinental Mark Hopkins, San Francisco, California

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Q&A WITH RALPH JONES

We recently sat down with new ICRI President Ralph C. Jones, PE (also featured on the cover of this issue of the *Concrete Repair Bulletin*) and asked him about ICRI and his thoughts on its future.

What one thing has impressed you most about ICRI?

ICRI has so many positive things to offer it is impossible to limit it to one—but the technical offerings have to be at the top. Technical offerings were the initial purpose of ICRI and continue to be its main emphasis. The original members of ICRI put into motion the development of many of the repair methods that are used today in the industry. Prior to that, there were no real standard repair methods and repairs were performed by individual design professionals and contractors on a trial and error basis. Error was a big part of that process. With the development of standard repair methods, the efficiency and long term durability of concrete repairs has greatly improved. We owe much to the original members of the organization.

Today the technical offerings are still the backbone of the organization. New products are being developed by member companies. Design professionals are preparing construction documents using the guidelines developed by ICRI and contractors are implementing these technologies in the field. Within ICRI the manufacturers, design professionals and contractors are all working together for the betterment of the industry.

ICRI is continuing to develop new technical publications but we are now broadening our efforts to include educational offerings, certifications and other construction aids. One such construction aid is the development and standardization of the Concrete Surface Profile (CSP) Chips. Prior to the development of the CSP Chips there were no standards on concrete surface profile. With the creation of the CSP Chips and the associated ICRI Guideline 310.2R-2013, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays and Concrete Repair, everyone in the repair industry now has a standard to go by for surface profile. Manufacturers can require specific surface profiles for their products, design professionals can specify specific surface profiles and contractors can provide the surface profiles consistently with a predetermined defined method and end product.

To create a similar consistent understanding of concrete repairs, ICRI has developed the new Concrete Surface Repair Technician (CSRT) program. The CSRT program provides a baseline of required knowledge for workers in the field as well as inspectors. With the CSRT program we can have consistent expectations of concrete repairs that can be agreed upon by the design professional designing the project, the contractor performing the repairs and the inspectors in the field observing the work.

What advice would you give to new ICRI members?

RALPH C. JONES, PE

My main advice to new ICRI members would be to engage other members in conversation. Joining an organization and going to a national convention can sometimes be daunting but I have always found ICRI members to be open and welcoming. I have observed this at the chapter level—Great Plains Chapter—as well as at the national level, so I know it to be true. There are members who have been in the concrete repair industry for many years and have collaborated with other experts in the field to improve concrete repairs. I encourage new members to seek out the expertise that is in the organization and profit from the knowledge that exists in the group.

I also encourage new members to visit the booths at the conventions. The manufacturers and specialty firms are there to share information on their products and services. No matter who you are in the repair industry, you need that information to make educated decisions and broaden your knowledge base of the industry.

What do you see for the future of ICRI?

I think the future of ICRI is bright. ICRI has a great technical foundation to build on. Technical guidelines continue to be developed to address repair issues, new certification programs are being developed and educational webinars are being developed—all for the purpose of advancing concrete repairs for the benefit of our clients. All this is being done while still fulfilling the original intent and mission of ICRI: to improve the concrete repair, restoration and protection industry.

ICRI is also working within our own internal processes to streamline development of the technical offerings. One of the outcomes of the recent Strategic Implementation Committee was the creation of the Secretariat. The Secretariat was implemented for the sole purpose of ensuring new ideas are being given due consideration and are being moved forward efficiently.

There are many exciting things going on in ICRI, but the most exciting ones to me are those yet to be thought of, developed and offered to the membership. ■

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ICRI would like to thank all of our Supporting Members, whose dedication to ICRI is greatly appreciated. Their continued support has greatly enhanced programs both within ICRI and the concrete repair industry as a whole.

TACTALK


FRED GOODWIN

The Fall Convention in New Orleans recently concluded. Attendance was great and enthusiasm even better. An update to the Technical Committees Manual was developed and will be balloted shortly. The major changes include adding a format section for specifications (thanks to Committee 110 for developing the first guide specification document that set the pattern to follow). Another change is to encourage development of a PowerPoint presentation concurrent with documents or as an alternative to a document to help disseminate information. Another change clarifies TAC's responsibility for review of the technical content of certification programs where the Certification Committee oversees the format, procedures, and policies of the programs. A form for the Technical Committee Meeting Summary and for copyright authorization have also been added to the appendix.

The ICRI Policy Manual is also being updated and the TAC section will be reviewed by TAC ballot. A request from the technical committees to have a location to download forms and templates and an idea to post them as a Wiki-type document on the Coordination web page is proposed. This would include committee membership applications, an agenda template, a meeting minutes template, the Technical Committees Manual in a convenient location, and other useful documents in editable Word format. By having this on the Coordination page, it will be easily accessible to all technical and administrative committee officers, board members, and the Secretariat. TAC is now offering to perform informal preliminary review of documents being developed by the technical committees to help avoid the dreaded 3R (revision, re-ballot, and resubmission) from TAC review.

A roadmap to the development of committee deliverables is also the work of a TAC subcommittee. Work began on this initiative in 2015 but was postponed during the transition of our management company and implementation of our strategic plan. Now that some of the dust has settled this work will continue and be refined to better assist with alternative deliverables from our technical committees (webinars, apps, etc.) to best fit the medium with the message.

Another TAC subcommittee is undertaking a review of the Concrete Repair Terminology. They will begin by reviewing all of the terminology from existing ICRI documents to make the definitions consistent within ICRI.

The TAC subcommittee for technical session presentation review and selection continues to produce outstanding technical session content at our conventions. They deserve many thanks for their unacknowledged hard work. This subcommittee will also be assessing convention presentations as potential webinars.

The end of 2017 also brings term expiration to technical committee chairs and TAC members. Technical committee chairs are appointed by TAC for 2-year terms and can serve two additional terms for up to 6 years total. Occasionally, a chair's term may be extended for one more year to finish work in progress. TAC members are appointed for 3 years by the ICRI president with TAC chair recommendation and subject to approval by the board of directors. Members can serve a maximum of 6 years from the date of appointment with one-third of the members appointed each year. TAC appointees are balanced between membership categories—currently manufacturer, engineer, and contractor.

Thank you to everyone for your hard work and dedication as ICRI continues to improve its service to the concrete repair, restoration and protection industry. ■

Fred Goodwin is Chair of the ICRI Technical Activities Committee (TAC).

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SECRETARIATUPDATE

Secretariat—One Year Later

The Secretariat is now one year old. We wanted to utilize this article to update you on the accomplishments of this past year and let you know our plans for 2018.

One year ago, the Secretariat began with the main directive to implement the ICRI Strategic Plan. From the work of Chris Lippmann and the Strategic Implementation Committee, we were able to uncover two specific needs to move our organization forward. The first need was to establish a way for ICRI committees to better communicate with each other. The second need was to provide a voice to all ICRI members. We also realized that to be truly effective in our efforts, those needs had to be fully transparent and available to ICRI's entire membership. After one year we can confidently say that the Secretariat has taken two big steps to accomplish these goals.

Inter-Committee Communication

The Secretariat has created a visible and detailed list of ideas and initiatives submitted by ICRI members. The list consists mostly of ICRI activities that need to be communicated between multiple ICRI committees. Often in the past, many great ideas and efforts would stall out in an individual committee due to lack of direction. Through this published ICRI Initiatives list, as well as the recent creation of the Coordination Wiki Page, we have now provided transparency and direction to many of the ICRI committee activities.

Ideas

The Secretariat and ICRI staff have created a mechanism for all ICRI members to communicate their ideas to the ICRI leadership and relevant committees. A link was created on the ICRI website allowing any ICRI member to send ideas directly to the Secretariat. Every idea submitted is discussed during our monthly conference calls and added to the list of Secretariat ideas and initiatives. The list is available to all ICRI members on the ICRI website. To date, the list includes over 30 ideas and initiatives.

We look forward to continuing to improve inter-committee communication as well as provide opportunities for all ICRI members to have a say in the future of this great organization. If you have any questions regarding the Secretariat or our efforts, please contact any of us directly.

Sincerely, your Secretariat:

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LEGALINSIGHT

Poaching: The ins and outs of *Not* Doing it, *Doing* it and Protecting Your Team

BY MATTHEW J. PAVLIDES AND ANTHONY W. KRAUS, MILES & STOCKBRIDGE

So you just survived the downturn in the economy, and things are starting to look better. The new project you were awarded is going to need more people, but the labor shortage is hurting your ability to hire the kind of specialized people you need to handle the new project and to grow your business…so is poaching an option?

The term "poaching" has less than stellar connotations. Poaching occurs because there is a sudden demand for skilled workers with limited options and few sources of supply. Poaching raises competing concerns from a legal standpoint: on one hand, the hunt for talent should be respectful of any rights of current employers, yet on the other hand, there should be a free market for labor. So what don't you want to do; what do you want to do; and how do you want to protect yourself from someone who wants to poach from you?

How not to do it

- Don't ask a new hire who hasn't yet left his/her current employment to solicit others to leave or bring others with him/her (breach of duty of loyalty).
- Don't obtain a copy of another company's employee list from an insider or third party (possible violation of trade secret law).
- Don't hire to obtain knowledge of a competitor's operations and customers. Hire to acquire the skills of the employee; and don't seek such information about competitors' businesses in interviewing candidates (possible violation of trade secret law).
- Don't ignore a recruit's obligations to his/her former employer, such as a binding and valid non-competition, customer and/or employee non-solicitation or confidentiality agreement. Be sure to question candidates intensely about the existence of any such restrictions. (Enforceability varies from state to state.)
- Don't disparage or misrepresent any facts about the former employer.
- Don't seek to obtain a competitor's personnel with the aim of competitively injuring it, or recruit more than a few from another business without first checking with counsel (possible liability for "raiding").

How to do it

Traditional "recruiting"

- Ask a new employee for referrals of other qualified candidates if there is no contractual or other special legal restriction against doing so: Referrals are a great gateway, but check with counsel about possible pitfalls and how to properly do it.
- Contact customers for contact information on employees of other companies they have worked with and that they would want to work with again.
- Cold call (as long as you don't get leads and numbers in an improper way)—it is effective to start the call with praising the talent and the desirability of the candidate—then transition to what new opportunities would exist in your business for the potential hire.
- Find out where your employees go to socialize and go to these events or pay someone knowledgeable about recruiting to "work" these events on your behalf.
- Attend workshops, trade shows, seminars, organizational meetings to "work" the crowd and obtain attendee lists to follow-up with the talent.
- Hire a head hunter to do any or all of the above.

New age "recruiting"

- Consider hiring from the workforce of other employers at the same job site (but not while the project is ongoing and could be impaired, if the customer could be affected or if there is joint venturing).
- Visit a competitor's project and furnish handouts (as long as you aren't trespassing or interfering).
- Use social media.

How to protect from poaching

a. Get an enforceable employee non-solicitation agreement up front or on the back end. A non-solicitation agreement is a promise that for a certain amount of time after an employee leaves, they will not solicit your existing employees. If you don't get it up front when you hire, then obtain one in exchange for the severance you may be paying out when they leave.

b. Use a non-compete. A non-compete agreement is a promise not to be employed in competing activity within a certain geographic region for a limited period of time. While a vehicle to thwart harmful employee behavior, it is unlawful in some states and requires an underlying justification or "protectable interest" (protecting the employer's trade secrets, etc.) arising from the employee's job functions.

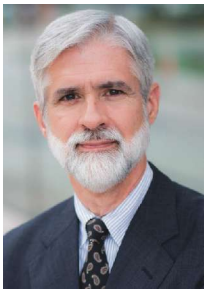
c. Use friendship, organizational participation and community to make it difficult for others in the industry to poach from you—likeability of a person or company makes poaching awkward and can be a deterrent. (Note: Don't enter into formal or informal agreements or employee policies with others that "I won't poach from you if you don't poach from me" as these may cause unfair competition and antitrust concerns.)

d. Offer things that are unique to your employees based upon their needs. When you hired a person, there was a reason that they ended up working for you—so find out what they needed and what they felt was missing at their old job. What benefits are important to them? As an employer you have the unique ability to offer that special incentive that makes an employee stick, but it has to be known upfront. Having that distinctive item that others don't know about ensures employee loyalty and thwarts poachers. Examples we have seen that make an employee stay put can vary widely, such as offering a job to another family member; a short-term loan for personal matters; additional time for travel with family within or out of the country; overtime upon request or when needed; housing assistance; a chance to mentor others; advancement; educational and leadership opportunities. ■

Disclaimer: This is for general information and is not intended to be and should not be taken as legal advice for any particular matter. It is not intended to and does not create any attorney-client relationship. The opinions expressed and any legal positions asserted in the article are those of the author and do not necessarily reflect the opinions or positions of Miles & Stockbridge, its other lawyers or Concrete Repair Bulletin.


MATTHEW J. PAVLIDES

Matthew J. Pavlides *is the managing principal in Miles & Stockbridge's Rockville, Maryland, office and a member of the law firm's Construction practice, representing owners, contractors, subcontractors, architects/engineers, sureties and vendors on their construction and personal matters.*


ANTHONY W. KRAUS

Anthony W. Kraus *is a principal in the firm's Labor, Employment, Benefits & Immigration practice in Baltimore. Tony counsels and defends regional and national clients on the full spectrum of traditional labor-management matters.*

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Repurposing New Construction: A Retrofit Case Study

BY MATTHEW HICKEY AND BOB ST. JOHN

Fig. 1: Overview of building exterior

While the construction sector continues to show positive growth over the last decade, new office buildings are something we see on a daily basis. It is increasingly common for developers to purchase land and build a new property without any prospective tenants. The idea being that they will continue to operate the building on an ongoing basis, and gain continuing revenue from long-term leases. This may sound like a slam-dunk investment if the capital is available, but what happens when the building remains vacant for an extended period of time?

This exact issue was burdening the owners of a four-story mixed-use office building in Los Angeles County (Fig. 1). The building was state of the art at the time of opening in 2008. To make a long story short, the building's entire fourth floor, and roughly half of the third floor (approximately 38% of the total building's available real estate) was vacant for 8 years straight when a prospective tenant appeared in 2016 and was interested in leasing the remaining 88,000 sf (8175 sm) of office space. However, an inherent design issue rendered the deal very challenging. The third and fourth floors were completely separated and accessible only by fire egress stairwells and two elevators outside the office space. The owner wanted continuity between the separated floors. It was understood that this was an ongoing issue with the building that ultimately led to a pile of leasing agreements that fell through.

Intrigued by the possibility of a long-term client leasing the entire available space, the building owner elected to undertake a challenging structural retrofit which involved creating a large stairway opening in a two-way, unbonded post-tensioned (PT) slab, even though the building was occupied below.

Architectural Concepts vs Engineering Design

An architect retained by the tenant to develop a high-level plan for the space envisioned a grand sweeping staircase at the office entrance behind the receptionist's desk. The preliminary renderings of the architectural drawings illustrated an opening

that required the removal of a 1,200 sf (112 sm) section of the fourth floor PT slab.

This initial layout proposed by the architect (Fig. 2) introduced several challenges including:

1. The removal of the slab around the two center columns doubled the unsupported length and created buckling issues.
2. The opening's proposed location was oriented such that it was close to the adjacent columns (PT tendon high-points) which presented challenges for establishing new PT anchorage locations.
3. The opening was along the center span of the column bay which left a large portion of unsupported slab edge surrounding the opening.
4. The removal of the large slab section caused a redistribution of forces and developed a localized region of negative moment overloading within an adjacent column bay.
5. Re-shoring below the third floor was not possible since the building was completely occupied with high-security tenants below.

Working through an iterative process with the Structural Engineer of Record (EOR), owner, and the architect, several resolutions to these challenges were proposed:

1. The size and shape of the opening were reconfigured to 900 sf (84 sm) so that only one column would be incorporated into the opening.
2. It was proposed to leave a section of the slab intact over the column, helping with lateral column stability.
3. Shift the opening 24 in (610 mm) inside the column face, and construct a thickened section of structural slab in the banded direction at the column face to facilitate PT tendon profiling.
4. Structural steel framing was installed below the slab free-edge and anchored into the columns using steel collars prior to the removal of any concrete (Fig. 3).
5. Utilize strips of bonded Carbon Fiber Reinforced Polymer (CFRP) at an area of high bending stress within an adjacent column bay.
6. A three-phase approach (Fig. 4) was proposed to limit gravity loads below the live load allowance onto the third story slab. No more than 35% of the PT tendons in each direction (distributed and banded) were de-tensioned and re-tensioned in each phase.

Construction

After several months of design and City approvals, the project began in January 2017. The first order of business was to confirm that the PT tendon layout was consistent with the project shop drawings. Radiography (X-ray) was utilized to confirm existing tendon location and depth.

Following the confirmation of tendon locations, the structural steel support system was installed around the perimeter of the future opening (Fig. 5). The top flange of the steel wide flange beams were anchored into the slab using mechanical anchors to prevent lateral torsional buckling and to provide seismic dia-

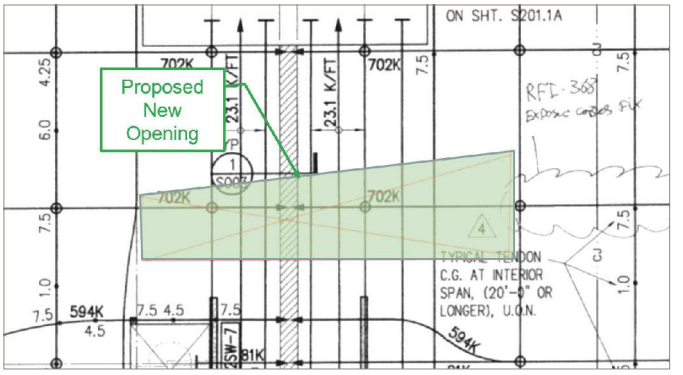

Fig. 2: Original opening proposed by architect

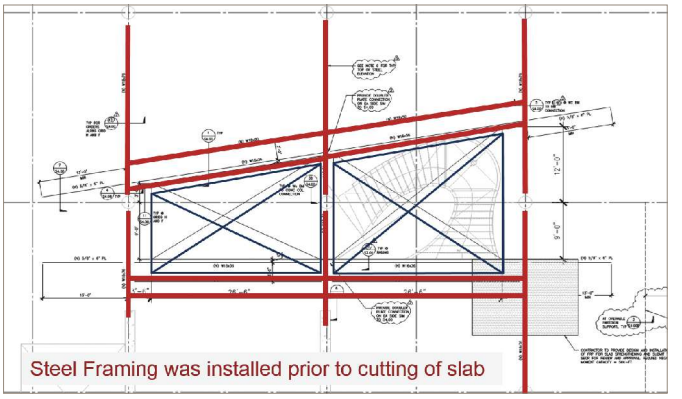

Fig. 3: Revised opening proposed by engineer

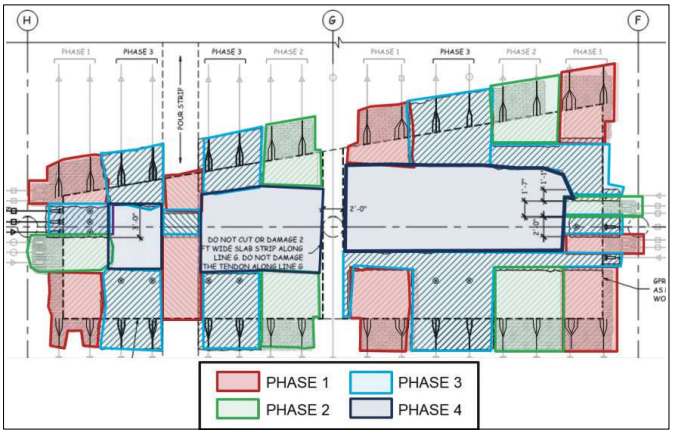

Fig. 4: Proposed phasing for post-tension work

Fig. 5: Structural steel and shoring below opening

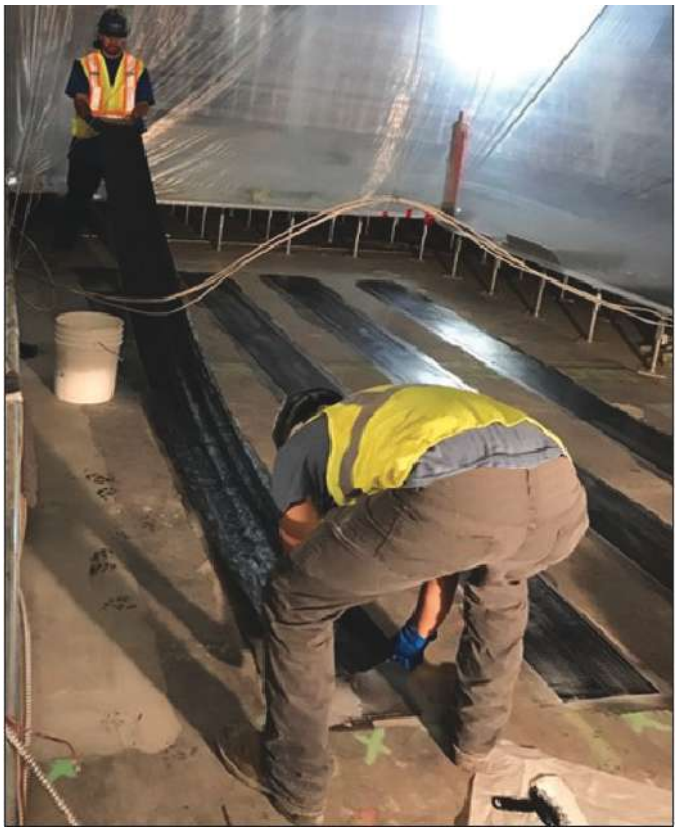

Fig. 6: Topside FRP installed at deficient bending location

Fig. 7a: Installation of lockdown device

Fig. 7b: Lockdown device installed prior to detensioning

phragm support to the new opening.

Additionally, prior to beginning the slab opening demolition, the CFRP system was installed within the area of deficient negative moment reinforcing (Fig. 6).

Shoring frames and a support platform (demo-deck) were installed below the slab opening. The shoring was extended 36 in (915 mm) past the perimeter of the opening to allow for the construction of the new PT anchorage locations.

A detailed demolition plan was engineered to ensure the safety of the structure so the occupied areas of the building would not be negatively affected during the construction process. A phased approach was developed to ensure the slabs were not overloaded without re-shoring below and to maintain adequate pre-stressing force in the adjacent slab bays. The phasing plan included the daily removal of concrete debris to eliminate the chance of excessive point loading.

De-tensioning of PT tendons is an incredibly dangerous procedure. In this particular case, large tendon lengths and the proximity of the new opening to perimeter edges increased concerns with damage to exterior glazing (curtain wall) systems and field personnel. An innovative procedure was developed using a lock-down device to assist with the gradual release of the tendon force in an attempt to limit residual property damage that might be caused by the release of anchor wedges (Fig. 7). A written procedure was developed to complement the demolition process which was continually reviewed with construction crews at the pre-shift safety meeting. To take this one step further, every PT tendon was marked prior to de-tensioning and assigned an anticipated elongation value to assess the length the strand should retract once it was cut. Following de-tensioning, the length of strand retraction was recorded and compared to the expected elongation. If the values varied by a significant amount, the procedure was stopped and engineering notified.

Following the completion of the Phase 1 PT tendon de-tensioning, the areas surrounding the new anchorage zones were saw-cut and chipped to allow the tendons to be re-profiled. The new anchorage hardware including the additional reinforcing steel (continuous back-up bars and hair pins) were installed (Fig. 8). Additional steel was also doweled into the existing areas of remaining slab to promote a cohesive bond and to support the new reinforcing steel within the anchorage zone.

High tendon congestion in the banded direction rendered tendon separation very difficult. The large number of tendons did not allow for conventional horizontal tendon splaying (separation). Instead, a multi-cable anchor system was utilized to separate (splay) the tendons vertically (Fig. 9). Additional sections of hooped (spiral) reinforcement and slab thickening reinforcing steel were used to construct the new banded anchorage zone at the column locations.

Following the PT tendon profiling and anchorage hardware installation, the area was formed using conventional lumber and

placed with a rapid curing, high-strength dry packaged concrete repair material. The repair material was cured for at least 24 hours, or until a core sample representing the placement reached 3,000 psi (21 MPa), before stressing began.

Stressing was commissioned under the witness of a deputy inspector to the full jacking force (33,000 lbs [33.0 Kips]). Elongations were recorded and provided to the Structural EOR for approval and project records.

Summary

Following the completion of Phase 1, subsequent Phases 2 and 3 were conducted using an identical approach. All concrete debris was removed in the phased approach and piles of debris were not left on the suspended slab for any period of time.

Following the Phase 3 stressing, debris removal and Structural EOR approval, the shoring frames below on the third floor were removed to highlight a new stairway opening (Fig. 10 and 11) which is the nucleus of the new office environment. ■

Fig. 8: Phase 1 post-tensioned tendons within new anchorage zone

Fig. 9: Multihead anchor within slab thickening at column locations

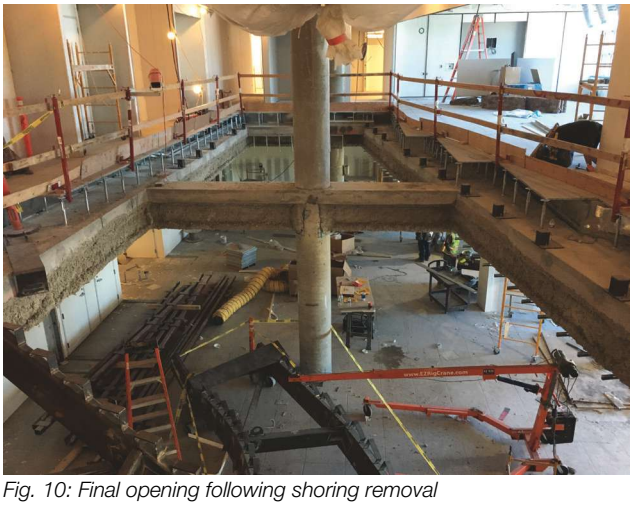

Fig. 10: Final opening following shoring removal

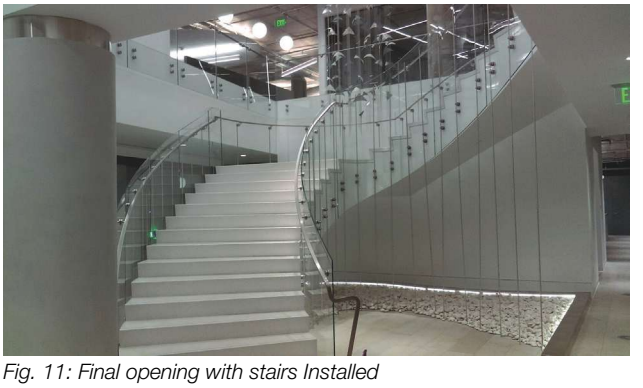

Fig. 11: Final opening with stairs Installed

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Cathodic Protection of New Reinforced Concrete Structures

BY GINA CREVELLO AND PAUL NOYCE

Fig. 1: Gateway Bridge, Brisbane, Australia

A desire for durability requirements in new construction is becoming more common when designing iconic, important, and critical structures. With increasing service life demands, engineers and contractors are expected to provide a client with a structure that will endure with time, meet performance requirements, and function for the specified service life with a high level of reliability. Reinforced concrete (RC) structures subject to durability-based performance requirements commonly have design life stipulations of 75 years or more. In fact, the Second Gateway Bridge in Brisbane, Australia (Fig. 1) was designed for 300 years.[1]

The design leader for the Second Gateway Bridge states, "designing for a very long service life has considerable economic and community benefits and is a means of maximizing the return on community investment in infrastructure. Delaying replacement and minimizing maintenance costs and the disruption caused by maintenance activities is an aim of asset owners. Designing for such a long service life can represent sustainable structural engineering without significant cost premium."[2] Increased knowledge of material science and deterioration has allowed an understanding of construction material performance in service.

Durability-based design approaches consider the exposure category of the structures' location, material performance of the components within the service environment, impacts of environmental load, and degradation rates of construction materials. Corrosion of the reinforcing steel can be sure to occur during the operational life of a structure within the specified design life in most environments. Additionally, increasing weather events and rising global temperatures are placing higher environmental stress loads on civil structures. Therefore, increased risks of material degradation and the acceleration of corrosion kinetics should be considered in the projected service life of a RC/post-tensioned structure.

Cathodic Protection Systems

In 1993, the SHRP S-337 Report stated that a bridge structure exposed to salt can expect corrosion of the embedded steel during its service life. Cathodic Protection (CP) has proven itself as the only permanent repair of existing corroding steel reinforced concrete. Therefore, CP must not be considered separately, but as part of a complete rehabilitation program.[3] With this in mind, electrochemical corrosion mitigation in the form of impressed current cathodic protection (ICCP) should be considered, not only as a retrofit, but as a method of corrosion

prevention for long-term durability assurance in new construction (Fig. 2).

Fig. 2: Expanded mesh anode ribbon installed

Impressed Current Cathodic Systems have a history of use dating back over 100 years. Early experimentation by the California Department of Transportation (Caltrans) in the late 1950s led to the development of ICCP systems for concrete. Cathodic protection has had a sustained use in RC structures since the 1970s. In Italy, between 1990 and 1993, the first use of "cathodic prevention" systems were installed on new bridge decks during construction.[4] The principles established by Pedereffi in 1995 were intended to address corrosion before chlorides entered the concrete. This lead to a major market for cathodic prevention systems in the Arabian Gulf where the level of chloride contamination combines with the drying conditions evaporating moisture to concentrate chlorides [creating] a highly corrosive environment.[5] Cathodic prevention systems are prevalent in the Arabian Gulf since the early 2000s, and have since been introduced into critical structures across Europe, the Far East, and in the United States (US).

Stages of Reinforcing Steel Corrosion

Mathematical models can be utilized to provide deterministic performance of how specified materials will perform within the given environment for the required service life. By forecasting the probabilistic long-term behavior, assumptions can be made as to when a preventative corrosion mitigation system will benefit the structure. It was originally surmised by early pioneers of the system that current density requirements would be less during the early stages; however, it was observed that notable current output levels, similar to those used in corroding structures, were required in aggressive environments.

Typical corrosion models established by Tuutti[6], as seen in Figure 3, define three modes of time based deterioration in reinforced concrete structures: t_i,t_p,t_f.

Where:

t_i = Time to Corrosion Initiation

t_p = Time to Corrosion Propagation

t_f = Time to Failure

When corrosion of steel is concerned, the service life (t_l) is assumed as the sum of an initiation period and a propagation period: $t_l = t_i + t_p$ (Tuutti,1982). Initiation of corrosion is usually chosen as limit state for chloride-induced corrosion. As a con-

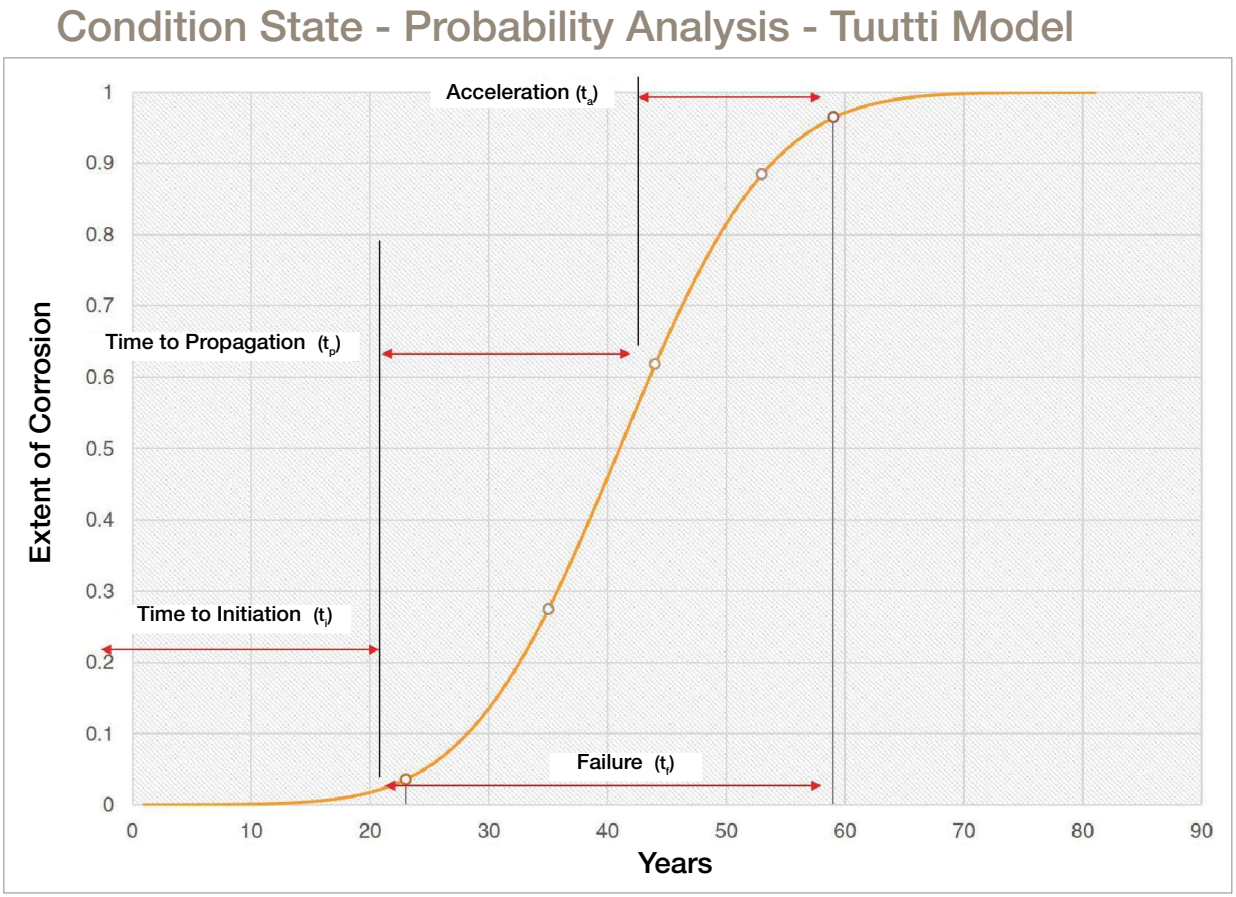

Fig. 3: Modified Tuutti model

sequence, the service life [of the reinforced concrete structure] is assumed to be coincident to the initiation time (i.e., $t_l = t_i$)[7]. In chloride rich environments, the service life (t_l) has proven to be very short in some instances and corrosion is certainly anticipated on structures within 20 years or less.

Therefore, when performing service life models, such as "Time to Critical Chloride Threshold," "Time to Cracking", "Time to Debonding", and "Time to Critical Section Loss," measurable activity can be predicted and subsequently halted. With predictive forecasting, corrosion can be managed at the onset so that the structure does not enter initiation and subsequent propagation.

Environmental Indexing

Understanding the environment and the deterioration mechanisms for a structure which is being built is critical when designing a durable structure. In addition, performance assumptions must consider future changes which may impact that structure. Site specific analyses must be performed for an in-depth understanding of the service environment. Keeping in mind that these models only address current conditions, it is important to realize that service life models have been developed more recently that are dynamic and address the impacts of climate change. These models can inform on a concrete structure's performance in the future with changing loads.

In the US, there are limited references in the ACI 318-14[8] building code to durability and exposure classifications. Chapter 19 Concrete Design and Durability Requirements is limited to four (4) sections covering performance requirements for both lightweight and normal weight concrete. Section 19.3.1 states that the licensed design professional shall assign exposure classes in accordance with the severity of the anticipated exposure of members for each exposure category in Table 19.3.1.1, and further states that concrete mix designs shall conform to code as required. The Corrosion category has three exposure classes. Quite simply, Exposure Category C in the commentary states "chloride ion limits apply."

Further reference to the maximum permissible levels of chloride and the effects of chloride on steel occur in ACI 201.2R[9] and ACI 222R[10]. Both documents provide substantial information regarding corrosion, but not corrosivity of the environment. ACI 222R provides information regarding corrosion of steel in concrete, drivers of corrosion and methods for remediation. Chapter 4, "Procedures for Identifying Corrosive Environments and Active Corrosion in Concrete," outlines an engineering analysis which assists in a condition survey methodology for understanding the structure. This briefly outlines what to review for the environmental indexing, and parameters for severity are left to the investigator's discretion. Table 1, from ACI 318, provides a categorization of service environments and the associated conditions the concrete will be subject to.

The Deemed-to-Satisfy Approach to durability outlined in the *f*ib Model Code 2010 Bulletin 65[11], Section 4.7.2 Durability Related Exposure provides two durability-based exposure

Category	Class	Condition	
Freezing and thawing (F)	F0	Concrete not exposed to freezing-and-thawing cycles	
	F1	Concrete exposed to freezing-and-thawing cycles with limited exposure to water	
	F2	Concrete exposed to freezing-and-thawing cycles with frequent exposure to water	
	F3	Concrete exposed to freezing-and-thawing cycles with frequent exposure to water and exposure to deicing chemicals	
Sulfate (S)		Water-soluble sulfate ($SO4^{2-}$) in soil, percent by mass	Dissolved sulfate ($SO4^{2-}$) in water, ppm
	S0	$0.10 \leq SO4^{2-} < 0.20$	$SO4^{2-} < 150$
	S1	$0.20 \leq SO4^{2-} \leq 2.00$	$150 \leq SO4^{2-} < 1500$ or seawater
	S2	$0.20 \leq SO4^{2-} \leq 2.00$	$1500 \leq SO4^{2-} \leq 10{,}000$
	S3	$SO4^{2-} > 2.00$	$SO4^{2-} > 10{,}000$
In contact with water (W)	W0	Concrete dry in service Concrete in contact with water and low permeability is not required	
	W1	Concrete with water and low permeability is required	
Corrosion protection of reinforcement (C)	C0	Concrete dry or protected from moisture	
	C1	Concrete exposed to moisture but not to an external source of chlorides	
	C2	Concrete exposed to moisture and an external source of chloride from deicing chemicals, salt, brackish water, seawater, or spray from these sources	

Table 1: ACI 318 service enviroments

tables, based on International Organization for Standardization (ISO) 22965-1 Concrete-Part 1, methods of specifying and guidance for the specifier[12]. Designations comprehensively include 18 environmental conditions, including classifications such as: no risk of corrosion or attack; corrosion induced by carbonation; corrosion induced by chlorides other than from sea water; "corrosion induced by chlorides from sea water;" "freeze thaw;" and "chemical attack." Establishing the environment is, therefore, vaguely defined.

ISO defines the corrosivity category as a technical characteristic that provides a basis for the selection of materials and protective measures in atmospheric environments subject to the demands of a specific application, particularly with regard to service life. This approach and classification is based on its standard ISO 9223:2012 (E)—Corrosion of Metals and Alloys—Corrosivity of Atmospheres—Classification, Determination, and Estimation[13].

Metals can suffer corrosion when their surfaces become wet, and the mode of attack may be accelerated by the contaminants within the environment. Atmospheric solids, i.e. particulates, can form surface electrolytes, which increase surface wetness. The duration of wetness and type of contaminants on the metal surface impacts the type and rate of corrosion attack. While this standard pertains to atmospheric conditions, the approach can be used to assist in determining the aggressiveness of the environment that the RC structure is being built in.

The corrosivity of the atmosphere is divided into six (6) basic categories that are defined in Table 2.

Category	Corrosivity
C1	Very Low
C2	Low
C3	Moderate
C4	High
C5	Very High
CX	Extreme

Table 2: Basic categories of corrosivity of the atmosphere (c)[14]

Corrosivity of the environment can be determined based on 1) corrosion rate measurements in standard specimens, 2) normative estimations based on calculated first year losses, and 3) information estimations based on a description of exposure conditions.

Oxygen influences all atmospheric corrosion reactions, while other materials in the environment also affect rates and types of corrosion.

Materials that contribute to corrosion are:

Solids
Solids such as salts will instigate and accelerate the corrosion reaction. Salts are negatively charged particles and are attracted to the oxidation reaction (anode) and become drawn into the corrosion reaction, which becomes self-perpetuating.

Liquids
Liquids can be defined as water, rain, steam, fog, relative humidity (RH) and dew point/condensation, and overall time of wetness (ToW). Relative humidity and dew point can have dramatic effects on corrosion when the moisture of the air condenses on the metallic structure.

Gases
Gases that affect corrosion include nitrogen and sulfur oxide. Gases can dissolve into dew and concentrate on the surfaces.

Temperature effects also impact corrosion. While temperatures can increase corrosion rates and material kinetics, higher temperatures can sometimes lead to lower time of wetness on atmospherically exposed metals and alloys. Reducing time of wetness can prevail over the damaging effects of higher temperatures, unless the humidity levels remains constant.

Time of wetness (ToW) is a somewhat elusive and challenging variable to establish. The ToW refers to the period of time during which the atmospheric conditions are favorable for the formation of a surface layer of moisture on a metal or alloy. In concrete, time of wetness can be considered in relation to high internal RH and wetting and drying cycles of specific components within the structure. For concrete RH values over 65% support corrosion related material degradation.

Table 3, from BS EN ISO 12944-2, "Corrosion Protection of Steel Structures by Protective Paint Systems - Part 2 'Classification of Environments'[15] illustrates corrosivity, section loss of steel, and typical examples of associated environments. Corrosion indices have been established throughout the world, typically by placing corrosion coupons in aggressive environments and measuring the loss of material over a 1-year period. With ferrous metals, the corrosivity category correlates to annual rates of metal loss in a general mode of attack. For RC structures, metal loss is correlated with corrosion rate [microns/year (μm^{-yr1})] and the accumulation of corrosion scale. Further deterioration rates, exerted by the tensile forces of scale on the concrete, can be correlated with service environments.

Using a combination of the foregoing standards, current site data and environmental testing can allow the investigator/designer to classify the environment. Then, one can make better and more informed decisions regarding material selection, and how conditions impact intended service performance of materials. This in turn, allows for more appropriate construction materials to be selected. In the most basic form, corrosivity in-

Atmospheric corrosivity categories and examples of typical environments (BS EN ISO 12944-2)				
Corrosivity category and risk	Low-carbon steel Thickness loss (µm)[a]/ mpy		Examples of typical environments in a temperate climate (informative only)	
			Exterior	Interior
C1 very low	≤ 1.3	0.05	—	Heated buildings with clean atmospheres, e.g. offices, shops, schools, hotels
C2 low	> 1.3 to 25	0.05 to 0.985	Atmospheres with low level of pollution. Mostly rural areas	Unheated buildings where condensation may occur, e.g. depots, sports halls
C3 medium	> 25 to 50	0.985 to1.97	Urban and industrial atmospheres, moderate sulphur dioxide pollution. Coastal area with low salinity	Production rooms with high humidity and some air pollution, e.g. food-processing plants, laundries, breweries, dairies
C4 high	> 50 to 80	1.97 to 3.152	Industrial areas and coastal areas with moderate salinity	Chemical plants, swimming pools, coastal, ship and boatyards
C5-I very high (industrial)	> 80 to 200	3.152 to 7.88	Industrial areas with high humidity and aggressive atmosphere	Buildings or areas with almost permanent condensation and high pollution
C5-M very high (marine)	> 80 to 200	3.152 to 7.88	Coastal and offshore areas with high salinity	Buildings or areas with almost permanent condensation and high pollution
CX	Extreme		Spaces with almost permanent condensation or extensive periods of exposure or extreme humidity effects and/or with high pollution from production process	Subtropical or tropical zone (very high time of wetness), atmospheric environment with high SO2 pollution including accompanying production factors.

Table 3: Atmospheric corrosion categories and typical environments[16]

dices can be developed to assess the aggressiveness of the environment. From this, proactive corrosion mitigation options can be pursued based on the required service life of a structure and desired client maintenance and time to first repair regimens.

Climate Change and Corrosion Kinetics

Going forward, service life models and corrosivity indices must also take into consideration future climatic changes and increased rates of material decay associated with corrosion kinetics. It has been demonstrated through Monte Carlo Simulations that exponential rates of depassivation and chloride penetration will occur in the future and current codes are not equipped to address concrete corrosion propagation. Therefore, it must be assumed that future deterioration is occurring more aggressively than it is today. Factors to consider for increased rates of degradation include:

- Exposure Classifications (ISO 9223, BS EN 206[17])
- Rising Temperatures
- Prolonged RH (within pore structure)
- Increased CO_2 Concentrations
- Increased Chloride Deposition Rates (Atmospheric)
- Increased Time of Wetness (ToW)
- Increased Driving Rain Events
- Solar Radiation
- Increased Salt Loads, Ground Salinity

It is suggested that rising temperatures as low as 3.6˚F (2˚C) can increase the rate of corrosion 15%[18]. Increased temperatures and higher RH values affect diffusion coefficients leading to increased rates of carbonation and chloride ingress into the concrete matrix. Increases in atmospheric CO_2 concentrations from current rates of 379 ppm to 1000 ppm in 2100 will increase depassivation rates of steel in concrete by carbonation reactions. Looking forward, the damage risks for concrete structures due to carbonation has been modeled to increase up to 460% and to 15% for chloride contaminated structures[19]. The probability of depassivation increases by 115% to the end of the 21st century[20], due to rising CO_2 levels. In all instances, **unprotected reinforced concrete structures** built in the future will have earlier time to first repair than structures built today, earlier corrosion initiation, and a decrease in service life.

Cathodic Prevention in Use

Impressed Current Cathodic Protection has been adapted for new construction with a rationale based on long-term performance and cost on numerous projects in the international arena. Cathodic protection in new reinforced concrete structures

has over 20 years of successful use, and published track records. Bertolini states that "if cathodic prevention is applied to passive steel embedded in concrete exposed to the atmosphere, even a modest lowering of the steel potential can produce a significant increase in the critical chloride content. In fact…by lowering the steel potential of only 100 mV can maintain steel passivity at higher chloride contents…It should therefore be emphasized that cathodic prevention has to be applied before corrosion initiates and must be maintained throughout the entire service life of the structure. If corrosion has initiated, cathodic prevention cannot be applied, and…cathodic protection has to be applied instead."[21]

The rapid deterioration experienced by new reinforced concrete sea water cooling towers owned by Saudi Basic Industries Corporation (SABIC) in Yanbu and Jubail after 12 years in service led the owners to instigate a program of preventative corrosion protection.[22] These systems, installed over 15 years ago, are operational and functional today. The structures have not experienced the rapid deterioration as the earlier structures, thus proof of concept was established.

In accordance with NACE 290[23] and BS EN 12696[24], design current densities for cathodic protection of steel in concrete for existing structures are to be between 2-20mA/m^2 of steel surface area and 0.2-2mA/m^2 of steel surface area based on the aggressiveness of the environment and levels of corrosion activity. Design currents for new structures in SOJECK (2002)[25] were initially established at 2mA/m^2; however it was determined after monitoring for a period that current density requirements for protection to achieve the required potential decay were between 3.5 and 4mA/m^2. These salt water cooling towers were subject to high temperature salt water, thus an extremely aggressive environment.

Additionally, engineers in Bahrain have incorporated cathodic protection systems into the Durrat Al-Bahrain Bridge System which interlinks reclaimed islands in the Arabian Gulf. The 13 new interlinking island bridge systems had a total length of approximately 2.2 miles (3.5km). CP systems were chosen based on durability requirements (50+ years) and a cost benefit analysis which clearly illustrated that the cost of black bar with cathodic protection was significantly less expensive than the use of solid stainless-steel reinforcing. Constructability issues aside, the cost comparison analysis demonstrated that the cost premium for stainless steel reinforcing would have been US$31.5 million and CP was US$2.35 million."[26]

The design current density for the work in Durrat-Al Bahrain (2007) was 5mA/m^2.[27] This illustrates that the current density requirements to achieve protection in an aggressive environment were twice as high as originally thought (Fig. 4).

For the projects above and other similar projects, cathodic prevention systems were chosen based on the structures having a 100-year design life, and minimal maintenance requirements going forward. In each instance, the aggressiveness of the environment was established prior to introducing the cathodic prevention design as a long-term proactive system. Owners were aware that the structure was of critical importance, and that corrosion of the steel would impact future functionality and would have a higher cost for mitigation once corrosion initiated.

Fig. 4: Durrat Al-Bahrain

Fig. 5: Burj Khalifa—Cathodic prevention has been used at the foundations of this supertall building

Structure types where cathodic prevention has been used include reinforced concrete foundations, buildings, industrial/petrochemical plant cooling towers, entire bridge structures, caissons, subgrade beams, above grade steel frames, and more (Fig. 5).

Conclusions

Owners of new structures should be informed that active, long-term cathodic prevention systems can be designed and integrated into any reinforced concrete and pre-stressed structures. By understanding the service environment, preventative measures can be established. Increased corrosion related deterioration is on the horizon, and undisputed technology is available to address chloride rich environments with proactive repairs. Where design life requirements of 50 years or greater are desired, cathodic prevention will help owners and asset managers achieve durability goals.

Minimizing repair cycles and reducing the cost of corrosion related deterioration can be planned at the outset of design, thus the structure should not enter corrosion initiation. By reducing corrosion, and subsequent materials deterioration, asset owners will reduce repair expenditures and have fewer maintenance cycles on their structures. The benefits of installing a cathodic protection system from inception versus retrofitting an ICCP system into an existing structure is significantly less in cost. In addition, the known electrochemical reactions that occur in cathodic prevention systems are founded in 200 years of science, and have known operating parameters for long-term corrosion prevention and mitigation. ■

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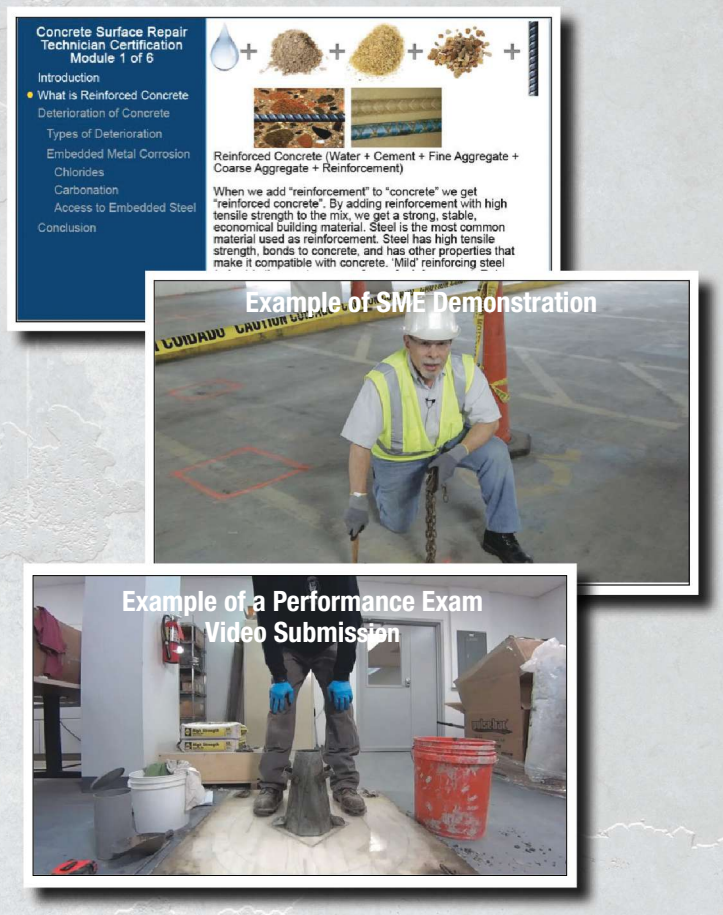

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Restoration of Shelf Angles in Brick Masonry Building Façades

BY MURAT "ROD" SEYIDOGLU

Repair and replacement of shelf angles is a commonly encountered phenomenon among restoration professionals. Oftentimes, façade repair projects in older buildings involve repair and replacement of deteriorated shelf angles. Depending on the type of construction, face brick may be supported with shelf or relieving angles, or loose lintels. Shelf or relieving angles are connected to a back-up wall system or slab edges with cast-in or post-installed anchors. Typical details used by industry professionals to address shelf angle restoration have evolved greatly in the past 50 years. Understanding the effects of buildings' cavity systems has encouraged architects to provide a cavity for drainage (and exterior insulation in newer systems) between the face brick and back-up walls. It is imperative for a restoration engineer to be aware of how the existing façade is intended to perform and the effects of repairs on the building façade. Before development of repair details, areas exhibiting distress should be carefully explored and the condition of the shelf angles evaluated through visual inspection methods (non-destructive) as well as inspection openings (probes) through destructive sampling techniques. Cracking, shifting and bulging in face brick typically indicate issues related to movement and performance of the façade. Causes of distress and investigation of brick façades is a well discussed topic and various resources are available to provide guidance to industry professionals. The focus of this article is inspection, evaluation and repair of existing shelf/relieving angles in brick masonry façades. In addition, commonly encountered problems with shelf angles in brick façades and repair methods will also be discussed.

Field Investigation

It is essential to determine the condition of the shelf angles through field investigation. Consideration must be given to accurately document the geometry of the connection to the existing structure. The number of brick courses being supported by the shelf angle, amount of brick bearing available over the angles, spacing, type, size, embedment, etc., of the anchorage (welds or anchors), and flashing details should be determined. If available, existing architectural, structural and shop drawings will provide invaluable information to the restoration engineer. After the field survey and review of available design documents, an analysis should be performed to determine whether the existing shelf angles and the connection to the base structure have sufficient strength to resist the required superimposed loads with the design parameters observed in the field. Original design assumptions, possibly considering modest eccentricities, may not have been followed during the original construction of the structure. If water penetration is an issue, corrosion of the shelf angles may have reduced the angle's cross-sectional area; hence, the angles should be verified with the remaining steel cross-section.

Repair Program

Options

In the case of deteriorated shelf angles, depending on the level of corrosion and cross-sectional area loss, several repair options can be considered. If minor surface corrosion is observed where surface corrosion results in no more than 10 to 15% section loss, shelf angles may be salvageable and retrofits may not be necessary. However, this would need to be verified through analysis by the engineer. If the angles are adequate for re-use, they can be cleaned by abrasive blasting and protected with a zinc-rich paint, or using similar techniques and materials.

If isolated and moderate cross-sectional area loss exists (i.e. 15 to 20%), the shelf angle could be retrofitted by welding retrofit plates to the angle legs or providing additional anchors to reduce the angle's span. Additionally, the existing corrosion should be cleaned by abrasive blasting, or other acceptable method. It must be considered that field welding to an existing angle is difficult and costly and this option may be chosen in situations where removal of the shelf angle cannot be easily performed (as in the case of steel framed buildings where the shelf angles may be supporting windows and brick or if there are other special conditions). Typically, 36 ksi (248 MPa) steel is utilized in buildings which were constructed within the last 30 to 40 years; however, lower grade steels may have been used in older, especially historic, buildings (American Institute of Steel Construction [AISC] provides excellent information on common types of steel used in historic buildings). If welding new steel is necessary, the engineer should make sure that the existing steel properties are known and the welds are specified properly (Refer to Blodgett for guidance on verification of steel material).

If a widespread and/or severe corrosion issue exists at the angles (i.e. section loss of 20% or more), such sections are typically removed and replaced in their entirety. After determining the

level of angle corrosion in the field, calculations should be performed to verify that the selected repair method is suitable and cost-efficient.

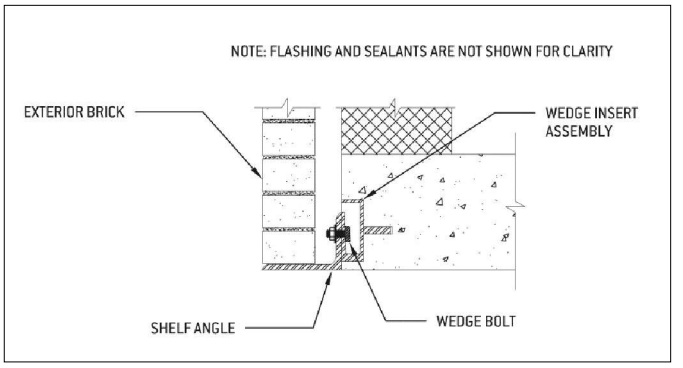

Fig. 1: Embed anchor cross-section

Anchorages

Another important item to consider in the repair process is the re-use of existing anchorages. Older brick façades in concrete buildings typically utilize cast-in headed studs to anchor shelf angles (Fig. 1). If the engineer chooses to re-use the existing headed studs, it should be verified that the existing anchors have adequate strength to carry the applied loads either by analysis or testing. If the structural adequacy cannot be verified by analysis, in-place testing can be performed at a representative number of sample locations to determine the capacity of the anchors. Testing methods should comply with the applicable building codes and or as determined by the authorities having jurisdiction. The condition of the slab edges should also be carefully investigated as horizontal pry-out reinforcement required to prevent shear failures are not typically present in older buildings (Fig. 2). In some instances, shelf angles can support multiple floor levels of the façade brick, typically in buildings constructed in the '50s and '60s. In such cases, it may be beneficial to add additional shelf angles at unsupported levels to reduce the stress on the support angles which would reduce the deflection. Furthermore, the provision of horizontal soft joints to allow vertical movement of the face brick between the supports is essential to prevent moisture expansion, thermal stresses and building creep (in concrete and wood framed structures) at the shelf angles. Such movements are often the cause of masonry walls' distortion/bulging due to the wall's inability to expand/contract, as well as the masonry panel's ability to manage structural frame movements. Special attention should be given to parapets and balcony walls as such elements are critical to life safety and more vulnerable due to being cantilevered.

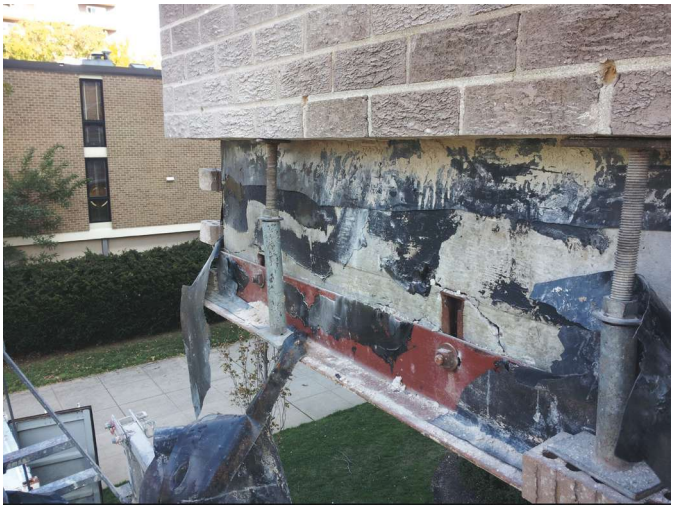
Fig. 2: Shear failures at anchor embeds

Original Construction Considerations

Construction methods and workmanship issues also contribute to the failures in brick façades. In most jurisdictions, shelf angle installations are typically not inspected (and not required to be inspected); therefore, poor workmanship is a commonly encountered problem. Some of the frequently observed workmanship issues include misplacement of headed studs in slabs, improper placement the brick over the angles (not having sufficient bearing), misplacement of anchor bolts, misplacement of expansion/control joints and use of wrong angle sizes. As shown in Figure 3, a 1 in (25 mm) change in brick eccentricity will significantly increase the tensile pull-out force on the angle.

This increase in force on the angle could cause an anchor bolt to become overstressed; and without proper inspections, it is more than likely that the bearing of the cladding over a shelf angle will be constructed with a 1 in (25 mm) or more tolerance and/or the cladding will experience movement over time which will increase the eccentricity, and pull-out force on the bolts.

During the investigation phase of façade rehabilitation projects, it is imperative to properly identify the

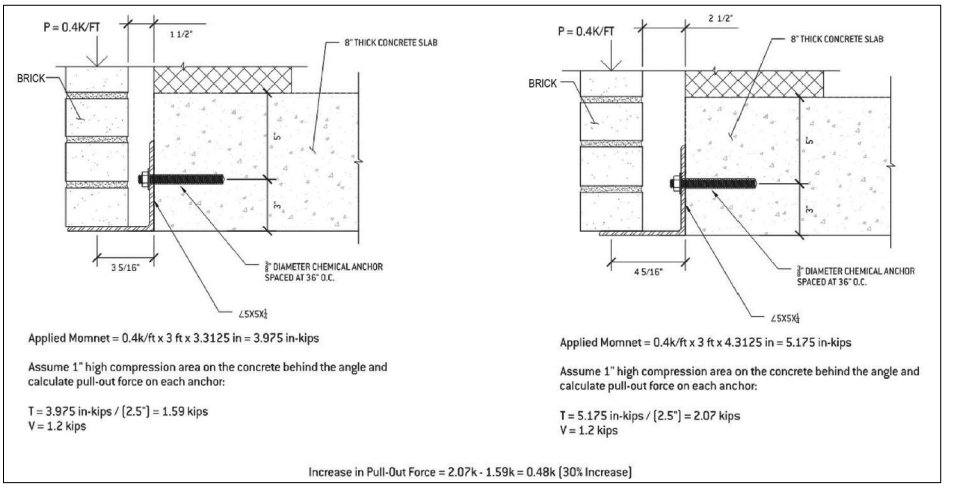

Fig. 2: Change in tensile force due to a 1 in (25 mm) additional brick bearing

Fig. 4: Waterproofed shelf angle and masonry substrate

Fig. 5: Joint spacing is provided for movement

Fig. 6: Shelf angle installation after repairs and waterproofing

underlying cause of the shelf angle distress and be aware of errors that may have been made during the original construction of the structure.

Waterproofing and Protection

After a structural solution is implemented to ensure that the shelf angles are adequate to support the superimposed loads, precautions should be taken to prevent the problem from repeating itself. If water penetration into the building cavity is a problem, appropriate waterproofing measures (typically flashing) must be implemented to protect the shelf angles and minimize water intrusion (Fig. 4). Weeps should be provided along the shelf angles to ensure that water accumulation over the angle is minimized and appropriate joint spacing should be provided below the shelf angle to allow movement (Fig. 5 and 6). Surface preparation and installation of the waterproofing materials in accordance with the flashing/waterproofing manufacturers' recommendations is also paramount for the longevity of the repairs. If the substrates receiving the waterproofing are not properly prepared (i.e. dirt, rust, mortar are not cleaned), waterproofing materials will de-bond rapidly. As a precaution, shelf angles can be coated with a zinc rich coating, or other similar material, prior to flashing installation. Use of hot-dipped steel may also be justified in instances where the shelf angles are to remain exposed to elements as in the case of exposed precast structures.

Conclusion

In summary, when done correctly, shelf angle rehabilitation projects will allow brick façades to remain in service longer. Rehabilitation of shelf angles and re-use of the existing façades is not only the most economical solution for the building owners, it is also the most environmentally sustainable solution as keeping an existing façade in service has a much lower environmental impact than demolishing an existing façade and replacing with new. ■

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Maintenance and Repair Costs for Different Types of Parking Structures

BY OMID GOORANORIMI AND K. NAM SHIU

Parking structures deteriorate over time due to aging and exposure to different types of aggressive environments. Regular repair and maintenance are critical in extending the anticipated service life of these structures. The main purpose of this article is to project the repair cost per type and age of the parking structures in order to provide effective and cost-efficient repair and renewal planning. Available deterioration curves of parking structures in the literature are mainly conceptual and no quantitative model has been established. Conceptually, as shown in Figure 1, the deterioration curve has the shape of an exponential function. More extensive repair and restoration work will move the deterioration curve of the structure to the right, thereby reducing the annual maintenance costs and at the same time extending the anticipated service life.

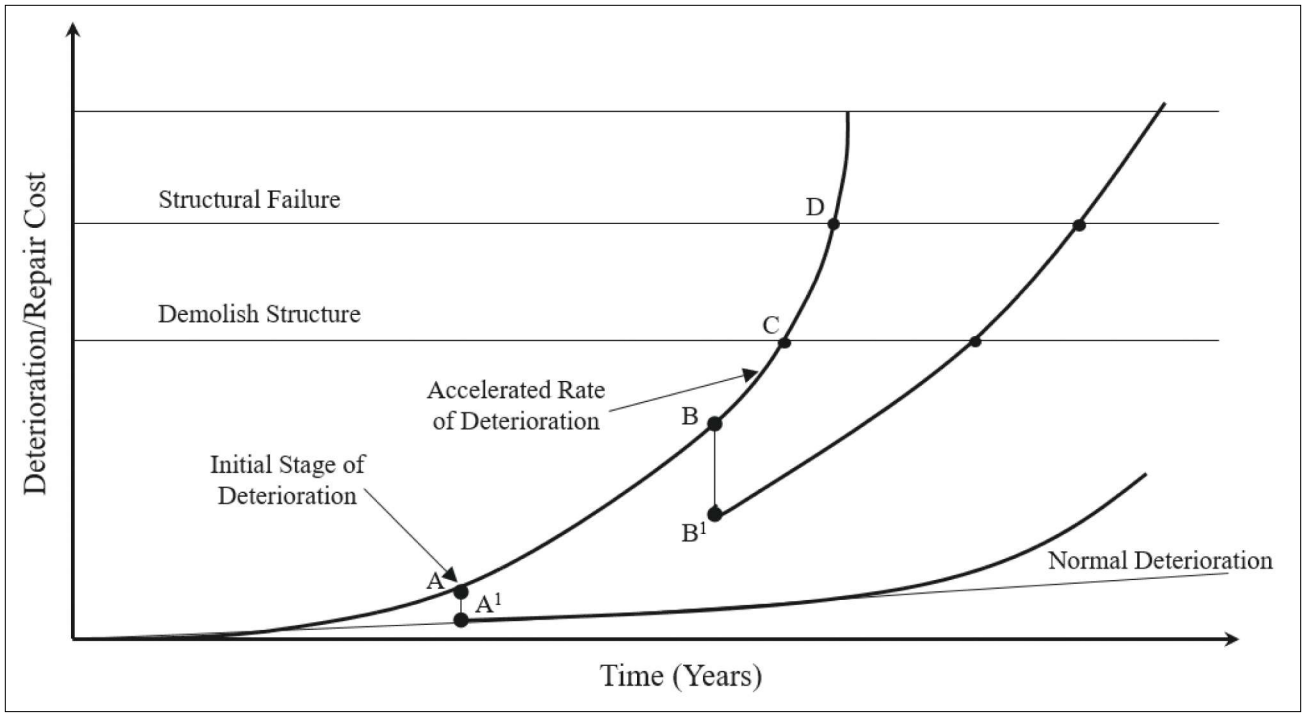

Fig. 1: Conceptual deterioration curve of parking structures (Chrest et. al, 2000)[1]

The main objective of the study is to understand what are typical costs for maintaining and keeping parking structures in a condition of good repair throughout their service life. The effect of type and age of the structure on repair cost were also investigated and are discussed. A total of 66 parking structures was included in this study. Parking structures are located in the Midwest region of the United States and are owned either by municipalities or universities. Collected information in the database included the following information:

- The structural types;
- The construction materials used;
- The construction year; and
- The usage and history of how the structures were used and maintained.

The repair and maintenance cost history of each parking structure was used to evaluate the general trend of the repair costs throughout its service life. A number of factors were identified that would and could affect the repair and maintenance costs for these parking structures. The database was then used to quantify the impact of those factors on the overall repair and maintenance costs for the parking structures.

Types of Maintenance and Repair

Maintenance and repair costs can include a wide variety of actions. In general, there are three main types of maintenance and repair as outlined below:

Type 1: Routine Operational Maintenance
Regular actions in keeping the structures in good condition, such as cleaning, protection, and routine work.

Type 2: Periodic Repair
Periodic repairs include concrete work such as sealing of cracks by injection or with caulking, concrete patching, re-coating of traffic bearing membrane, replacement of expansion joints, etc.

Type 3: Replacement
Rehabilitation or restoration of structural capacity due to excessive load-induced distress such as wind storms, earthquakes, and flooding; design flaws or built-in deficiencies; corrosion deterioration; and material defects, such as poor freezing and thawing resistance, and concrete alkali-silica reactions (ASR).

Major Factors Affecting Maintenance and Repair

Three major factors have been identified that affect the maintenance and repair of parking structures, and include the structural system, age, and environmental exposure.

Structural System
Different types of structures behave and age differently. To assess the impact of structural systems on the maintenance and repair, the parking structures were divided into two main groups for each set of comparison:

- Conventional Reinforced Concrete (RC) versus Post-Tensioned (PT) Concrete structures; and
- Precast versus Cast-in-place (CIP) Construction.

Conventional RC Versus PT Concrete Structures
Conventional RC structures count on the composite actions with mild reinforcement steel and concrete to provide the necessary strength for the structural elements. As such, cracking is expected and commonly found in conventional reinforced concrete structures. With cracking, the protection offered by the concrete cover is drastically diminished. Corrosive contaminants can penetrate through open cracks to reach the embedded reinforcement steel, thereby promoting corrosion. Even with the increased concrete cover in current specifications, cracking continues to be a weak link in the durability of conventional RC elements.

On the other hand, PT structures count on compressive stresses induced to the concrete elements through the elongation of the PT strand system to minimize potential cracking. As a result, durability of the PT structure is expected to increase, and the maintenance and repair costs to reduce proportionally.

Precast Versus Cast-in-Place Construction
Precast construction involves casting the concrete elements off-site. Concrete elements are made in a precast plant under a controlled environment and then shipped to the job site for assembly. The advantage of this construction method is that precast concrete usually has better quality. On the other hand, precast construction comes with many joints. Maintaining the structural integrity and water tightness of these joints is a challenge. In contrast, cast-in-place construction (CIP) generally encounters quality control issues. Casting good quality concrete in diverse, rapidly changing, and environmental demanding conditions is not easy. Quality control for concrete placement, consolidation, and curing all contribute significantly to the eventual concrete durability. So, though not explicitly proven, it is expected and commonly accepted that CIP concrete would have costlier maintenance and repair demand compared to precast concrete.

Age of Parking Structures

As one would expect, the older the structure, the higher the maintenance and repair costs would be. The age of the parking structure is directly proportional to the level and severity of deterioration in the following areas:

- The wear and tear from normal operational use of the parking structure; impact of the seasonal weathering from wind, rain, heat, and snow; and the aging of construction materials all contribute to the overall deterioration.

- Older parking structures may have some built-in deficiencies that were not known to design professionals at the time of construction. For example, concrete structures built after 1980 were designed with a thicker concrete cover (1 ½ in [38 mm] instead of ¾ in [19 mm]) over steel reinforcement steel to combat steel corrosion. As a result, concrete structures built after 1980 are expected to have less corrosion-related deterioration.

- Newer structures incorporate better and more advanced building technologies. For example, pre-1975 PT systems generally used single wire button-head systems covered with paper wrap. The paper wrap sheathing offers practically little to no protection against corrosive agents such as chloride ions. As a result, extensive corrosion has occurred with the button-headed systems. To correct such deficiency, plastic sheathing was adopted and widely used after 1976. At the same time, high strength bundled wires or 7-wire strands were introduced, further improving the PT systems. Another wave of improvement came after 1991 when double protection was provided at intermediate anchors to protect the elongated tendon lengths. Soon after, the PT anchorage hardware was completely encapsulated against hardware corrosion. For this progressive development and improvement, different deterioration curves and laws are anticipated, hence the PT parking structures are grouped into pre-1975, 1976-1990 and 1991-present.

- Use of better construction materials such as high-performance concrete with higher compressive strengths, better impermeability, and lower concrete shrinkage offers much better durability performance.

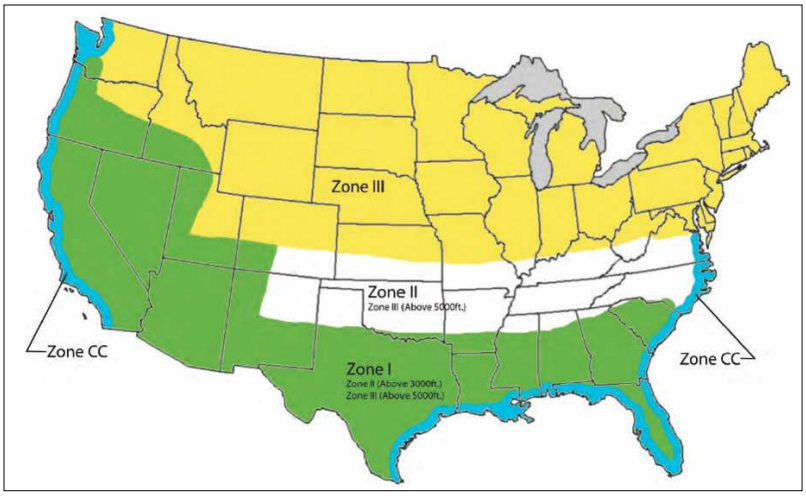

Fig. 2: Climate exposure zones for parking structures (Source: ACI 362.1R-12)

Table 1: Database of different types of structural systems

Structural Type	Definition	No. of Structures (#)	Range of Construction Year
A	CIP/PT Button Head	3	1966-1970
B	CIP/PT Mono-Strand	43	1972-2006
C	CIP Short Span Conventional RC	8	1957-1968
D	Precast Double-T Field-Topped	9	1973-2006
E	Precast Double-T Pre-Topped	3	1972-1990
Total		**66**	**1967-2006**

Table 2: The number of structures for each age category

Structural Type	Pre-1975 (#)	1976-1990 (#)	1991-Present (#)
A	3	0	0
B	4	16	23
C	8	0	0
D	3	4	2
E	1	2	0
Total	**19**	**22**	**25**

Table 3: Regression constants and the coefficient of determination for all considered categories

Structural Type & Category	A	B	R^2
Type A - CIP/PT Button Head	0.320	0.082	0.84
Type B - CIP/PT Mono-Strand	0.054	0.145	0.84
Type C - CIP Short Span Conventional RC	0.320	0.089	0.75
Type D - Precast Double-T Field-Topped	0.069	0.124	0.75
Type E - Precast Double-T Pre-Topped	0.016	0.169	0.78
Precast	0.057	0.132	0.75
CIP/PT	0.077	0.127	0.84
PT Pre-1975	0.173	0.094	0.87
PT 1976-1990	0.072	0.115	0.74

Environmental Exposure

The geographical region and type of environmental exposure of parking structures are known to be critical in durability. The American Concrete Institute (ACI) committee for design and construction of durable parking structures (ACI 362.1R-12)[2] suggests five different geographical zones with different types of exposure and weather-related wear as follows (Fig. 2):

- Zone III: Exposed to moisture with freeze-thaw cycles and de-icing salts;
- Zone II: Exposed to moisture with freeze-thaw cycles but no de-icing salts;
- Zone I: Exposed to moisture;
- Zone CC-I: Areas within 1 mile (1.6 km) of salt water bodies; and
- Zone CC-II: Areas within 2 to 5 miles (3.2 to 8 km) of salt water.

As expected, parking structures in Zone III are exposed to the harshest environments. However, they are also designed for these harsh conditions with different levels of protection. So, it is not immediately clear that geographic location of the parking structure would have an impact on its maintenance and repair costs. Unfortunately, all 66 parking structures used in this study are in Zone III, i.e. in the Midwest region, particularly in the states of Michigan and Minnesota. Therefore, no comparison can be made with structures exposed to other climate exposure zones.

Repair Cost Database for Parking Structures

The parking structures were divided into five categories per their structural and construction types including CIP/PT with button head anchorage, CIP/PT with mono-strand wire, CIP conventional short span RC, precast Double-T field topped, and precast Double-T pre-topped structures. Table 1 shows the categories with the number of structures for each type and the range of the construction year within each group.

As shown in Table 1, the number of samples for Types A and E are not statistically significant compared to the other types. Structures were also categorized per their construction year as shown in Table 2.

Theoretical Deterioration and Repair History

It is well recognized that structures deteriorate slowly over time in a non-linear rate (Frangopol et al., 1997)[3]. Deterioration is hardly visible in the beginning. As the structure ages, deterioration becomes more pronounced and the demand for maintenance and repair increases (Shiu & Stanish, 2008)[4]. This is reflected proportionally in the costs needed for maintenance and repair. So, the

deterioration curve is assumed to follow an exponential function with time. Different functions can be defined to describe the behavior of different types of parking structures. In this study, the collected maintenance and repair data from actual parking structures were used to derive the deterioration curves of different types of parking structures.

The known repair dates were converted to time periods based on the age of the structures. First, cumulative repair and maintenance costs were calculated for each point of time according to the history of performed repair. Then, the cumulative cost per square foot was calculated ($/sf).

In this article, routine operational maintenance (Type 1) was excluded and only periodic and replacement repairs (Types 2 and 3) were considered. Upgrades such as lighting, elevators, and equipment replacement are not part of the analysis. The cumulative cost/sf was plotted versus the age for each structural category.

Statistical panel regression analyses were performed for each parking structure and the analysis software was able to derive the best-fit exponential formulation of the cost/sf as a function of the age (year). The exponential equation with the format of $C=Ae^{Bt}$ is reported for each type of structure where…

C = Cumulative repair and maintenance cost ($/sf)
t = Age of the structure (years)
A and B = Constants obtained from the regression analysis and vary for each structural type
e = Base of Natural logarithms, approximately equal to 2.718

It should be emphasized that the cumulative repair and maintenance cost is the total amount of money spent per square foot of that structure from the construction time up to any desired time.

Observations and Findings

Structural Type

The best-fitted curves for all five considered types of structures are shown in Figures 3 to 7. The formulation of the exponential curve and the coefficient of determination (R^2) of the regression are shown on each graph. Table 3 provides the regression constants and the coefficient of determination for the graphs in these figures. The regression is conducted up to the final available data for each type and no interpolation is performed beyond that point.

Due to the exponential nature of the deterioration curve, the rate of deterioration is increasing over

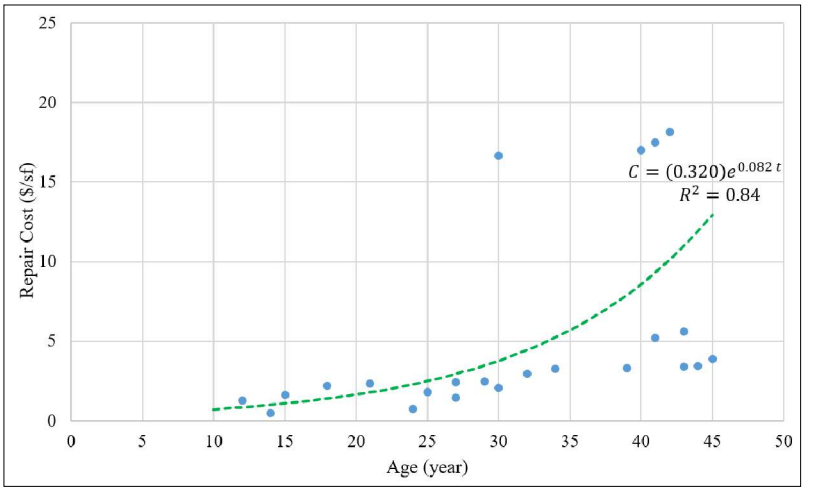

Fig. 3: Deterioration curve of CIP/PT structures with button head anchorage system

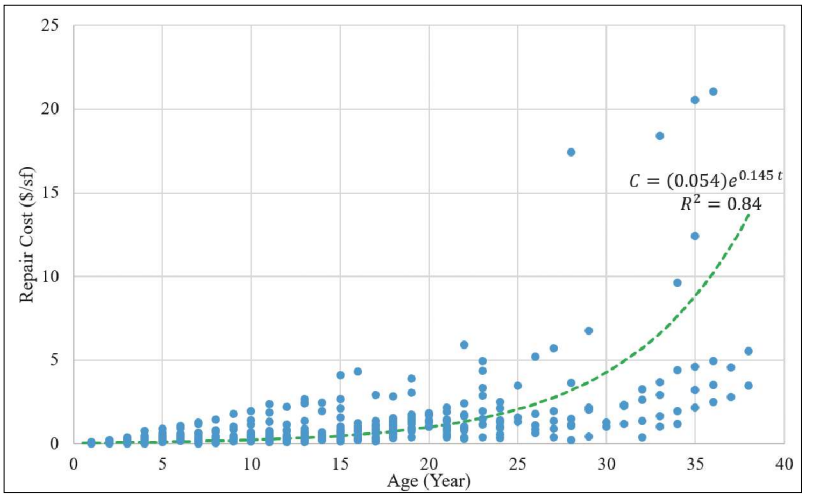

Fig. 4: Deterioration curve of CIP/PT structures with mono-strand wire

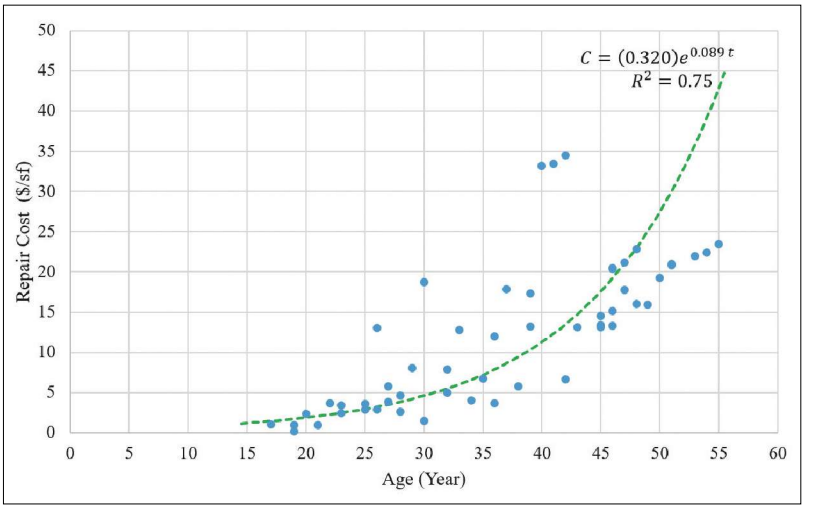

Fig. 5: Deterioration curve of CIP short span-conventional RC structures

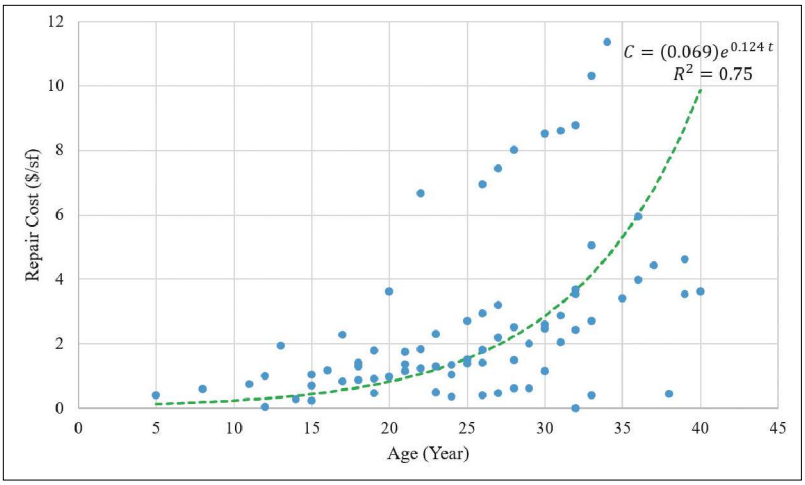

Fig. 6: Deterioration curve of precast Double-T field-topped structures

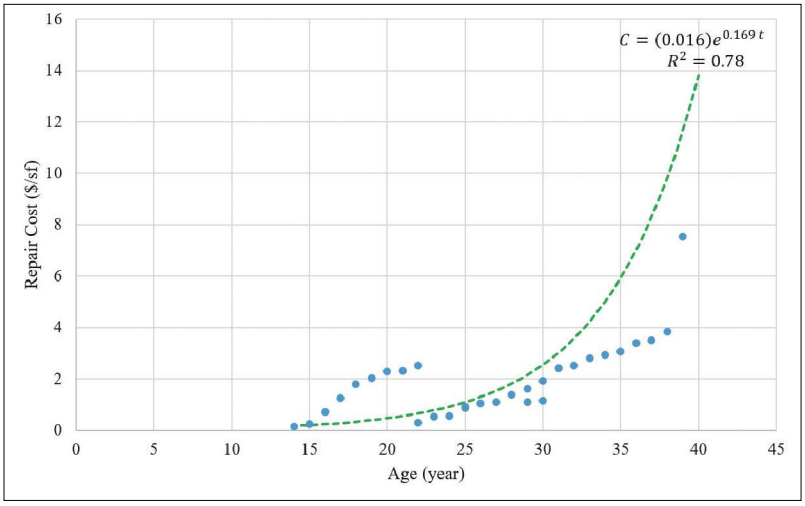

Fig. 7: Deterioration curve of precast Double-T pre-topped structures

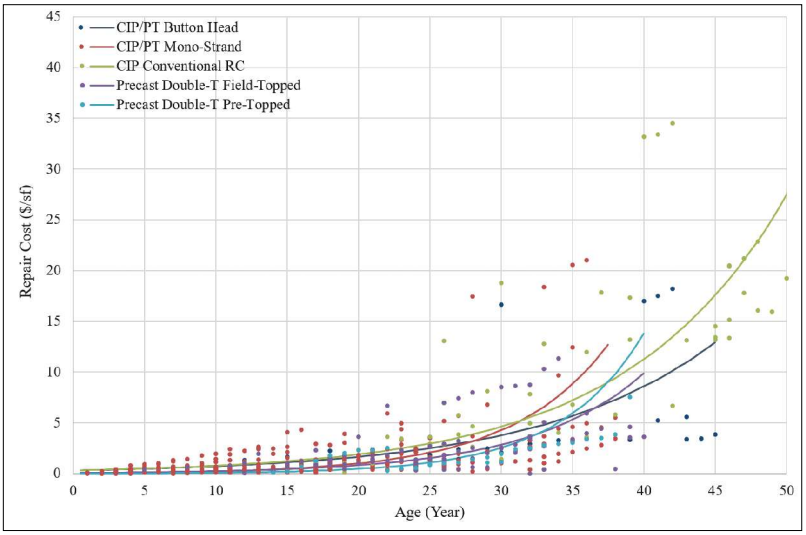

Fig. 8: Deterioration curves of different types of parking structures

time. It implies that any delay in required repair at a certain time leads to a more expensive repair in the future.

Figure 8 provides the real data points and the estimated exponential deterioration curves of all five types of investigated structures for comparison purposes.

From Figure 8, it appears that regardless of the structural type or age, the cumulative maintenance and repair cost is less than $2.50/sf during the first 15 years and $5.00/sf between the age of 15 to 30 years. In other words, it would be more than adequate for one to budget according to these values for Types 2 and 3 maintenance and repair for the first 30 years afer construction. It should be noted that these curves are derived from a limited set of data. Having a broader database would increase the dependability and validity of these curves.

Using the derived deterioration curves, the deterioration characteristics of different types of parking structures were compared. CIP/PT (Type A and B) and precast Double-T construction (Type D and E) have similar cost profile in the early 20 years (Figure 9). The repair cost for CIP/PT structures increases slightly as compared to precast structures after the first 20 years.

A comparison was also made between the conventional RC (Type C) and the PT structures (Types A and B). The result is shown in Figure 10. As expected, the maintenance and repair costs are less for PT construction in the first 37 years. The minimization of cracking in PT construction explains the lower costs. However, the maintenance and repair costs start exceeding the conventional concrete construction after an age of 37 years. This is also reasonable as repair and replacement of PT strands are more involved and expensive than conventional concrete reinforcement steel.

In addition, the effect of topping placement was investigated on the precast Double-T structures by separating them into two groups, field-topped (Type D) and pre-topped (Type E) structures. The result is presented in Figure 11.

The precast Double-T structures with field topping showed higher costs compared to the ones with pre-topping until an age of 32 years. This result is anticipated since field-topped Tees generally have a low-quality deck surface. However, the curve becomes steeper for structures with pre-topping after the age of 32 years. Expanding the database for these two types of structures can lead to more accurate results.

Structural Age

The PT structures were separated into three categories per their time of construction to reflect the effect of available technology at the time of construction on the repair and maintenance costs. These categories include pre-1975, 1976-1990 and 1991-present. The repair and maintenance cost is estimated for each category as shown in Figure 12. Regression constants and the coefficient of determination are provided in Table 3.

As such, the PT structures built in the pre-1975 period show a higher cost compared to the ones built in 1976-1991 which agrees with the improvement of technology for PT construction. The cost of both categories increases with a similar rate. The available data for CIP/PT structures built after 1990 only includes the first 20 years of repair. In order to provide a long-term deterioration curve comparable with the other two categories (which comprise around 40 years of repair history), no curve was estimated for CIP/PT structures built after 1990 and only the point data (green dots) are presented in Figure 12 for this category.

Conclusions and Summary

The repair and maintenance cost of 66 parking structures were included in this study, including CIP/PT with button head anchorage system, CIP/PT with mono-strand wires, conventional short span RC, precast Double-T with field topping and pre-topped precast Double-T structures. The deterioration curve (in terms of repair cost per unit area) for each structural type was calculated as an exponential function of the age of the structure using the panel regression approach. A general comparison was made between the different structural systems. The CIP/PT and precast structures showed a similar deterioration curve for the first 20 years while the CIP/PT structures showed a higher cost afterward. RC structures showed a higher cost compared to the PT structures for the first 37 years while the PT structures showed a higher cost afterward. The field topped precast Double-T structures showed a higher cost compared to the pre-topped precast Double-T structures during the first 33 years while the curve becomes steeper for structures with pre-topping after the age of 32 years. The effect of the structure's age and the available technology at the time of construction was also investigated for PT structures by separating them into three groups per their construction period: pre-1975, 1976-1990 and 1991-present. The PT structures constructed in the period of pre-1975 showed a higher cost compared to the structures constructed in 1976-1990 which is in agreement with the improvement of the technology.

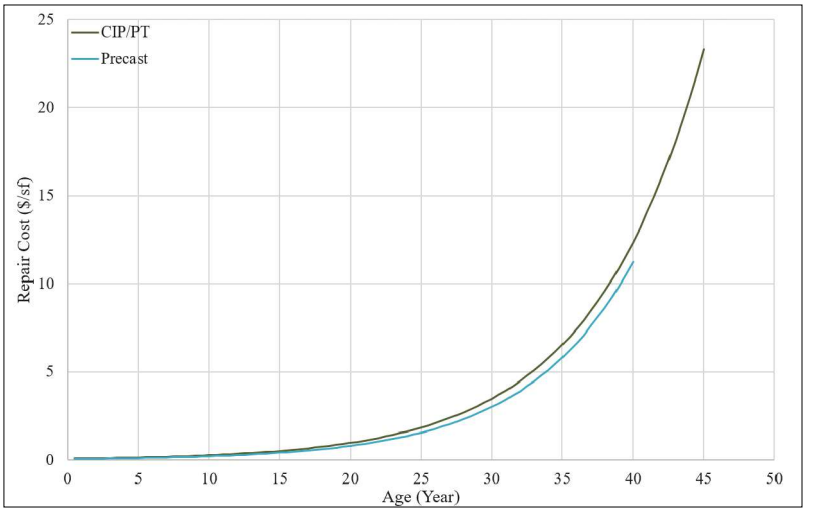

Fig. 9: Deterioration curves of CIP and precast structures

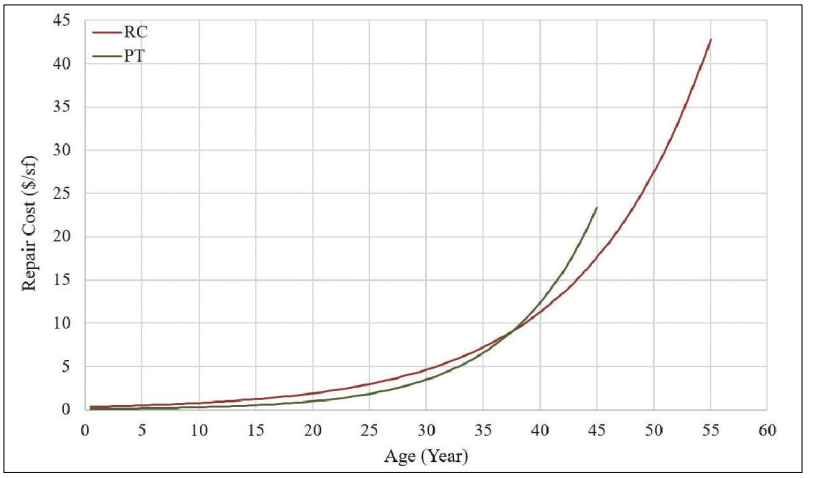

Fig. 10: Deterioration curve of RC and PT structures

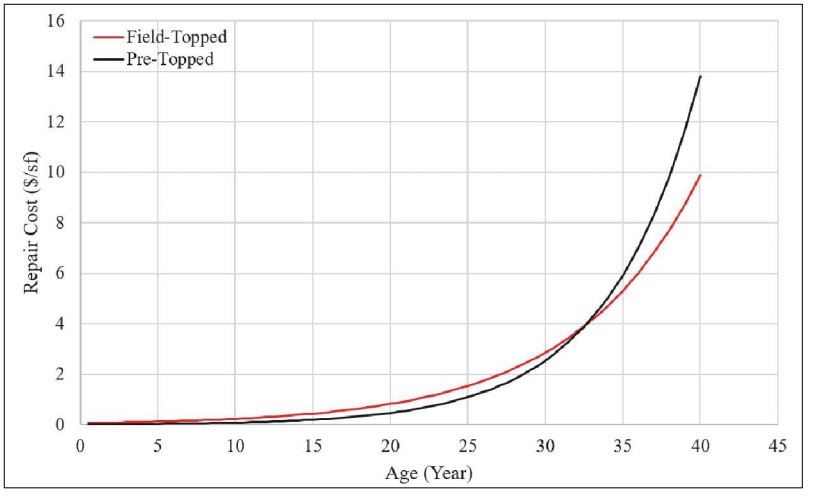

Fig. 11: Deterioration curve of precast double-T structures based on their type of topping

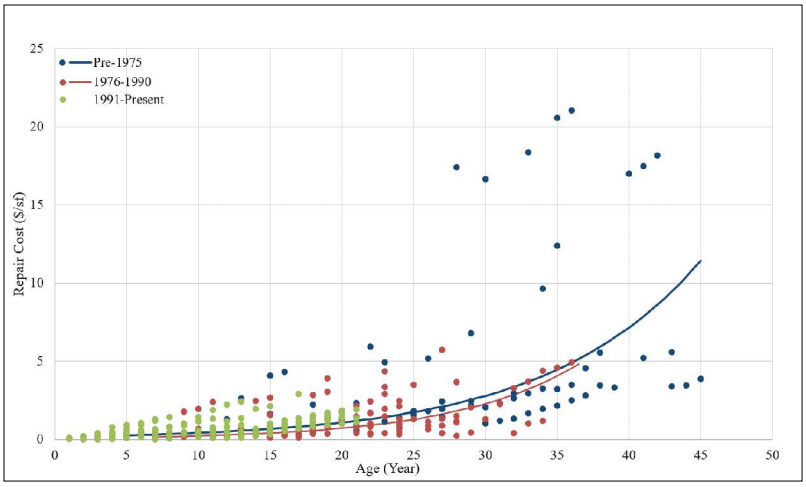

Fig. 12: Deterioration curve of CIP-PT structures based on their construction period

It was concluded that regardless of the structural type and age, the cumulative maintenance and repair costs of parking structure is less than $2.50/sf during the first 15 years and $5.00/sf between the period of 15-30 years. In other words, it would be more than adequate for one to budget according to these values for Types 2 and 3 maintenance and repair before the first 30 years since construction. The proposed deterioration curves can be helpful to evaluate the possible cost of the maintenance and repair at a certain age of the structure by obtaining the possible cumulative cost from the proposed curve and subtracting the total maintenance and repair cost that the structure underwent before the target time. The results of this study also lead to more optimal and cost-efficient repair and renewal planning for different types of parking structures.

More research should be performed by collecting additional data to verify or modify the proposed models. The database used in this study was limited to the Midwest area. Similar database should be prepared for the structures in other geographical zones to be able to propose the deterioration curve of parking structures located in different regions. Additionally, studies should be performed on how to implement the proposed data in this study into asset management and budgeting projects. ■

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Omid Gooranorimi *is a Restoration Engineer at Walker Consultants focusing on structural repair and performance evaluation. Omid received his Ph.D. in Civil Engineering from the University of Miami in 2016. He is a member of ACI Committee 440 Fiber Reinforced Polymer Reinforcement and ACI Committee 437 Strength Evaluation of Existing Concrete Structures. Enhancing the application of composite materials in the construction industry, structural repair and strengthening, and computational mechanics are his main areas of interest.*

K. Nam Shiu *is the Managing Director of Walker Consultants' Restoration Services. He has over 40 years of experience identifying contributing causes for different structural distresses and construction related defects. Nam has worked with building owners, property management companies, insurance companies, healthcare facilities, and government agencies. He has in-depth knowledge with the behavior of existing parking structures, building envelopes, bridges and special structures. His expertise includes distress and forensic investigation, repair and restoration design, water leakage evaluations, waterproofing, expert witnessing and mitigation of corrosion related deterioration. He is a Fellow of the American Concrete Institute and American Society of Civil Engineers, former chair of the Vision 2020 Concrete Repair Council and former Board member of the Strategic Development Council of ACI. He is also an active member of Building Owners & Managers Association. Nam has published over 39 technical papers and is a frequent presenter at technical conventions.*

CONCRETE REPAIR CALENDAR

JANUARY 22, 2018
ICRI 2018 Kick-Off Party
The Rio, Las Vegas, Nevada
Website: **www.icri.org**

JANUARY 23-26, 2018
World of Concrete
Las Vegas Convention Center
Las Vegas, Nevada
Website: www.worldofconcrete.com

JANUARY 24-25, 2018
ICRI Concrete Slab Moisture Testing Certification
World of Concrete
Las Vegas Convention Center Las Vegas, Nevada
Website: www.worldofconcrete.com

JANUARY 30-31, 2018
ICRI Concrete Slab Moisture Testing Certification
TISE West
Mandalay Bay Convention Center Las Vegas, Nevada
Website: www.tisewest.com

FEBRUARY 14, 2018
ICRI Concrete Surface Repair Tech Certification
McKinney, Texas
Website: **www.icri.org**

MARCH 12-13, 2018
ICRI Concrete Slab Moisture Testing Certification
Vancouver, British Columbia, Canada Area
Website: **www.icri.org**

MARCH 21-22, 2018
ICRI Concrete Slab Moisture Testing Certification
Biloxi, Mississippi
Website: **www.icri.org**

APRIL 11-13, 2018
2018 ICRI Spring Convention
The InterContinental Mark Hopkins
San Francisco, California
Theme: *Seismic Solutions*
Website: **www.icri.org**

INTERESTED IN SEEING YOUR EVENT LISTED IN THIS CALENDAR?

Events can be emailed to editor@icri.org. Content for the May/June 2018 issue is due by March 1, 2018 and content for the July/August 2018 issue is due by May 1, 2018.

FOUNDER AND CHAIRMAN OF AMERICAN ENGINEERING TESTING, INC. ANNOUNCES RETIREMENT


Terrance (Terry) Swor

American Engineering Testing (AET), a leader in the fields of geotechnical, environmental, materials and forensic engineering, announced that one of its founders and Chairman Terrance (Terry) Swor, PG, is retiring on January 2, 2018. The announcement comes after a planned transition period commensurate with Daniel Larson, PE, being named CEO in 2016.

With Terry serving as its first President, AET flourished within the engineering and environmental communities as well as creating specialized laboratories for chemistry, petrography and material testing. "His passion for exceptional customer service and building meaningful relationships with clients and vendors alike has allowed the organization to grow and excel through considerable market and economic change," said Larson. "AET is stronger than ever thanks to Terry's tireless dedication to the industry and to our employees."

Swor founded AET in 1989 with Donovan Stormoe, PE, Richard (Dick) Stehly, PE and Robert Krogsgaard, CFO as a company focused on being a leading provider of engineering, environmental and materials testing services in the Minneapolis/St. Paul region. Under Swor's leadership, AET grew from a small local firm into an internationally recognized company. The footprint of services AET provides has increased exponentially and only continues to grow, keeping on path with the founder's vision.

A passionate leader, Swor developed strong relationships with a broad base of engineering, architecture and construction firms, and kept AET financially secure throughout his tenure, sharing the organization's success with employees by creating an Employee Stock Ownership Program (ESOP) early on.

Over his 53-year career, Swor has become a leader in the engineering industry and wider community. Swor served as president of the American Institute of Professional Geologists Minnesota/Wisconsin chapter; president of Minnesota Concrete Council; and is an active member in the Minnesota Geotechnical Society and American Council of Engineering Companies (ACEC). He authored numerous technical publications and presented at professional and technical seminars throughout his career, always looking for ways to advance the geological and engineering profession. He has been the recipient of both the President's Award and Tom Roche Lifetime Achievement Award given annually by ACEC/MN for his dedication to and advocacy for the consulting engineering community. He also received the Richard Stehly Industry Advancement Award by the Minnesota Concrete Council for his dedication and research in the cast-in-place concrete/cement industry.

"AET would like to recognize and thank Terry for his extraordinary leadership and uncompromising drive to create a quality organization during his tenure," says Larson. "All of us in this industry owe Terry much appreciation and gratitude for his commitment to improving the engineering, architecture and construction market, and the communities where we work and live."

American Engineering Testing provides geotechnical, environmental, construction materials, building forensics, petrography, chemistry, and nondestructive testing (NDT) services to public and private sector clients in a broad spectrum of industries. With upwards of 400 employee-owners, AET has a strong reputation as knowledge leaders in our fields of practice. Having its corporate headquarters in St. Paul, MN and over 20 offices throughout the United States, AET's skill set and technical expertise have developed connections that reach nationally and internationally to sophisticated clients in a variety of market sectors. Learn more at www.amengtest.com.

SOON-TO-BE VETERANS GET CONCRETE START IN CIVILIAN LIFE WITH ALCATRAZ PROGRAM

NPS gets help with deferred maintenance repairs as active duty military train for infrastructure jobs

A group of active duty military personnel is taking the first step in their transition to civilian life by learning a new trade and industry management skills as part of a 12-week program sponsored by the Concrete Preservation Institute (CPI). The program trains the soon-to-be veterans in hands-on projects repairing concrete landmark structures at Alcatraz Island, which is a National Park Service (NPS) site. The program helps the active duty participants get ahead of the veteran-to-civilian transition curve and avoid unemployment and underemployment.

"We provide valuable career development opportunities for our deserving service members and train the critically-needed workforce for the concrete industry facing a shortage of skilled tradespeople and managers required to build and fix our country's infrastructure," said CPI President and CEO Tanya Komas. "CPI is a win-win-win public-private partnership that repairs deferred maintenance projects that may not otherwise be completed on National Park Service sites with irreplaceable cultural heritage."

CPI's Field School is an official US military Career Skills Program offered in partnership with the National Park Service at Alcatraz Island and Pearl Harbor's Battleship Row in Hawaii. Averaging over a million visitors a year at each site, the popular NPS sites face deferred maintenance issues also plaguing overall US infrastructure. CPI's work increases visitor safety and access, while preparing the trainees to transition out of the military and begin civilian careers in infrastructure, construction, and concrete.

CPI holds three 12-week, full time sessions per year at each location. Service members remain on active duty while training, receive hands-on technical and management skills, and can earn professional

certifications upon passing examinations. CPI then connects candidates with industry employers, who actively seek to hire qualified individuals in concrete repair, new construction, material production, transportation, business, sales, operations, safety, and other construction-related areas.

CPI's Alcatraz Island Field School began eight years ago with college students and military veterans; going forward, it will continue to focus on active duty military. CPI held a graduation ceremony to honor the current class (that included one veteran) on November 15, 2017, at Fort Mason in San Francisco.

INTERESTED IN SEEING YOUR NEWS IN THIS COLUMN?

Email your association news to editor@icri.org. Content for the May/June 2018 issue is due by March 1, 2018 and content for the July/August 2018 issue is due by May 1, 2018.

ASSOCIATIONNEWS

ACI TO CONNECT JOB SEEKERS WITH HIRING EMPLOYERS AT VIRTUAL CAREER FAIR

The American Concrete Institute (ACI) announced its first virtual career fair scheduled for February 27, 2018, from Noon – 5:00 p.m. EST.

ACI's free virtual career fair will help early-career as well as experienced concrete industry professionals advance their job-seeking skills and gain access to leading employers from throughout the U.S. and abroad. During the fair, job seekers will have the opportunity to meet recruiters and enter private chat rooms for real-time engagement in personalized one-to-one interactions. Job seekers will be able to network with potential employers and receive resume consultations from the comfort of their home or office.

Employer advantages include recruiting costs lower than those of face-to-face recruiting events, along with access to registered candidates' information. Additionally, ACI has developed a sponsorship program that will provide additional employer visibility to job seekers.

Learn more and register for the event at www.concrete.org/careercenter.

NEW EXECUTIVE DIRECTOR NAMED FOR CONNECTICUT CONCRETE PROMOTION COUNCIL

Don Shubert, Executive Director of the Connecticut Construction Industries Association (CCIA), is pleased to announce the appointment of Dominic Di Cenzo as executive director of the Connecticut Concrete Promotion Council (CCPC), a supporting committee of the Connecticut Ready Mixed Concrete Association (CRMCA). Di Cenzo comes to the CCPC with extensive experience in the construction and building materials market. His responsibilities will be promoting the Connecticut Ready Mixed Concrete Association, managing educational programs for both members and those allied to the field, and managing communications to the media and digital outlets.

CRMCA President Kevin Miller of Tilcon Connecticut remarked, "The mission of CRMCA is to promote the use of ready mixed concrete and innovative construction products and technologies. The CRMCA provides both social and educational opportunities for members to discuss and learn about the latest trends and technologies in the ready mixed concrete industry. CRMCA also offers a concrete inspection certification program to ensure quality control for concrete products and applications. Additionally, the CRMCA works through the National Ready Mixed Concrete Association (NRMCA) on federal and local industry matters. We are looking for Dominic, with his marketing and industry experience, to assist the CRMCA to promote the NRMCA national *Build with Strength* campaign to get that message out to the Connecticut construction community."

Di Cenzo has held international marketing and sales positions with several Connecticut construction product manufacturers including LATICRETE International, a global manufacturer of tile and stone installation products headquartered in Bethany; Five Star Products of Shelton, a supplier of precision grouts and concrete repair mortars; and Neoperl, Inc., an OEM supplier of faucet aerators and plumbing attachments located in Waterbury. He is a past member of ICRI (International Concrete Repair Institute) and the IPCMA (International Packaged Concrete Manufacturers Association).

For more information on the Connecticut Concrete Promotion Council and the Connecticut Ready Mixed Concrete Association, please contact Dominic Di Cenzo, Executive Director, Connecticut Concrete Promotion Council, at ctconcretepromotion@gmail.com or 203.915.0279 or call CCPC headquarters at 860.529.6855. Visit www.ctconstruction.org for more information on educational and certification programs.

ACI EXPANDS MISSION TO FOCUS ON GLOBAL STANDARDS ADOPTION

The American Concrete Institute announces that its mission has been

expanded to reflect its proactive approach to advocating the global adoption of ACI standards.

ACI—a leading authority and resource worldwide for individuals and organizations involved in concrete design, construction, and materials—has long focused its efforts on knowledge development and dissemination. Through this expanded mission, the Institute will now dedicate additional resources and effort to also advance the adoption of its consensus-based knowledge. The Institute's expanded mission statement now reads: "ACI develops, disseminates, and advances the adoption of consensus-based knowledge on concrete and its uses."

Recent efforts include partnering with the Saudi Arabia-based Gulf Cooperation Council Standardization Organization to develop a Gulf Building Code based on ACI's Building Code Requirements for Structural Concrete (ACI 318). Similarly, ACI has been working with officials from Vietnam to translate ACI 318 and other documents for use in the country. The Institute also continues to work with the International Code Council to ensure that concrete design and concrete repair provisions are adequately referenced in the International Building Code and International Existing Building Code. Domestically, ACI continues its work with state and local jurisdictions to reference the Institute's standards.

ACI's focus on the development of new code requirements and global adoption and use of ACI knowledge will assist concrete industry professionals globally to manage increasing requirements for the design of concrete structures.

To learn more about ACI's expanded mission, visit www.concrete.org or call 248-848-3800.

THE AMERICAN CONCRETE INSTITUTE ANNOUNCES EDUCATIONAL PARTNERSHIP WITH THE BIG 5 HEAVY SHOW IN DUBAI, MARCH 2018

The American Concrete Institute announces that it will host the ACI Concrete Essentials Seminar Series at the Big 5 Heavy Show in Dubai, UAE, March 26-27, 2018.

The two-day seminar series will give participants an in-depth look into topics including concrete repair, self-consolidating concrete, mass concrete, and more. Additionally, the seminar series will feature a three-part course on the ACI Building Code Requirements for Structural Concrete, which—under a recently-signed agreement with the Gulf Cooperation Council Standardization Organization—will be used to develop a Gulf Building Code.

The Concrete Essentials Seminar Series will take place during the inaugural Big 5 Heavy show. Big 5 Heavy organizes the show into five different sections—concrete, PMV, roadworks, mining, and building materials manufacturing. This show will be the only dedicated platform for professionals involved in large and small-scale construction and demolition projects in the Middle East that require heavy machinery, equipment and concrete.

Partnering with The Big 5 Heavy is one of the ways ACI is establishing stronger relationships with organizations internationally. ACI maintains its relationship with the international concrete community through its participation in international events, its active and influential International Chapters, its collaboration with International Partners, and the Ambassador Speaker Program.

For more information on how to participate in the ACI Concrete Essentials Seminar Series and The Big 5 Heavy, visit www.thebig5heavy.com.

Email your association news to editor@icri.org. Content for the May/June 2018 issue is due by March 1, 2018 and content for the July/August 2018 issue is due by May 1, 2018.

PEOPLE ON THE MOVE

RICK MONTANI NAMED PRESIDENT AND CEO, SIKA CORP


Richard Montani

Richard (Rick) Montani has been named President and CEO of Sika Corporation (USA), effective January 1, 2018. A veteran leader for Sika for over 29 years in the United States, Rick has played a decisive role in the development of Sika's Construction materials business over his distinguished career with the company. He brings a successful track record in marketing, sales, business management, strategic planning, and mergers & acquisitions to his new position.

Most recently, as Executive Vice President from 2013 through 2017, Rick led strong, organic, double-digit sales and profit growth in the Sika target market business areas of Refurbishment and Sealing & Bonding. He also led the development and execution of a successful company-wide, cross-selling strategy that continues to drive growth, and led the completion and integration of 5 new acquisitions for Sika in the United States over the past 3 years.

Rick is a graduate of the Wharton Business School, Advanced Management (AMP) at the University of Pennsylvania. He also holds a Bachelor of Science degree in Chemical Engineering from the University of Dayton, Dayton, OH. Rick is based at the company headquarters in Lyndhurst, New Jersey.

CHRISTOPH GANZ PROMOTED TO PRESIDENT REGION AMERICAS, SIKA AG


Christoph Ganz

Christoph Ganz has been promoted to President, Region Americas of Sika AG, effective January 1, 2018. In his new role, Ganz will be responsible for all Sika companies and countries in North, South, and Central America.

In his over 20 year career at Sika, Ganz has demonstrated strong leadership and continuous success and growth in the various positions he has held. As General Manager, North America since 2013, Ganz led Sika Corporation in the U.S. and Sika Canada, Inc. to double digit growth and has strengthened the U.S. portfolio through strategically aligned mergers and acquisitions, making it one of the most successful companies throughout global Sika.

Before coming to North America for Sika, Ganz was Global Head of Corporate Business Unit Distribution from 2007 to 2012, based in Zurich, Switzerland. He was also General Manager of Sika France and Area Manager of France, North Africa & Mauritius from 2009 to 2012.

Ganz obtained his MBA from The University of St. Gallen in 1996 and received Executive Training from 2007-2015 at IMD Lausanne in Switzerland.

PEOPLE ON THE MOVE

OSCAR VALENZUELA JOINS GARDNER ENGINEERING


Oscar Valenzuela

Gardner Engineering announced the addition of **Oscar Valenzuela** to its team. He is a Virginia Tech graduate with over 17 years of experience in design and restoration projects. As a Project Consultant with Gardner Engineering, Mr. Valenzuela will continue his career in building restoration, providing the firm with his technical and management expertise. With experience gained by having worked in the United States and United Kingdom, he has developed a list of projects that spanned regionally, nationally and internationally. Working as a contractor with Structural, formerly known as Structural Preservation Systems, Inc., he managed projects, from small to large, full scale restorations. Moving to the engineering firm, Smislova, Kehnemui & Associates, P.A., Mr. Valenzuela was involved in design and management of restoration projects, that included parking garages, buildings, façades, plazas, roof replacements, and structural evaluations. Making a move to Great Britain, Mr. Valenzuela worked for Ramboll Group, an international, multi-discipline firm, where he worked on international projects as well as local refurbishment projects. He then took the position of Structural Section Head at The Austin Co. of UK, Ltd., in which he oversaw a small team of structural engineers that designed new structures as well as renovated existing structures for pharmaceutical companies and universities. In addition, Mr. Valenzuela has held many leadership positions within ICRI, both on the local and the national level, and plans to renew and continue his involvement now that he is back in the U.S.

PROSOCO PROMOTES NICK SAVAGE


Nick Savage

Nick Savage has been promoted to lead PROSOCO's Consolideck concrete flooring line of products designed to harden, decorate, protect and maintain finished concrete floors.

A seven-year veteran with PROSOCO, Nick previously worked as the company's regional sales manager covering the Midwest. He started working for PROSOCO in 2010 as a field technician for the concrete flooring group.

He succeeds Kevin Sigourney, who earlier this year was promoted to serve as the company's vice president of brand integrity.

As head of the concrete flooring group, Nick will manage a team of concrete flooring technical specialists, report objectives and strategies to field sales, and lead the group's interdepartmental sales strategy team.

PROSOCO ANNOUNCES PROMOTIONS, NEW HIRES

PROSOCO announces a series of personnel updates to meet the growing demand of its products and services.

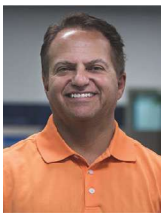

Jake Boyer

Jake Boyer has been promoted from Regional Sales Manager covering the Pacific Northwest to the Business Unit Leader of the company's Clean and Protect product line. This includes the Sure Klean and Enviro Klean sub-brands of cleaners and protective treatments for masonry buildings. Prior to joining PROSOCO in 2013, Jake worked as a technical/territory sales rep for Sherwin-Williams Automotive. He received a degree in Automotive Technology and Business Management from Pitt State University in Pittsburg, Kan. Contact Jake Boyer at jake.boyer@prosoco.com.


Richard McPherson

PROSOCO also has hired **Richard McPherson** as its Architectural Project Coordinator. A registered architect, Richard has more than 30 years of experience in the architecture and construction industry. He most recently worked as a consultant to Burns & McDonnell on projects in Dubai, UAE, and Doha, Qatar. Prior to that role, Richard spent 19 years with Populous Sports Architecture, where he worked as a project manager on many significant domestic and international sports facilities. A graduate of Muskingum Area Technical College in Zanesville, Ohio, Richard lives in Olathe, Kan., with his wife.

His primary role at PROSOCO will be to improve PROSOCO's interface with architects, engineers and contractors. For questions about how PROSOCO can assist in your next project, contact Richard McPherson at Richard.mcpherson@prosoco.com.


Abe Koury

Abe Koury has been hired as a Technical Specialist for PROSOCO's Building Envelope Group focused in the U.S. Southeast. A 28-year veteran in the construction industry, Abe previously worked as a senior technical service representative for STO Corp., in Atlanta for 13 years. A graduate of Wentworth Institute of Technology in Boston, Abe will service customers of PROSOCO's R-Guard line of air and water barriers in Virginia, Maryland, Washington, D.C., North Carolina, South Carolina, Tennessee, Florida, Georgia, Alabama, Texas and Louisiana. Abe is a native of New England but a resident of Atlanta for the past 15 years. Contact Abe Koury with any R-Guard questions at abe.koury@prosoco.com.

INTERESTED IN SEEING YOUR PEOPLE IN THIS COLUMN?

Email your People on the Move announcements to editor@icri.org. Content for the March/April 2018 issue is due by January 2, 2018 and content for the May/June 2018 issue is due by March 1, 2018.

CHAPTER MEETINGS & EVENTS

CONNECTICUT
January 10, 2018
CHAPTER DINNER MEETING
Best Western Plus
North Haven, CT

DELAWARE VALLEY
January 13, 2018
CHAPTER WINTER SOCIAL
Helium Comedy Club
Philadelphia, PA

MINNESOTA
January 11, 2018
CHAPTER 2018 MEGA DEMO DAY
Cement Mason Training Center
New Brighton, MN

FOR UP-TO-DATE CHAPTER ACTIVITIES AND FULL DETAILS ON THOSE LISTED HERE, VISIT WWW.ICRI.ORG.

The ICRI Chapter Awards Program gives recognition to our chapters that, through their operations, programs and activities, display a dedication to excellence and a commitment to success.

Chapter of the Year, Outstanding Chapters, Excellent Chapters, Most Improved Chapter, and Outstanding Chapter Event awards are presented during ICRI's Annual Spring Convention.

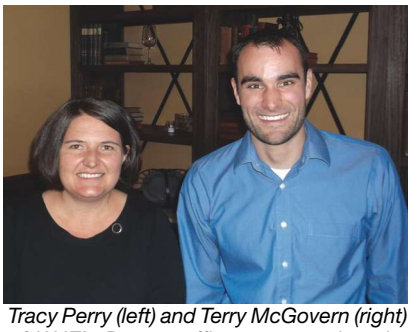
Visit www.icri.org for more information on ICRI Chapters.

CHAPTER NEWS

ROCKY MOUNTAIN HOSTS NDE EVALUATION SEMINAR

The Rocky Mountain Chapter held its third technical presentation of 2017 at the ViewHouse in Centennial, Colorado on Thursday, October 12, 2017, with 37 members and guests in attendance. The topic of the technical presentation, *Nondestructive Test Methods for Evaluation of Concrete,* was presented by Tracy Perry and Terry McGovern of Wiss Janney Elstner Associates' Denver office.

37 attendees listen to Tracy Perry present on Nondestructive Methods



Tracy Perry (left) and Terry McGovern (right) of WJE's Denver office presented at the Rocky Mt. Chapter Technical Presentation

ICRI DUBAI CHAPTER AT CONCRETE TECHNOLOGY FORUM

The ICRI Dubai Chapter was given the opportunity to have a 1-hour slot at the International Concrete Technology Forum in Dubai on Dec. 5, 2017. The chapter provided two unique presentations. ICRI Dubai Vice President Dr. Ashraf Biddah, eForce Engineering, presented *Repair and Strengthening of Structures*. He was followed by ICRI Dubai member Faiz Khan, Technical Director of Simco Middle East, presenting *Durability Engineering for New & Existing Structures*.

Dr. Ashraf Biddah from eForce Engineering giving his presentation on strengthening

Faiz Khan, Technical Director of Simco Middle East

FLORIDA WEST COAST CELEBRATES DONATIONS

On December 8, 2017, the Florida West Coast Chapter of ICRI celebrated the year and the holiday season with a social event at a local TopGolf facility in Tampa, Florida. The highlight of the event came with the opportunity for the chapter to donate $2,000 to University of South Florida College of Engineering.

The Florida West Coast Chapter gathers to present a sizeable donation to the University of South Florida College of Engineering

Florida West Coast Chapter members enjoyed a social evening at TopGolf Tampa

The Florida West Coast Chapter also had the opportunity to provide money and donations to Puerto Rico to help with much needed hurricane relief. Photos of what they witnessed on the island are below.

Did you know that ICRI has 38 chapters, including 2 student chapters, across the US and Canada? Visit www.icri.org to find out more.

METRO NEW YORK HOSTS TERRA COTTA BASICS

On Thursday, October 26, ICRI-Metro New York hosted its second annual all-day technical seminar. This year's topic, *The Basics of Terra Cotta*, covered terra cotta materials, repair, replacement, and much more. Over 170 guests attended to hear speakers Diane Kaese of Kaese & Lynch Architecture and Engineering, Donald Friedman of Old Structures Engineering, Lurita McIntosh-Blank of Walter P. Moore, Jason Coleman of O'Donnell & Naccarato Structural Engineers, Helen Thomas-Haney of Jablonski Building Conservation, and Daniel Allen of CTA Architects. The seminar also included demonstration sessions by Mike Ferrell of Cintec USA and Daniel Perakes of Cathedral Stone Products, Inc. The day concluded with a panel discussion moderated by Dom Diaz of Diaz Architects and included participants Michelle Perez of Gladding, McBean, Jason Hirschhorn of Corinthian Cast Stone, and Christopher Dabek of MicroCotta. Thanks to the support of our insightful speakers, as well as supportive members and guests, this year's seminar was a great success and the chapter looks forward to another great seminar next year.

Speaker Diane Kaese of Kaese & Lynch Architecture and Engineering

Over 170 guests attended Metro New York's second annual all-day technical seminar.

2018 CHAPTER NEWS DEADLINES

MAY/JUNE 2018
March 10, 2018

JULY/AUGUST 2018
May 10, 2018

Send your Chapter News to Dale Regnier, Chapter Relations Director, at daler@icri.org

CHAPTER NEWS

CHAPTERS COMMITTEE CHAIR'S LETTER

JOHN McDOUGALL
Chapters Chair

2017 has been quite a year. We have seen growth and strengthening in many of our chapters, as well as significant activity with our Toronto Chapter! A few programs and chapter activities to note include the North Texas Chapter hosting ICRI CSRT training and certification days, and a tremendous update from our Dubai Chapter.

ICRI UAE held its first international event on Concrete Repair and Rehabilitation on October 25, 2017 in Dubai. This event can be considered the first of its kind in the region and attracted all sectors of the construction industry, including but not limited to: authorities from Dubai, Abu Dhabi, Sharjah and Ras Al Khaimah; consultants; main contractors; repair contractors; and material suppliers. Feedback about the event was very encouraging and they are hoping for more activities from the ICRI organization in the Middle East in the future.

Please look ahead at your chapter calendars for the Roundtable program in Area 4 in the Tampa area in February—Virginia, Carolinas, Georgia, Gulf South, Florida First Coast, Central Florida, Florida West Coast, Southwest Florida, Southeast Florida chapters are all invited. In the fall, likely November, we will be in Area 1, likely Philadelphia—invited are Baltimore Washington, Delaware Valley, Metro New York, Connecticut, Pittsburg, New England, Quebec, Toronto. There are also chapter awards points to be gained through attendance and chapter support of the program.

The roundtable has made 4 cycles across the country and has been a great benefit to both established chapters with consistent programming as well as new and forming chapters. Having been to 7 or 8 of these events—first as a representative of the Carolinas Chapter, as a regional representative and then chapters committee chair—I have always left the meetings with more knowledge of chapter operations than I started with. I have said since my first Roundtable in 2012 in Tampa, the best takeaway is the understanding that any chapter challenge can be worked through—non-responsive board, low attendance, polarizing board member, funding issues, communications problems—all are within our ability to overcome. The connections made at the roundtable meetings with chapter leaders from surrounding areas are a great resource. If you have a question, want some advice, want to know how another chapter does a social event, demo day, or training program—just ask. I've yet to hear anyone refuse to share information with a fellow chapter leader.

I trust your annual report and awards forms are well underway or have been sent to Dale—these are important documents. They will offer a guide to chapter operations best practices, essentially a roadmap to success. If you run into roadblocks with the report, do not hesitate to reach out to me or Dale, the process is not as complicated as it is intimidating. If your chapter has struggled in the past with the awards form, it's a good time to start the new year off with a solid plan. Start organized and stay organized—it will be well worth it next year.

Many new opportunities on the road ahead for our chapter partners, including new revenue streams for partnering with ICRI through hosting certification events and renewals. Look for updates in the new year from Dale and Ken Lozen regarding certification opportunities.

As this will be my final chapters chair message, I want to say a heartfelt thank you to Dale Regnier, ICRI Chapters Director, Guru, go-to guy for all things chapters. He is a tremendous asset to all of our chapters and ICRI as a whole. There will be a new chapters chair – stay tuned.

All the best,

John McDougall
ICRI Chapters Committee Chair

NEW PRODUCTS

VEXCON ANNOUNCES NEW FAST DRYING PENETRATING WATER REPELLENT SEALER

CERTI-VEX PENSEAL 244 FD is a high performance, breathable fast drying penetrating clear silane water repellent penetrating sealer. The product is ideal for cool weather applications and where dry time is critical for fast return to service.

Certi-Vex Penseal 244 FD stops the intrusion of water, salts, deicer chemicals, and acids, which often result in efflorescence, mildew growth, corrosion, scaling, spalling, surface erosion, and other costly damage to hard surfaces.

Treatment of reinforced concrete reduces surface erosion and corrosion of rebar caused by attack of water and water borne salts and alkalis.

Benefits:

- Fast drying - Quick return to service
- Ideal for cool weather application
- Extends the life of concrete and masonry surfaces
- Long term protection against salt corrosion, deicing chemicals, mildew, water, wind driven rain, airborne contaminants, surface spalling from freeze/thaw cycles and other extreme weather conditions

About Vexcon Chemicals: Vexcon produces construction materials designed to build, repair, enhance, protect and maintain a wide variety of concrete and masonry. Our products span numerous markets and product categories and are commonly used on commercial, distribution, industrial, institutional residential and transportation projects both nationally and globally. To learn more about Vexcon and our products go to vexcon.com.

SIMPSON STRONG-TIE LAUNCHES NEW BLOG FOR CONSTRUCTION PROFESSIONALS

The Building Strong blog is a new industry resource that provides insights and fresh perspectives to help construction professionals design and build safer, stronger structures as efficiently as possible. Simpson Strong-Tie has developed the new blog to discuss issues of special interest or importance to building professionals. The blog will cover topics from rising labor costs, proper installation methods and new design technologies to unique viewpoints on the changing landscape of the building industry.

The Building Strong blog is featured on the homepage of strongtie.com and will include articles on the following topics and more:

- Safety, codes, and compliance
- Residential and commercial construction
- Decks and outdoor living
- Building resilience
- Emerging trends and industry insights
- Collaborations and giving
- Pro tips

To read the latest post and subscribe to Building Strong blog updates, visit http://blog.strongtie.com.

WGSSI SHOWCASES IT'S LATEST GPR TECHNOLOGY AT WORLD OF CONCRETE 2018

GSSI, the world's leading manufacturer of ground penetrating radar (GPR) equipment, highlighed its latest GPR technology at the 2018 World of Concrete conference in Las Vegas, Nevada. They displayed a new affordable UtilityScan® GPR System, StructureScan™ Mini XT all-in-one concrete inspection GPR system, and the new Palm XT miniaturized GPR antenna for the StructureScan Mini XT.

The new UtilityScan GPR system, is a compact unit that makes it extremely portable and easy to maneuver in tight survey areas. This model sets a new standard in performance and price. UtilityScan features a robust new wireless antenna that can handle required data rates and is ruggedly built to withstand challenging field conditions. The electrical design uses GSSI's patented HyperStacking technology, which has proven to increase depth penetration in challenging soils, while also providing high near surface data resolution. The unit also has a backup Ethernet connection if WiFi is not desired or allowed on a particular jobsite or facility. The UtilityScan can also be equipped with the LineTrac™ accessory, which helps locate specific power sources situated underground, including AC power and induced RF energy present in conduits. The StructureScan Mini XT is the newest generation of GSSI's popular all-in-one concrete inspection GPR system. Rugged, compact, and flexible, StructureScan Mini XT is ideal for locating rebar, conduits, post-tension cables, and voids. The Mini XT can help identify structural elements, including pan decking and concrete cover, and can also provide real time determination of concrete slab thickness. StructureScan Mini XT is the perfect blend of price and performance, and is backed by a two-year warranty. It features an intuitive touchscreen interface and six-button control options.

The Palm XT Antenna, the newest accessory for the StructureScan Mini XT, is a miniaturized GPR antenna that is designed to greatly enhance the capabilities of the StructureScan Mini XT. The handheld Palm XT antenna turns a basic Mini XT into an advanced system by giving users unparalleled access in tightly spaced areas and enabling overhead scanning. Designed to withstand challenging construction sites, the Palm XT is an excellent choice for contractors who need to perform concrete scanning services. Visit www.geophysical.com for more information.

BOSCH BLAZE™ ONE AND BLAZE™ PRO OFFER PROFESSIONAL LASER MEASURE EXPERIENCE WITH RANGE UP TO 165 FT.

Two options that offer the user a best-in-class solution based on application

Professionals are looking for precision and ease of use in the tools they rely on every day. If that professional-grade tool comes in a compact, go-anywhere size

that's even better. The Bosch BLAZE™ One and BLAZE ™ Pro offer a precision laser measure with 165 ft. range, accuracy up to ±1/16 In., a backlit display and professional features. And all of that capability can fit in a shirt pocket.

The BLAZE One is a one-button measurement tool that offers real-time measurement, which adjusts measurements the closer to or farther away from the target the laser measure is located. The Auto Square function automatically calculates square footage for determining room sizes and material purchase estimates.

The BLAZE Pro is a fully featured, simple-to-use tool that delivers real-time point-and-shoot measurement, plus area, volume, indirect measuring functions and a 10-measurement storage capability. The laser measure also includes addition/subtraction functionality.

The Bosch BLAZE One and BLAZE Pro laser measures offer an easy-to-read display that illuminates numbers with distinct resolution, allowing work in low-light or no-light conditions. In addition, the measurement tools are built to withstand rainy or dusty jobsite conditions and come with an IP54 rating. The tools come with a handy wrist strap, target cards and a pouch.

To learn more about the Bosch BLAZE One or BLAZE Pro or to find a local dealer, visit www.boschtools.com.

BOSCH DDH361 36V BRUTE TOUGH™ ½" CORDLESS DRILL/DRIVER AND HDH361 36V BRUTE TOUGH™ ½" CORDLESS HAMMER DRILL/DRIVER DELIVER BOTH POWER AND PROTECTION

From day-to-day construction tasks to the toughest concrete and metal applications

The Bosch DDH361 36V Brute Tough™ ½" drill/driver and corresponding Bosch HDH361 Brute Tough™ ½" hammer drill/driver deliver corded tool power and performance in a versatile cordless tool.

The Bosch DDH361 36V drill/driver supplies 885 In.-Lbs. of max torque and no-load rpm of 0-1,800 to handle jobs all over the jobsite. The Bosch HDH361 36V Hammer Drill/Driver delivers 885 In.-Lbs. of max torque, a no-load bpm of 0-27,000 and a no-load rpm of 0-1,800. This is one hammer drill that can handle tough materials that range from concrete to metal.

At only 4 lbs. for DDH361 and 4.25 lbs. for HDH361 (tool only, not including battery), these tools are easy to carry and maneuver on the job. Each has two speed settings – one for high-power tasks (0-420 rpm) and one for high-speed drilling (0-1,800 rpm).

The Bosch DDH361 36V drill/driver and Bosch HDH361 36V hammer drill/driver feature Bosch-exclusive Kickback Control, an integrated acceleration sensor that limits tool rotation by detecting sudden movement and shutting down the motor. The feature mitigates injury risk in bind-up situations.

The tools also include a 25+1 precision clutch for more accurate fastener driving and reduced over tightening. Not only will the user see fewer damaged screw heads and bits, but longer life and less wear on the tool. In addition, the tools are built with an all-metal chuck to stand up to severe jobsite conditions and provide high clamping force to stop bit slippage. A 360° Sure-Grip side-assist handle features a tongue-and-groove locking structure to increase control and manageability. And the tools are made with flexible Durashield housing that's designed to withstand accidental drops on concrete.

The Bosch 36V drill/driver and Bosch 36V hammer drill/driver include Bosch-exclusive Electronic Cell Protection (ECP) that protects the battery against overload, overheating and deep discharge for longer life. Likewise, Bosch Electronic Motor Protection (EMP) protects the motor against overload with integrated temperature management. A four-pole brushed motor not only makes the tools more powerful, but also more efficient in battery usage.

To find a local dealer, visit www.boschtools.com.

SKILSAW IS EXCITED TO ANNOUNCE THE SECOND EDITIONS OF SAWS PROS KNOW AND LOVE WITH THE MEDUSAW WALK BEHIND AND SUPER SAWSQUATCH.

MEDUSAW Walk Behind

SKILSAW has taken the next step in scoring concrete with the introduction of its 7-Inch MEDUSAW™ Walk Behind Worm Drive Saw for Concrete, model SPT79A-10. This new walk-behind saw satisfies a user's need for a complete, ergonomic solution for scoring concrete in larger-area applications where productivity is important. This saw incorporates the same wet/dry dust management system and powerful worm drive motor as MEDUSAW, with the addition of an efficient walk-behind configuration.

Super Sawsquatch

SKILSAW brings its biggest saw yet, the 16-5/16-Inch Magnesium Super Saws-

quatchTMWorm Drive Saw, to life. Featuring the company's legendary worm drive gearing, 15 Amp Dual-FieldTM motor and specially engineered 16-5/16-inch 32-tooth SKILSAW blade, the Super Sawsquatch delivers unmatched power and performance thanks to this incomparable engineering trifecta.

NEW SET-3G™ HIGH-STRENGTH ANCHORING ADHESIVE FROM SIMPSON STRONG-TIE

Formulated to yield superior performance in threaded rod anchor and rebar dowel installations in cracked and uncracked concrete at elevated temperatures, the new SET-3G high-strength anchoring adhesive is the latest innovation in epoxy anchoring adhesives from Simpson Strong-Tie. In addition to providing exceptional bond strength with a cure time of just 24 hours, SET-3G adhesive has been proven to outperform other products on the market.

Application and Installation

The two-component, one-to-one-ratio, epoxy-based anchoring adhesive formula dispenses in a uniform gray color to match surrounding concrete surfaces, and can be easily installed in downward, horizontal, vertical and overhead orientations.

The versatile SET-3G adhesive is designed for dry or water-saturated use conditions with temperatures anywhere between –40˚F (–40˚C) and 176˚F (80˚C). The low-odor formula also offers contractors jobsite flexibility with its ability to be installed in dry, water-saturated or water-filled holes in base materials whose temperatures range from 40˚F (4˚C) to 100˚F (38˚C).

Testing Criteria

Available in three sizes, SET-3G adhesive has been thoroughly tested.

- Tested in accordance with ICC-ES Acceptance Criteria for Adhesive Anchors in Concrete Elements (AC308) and ACI 355.4 for use in cracked and uncracked normal-weight and lightweight concrete.
- Qualified for use in structures assigned to Seismic Design Categories A through F.
- Code listed to work with the Speed Clean™ DXS dust extraction system, which complies with updated OSHA Silica Dust Compliance Regulations to save time and keep workers safe from hazardous airborne dust.

For more information about SET-3G high-strength anchoring adhesive, including detailed strength design data tables for various surfaces and drill bits, code listings, cure times and more, visit strongtie.com/set3g.

SIMPSON STRONG-TIE LAUNCHES NEXT GENERATION OF COMPOSITE STRENGTHENING SYSTEMS™ FOR CONCRETE AND MASONRY STRUCTURES

With the new fabric-reinforced cementitious matrix (FRCM) from Simpson Strong-Tie, contractors can effectively repair, protect and strengthen concrete and masonry structures for a fraction of the installed cost of traditional shotcrete repairs that use rebar. The FRCM externally bonded Composite Strengthening System™ combines high-performance sprayable mortar with a carbon-fiber grid that creates a thin structural layer without significantly increasing the structure's weight or volume.

Because of its reduced preparation and installation time, FRCM is in many cases the most economical available solution for adding flexural, axial, or shear strength to a range of structures. The lightweight, sprayable matrix is ideal for application on overhead or vertical surfaces in structures such as tunnels, mines, parking garages, silos, bridges, and other buildings with large surface areas. A single, one-inch layer provides sufficient structural strengthening without substantially constricting tight spaces or adversely affecting facility operations. Further strengthening can be obtained as necessary through the application of additional half-inch layers.

FRCM can:

- Strengthen aging, damaged or overloaded structures
- Be used to repair surfaces and strengthen them in a single application
- Correct size and layout errors
- Match the substrate's finish
- Upgrade ratings for live loads due to changes of use or new equipment
- Assist in seismic retrofits by adding shear strength and mitigating displacement and ductility
- Be used on damp substrates, and in harsh environments that may expose the system to high temperatures, humidity, abrasion, and ultraviolet (UV) exposure

FRCM Components

The sprayable, fiber-reinforced cementitious matrix (CSS-CM) is available in 55 lb. (24.9 kg) bags. The accompanying carbon-fiber grid is available in two separate models to suit the needs of any project: bidirectional (BCG) and unidirectional (UCG). Each roll of carbon-fiber grid measures 77 inches (1.95 meters) wide and 164 feet (50 meters) long.

These products and components were tested together in UL Design No. N859, and achieved a four-hour fire rating when subjected to ASTM E119/UL 263 full-scale fire testing.

For additional information on FRCM, including technical data sheets, load ratings and more, strongtie.com/frcm.

INTERESTED IN SEEING YOUR NEW PRODUCTS IN THIS COLUMN?

Email your new product information to editor@icri.org. Content for the May/June 2018 issue is due by March 1, 2018 and content for the July/August 2018 issue is due by May 1, 2018.

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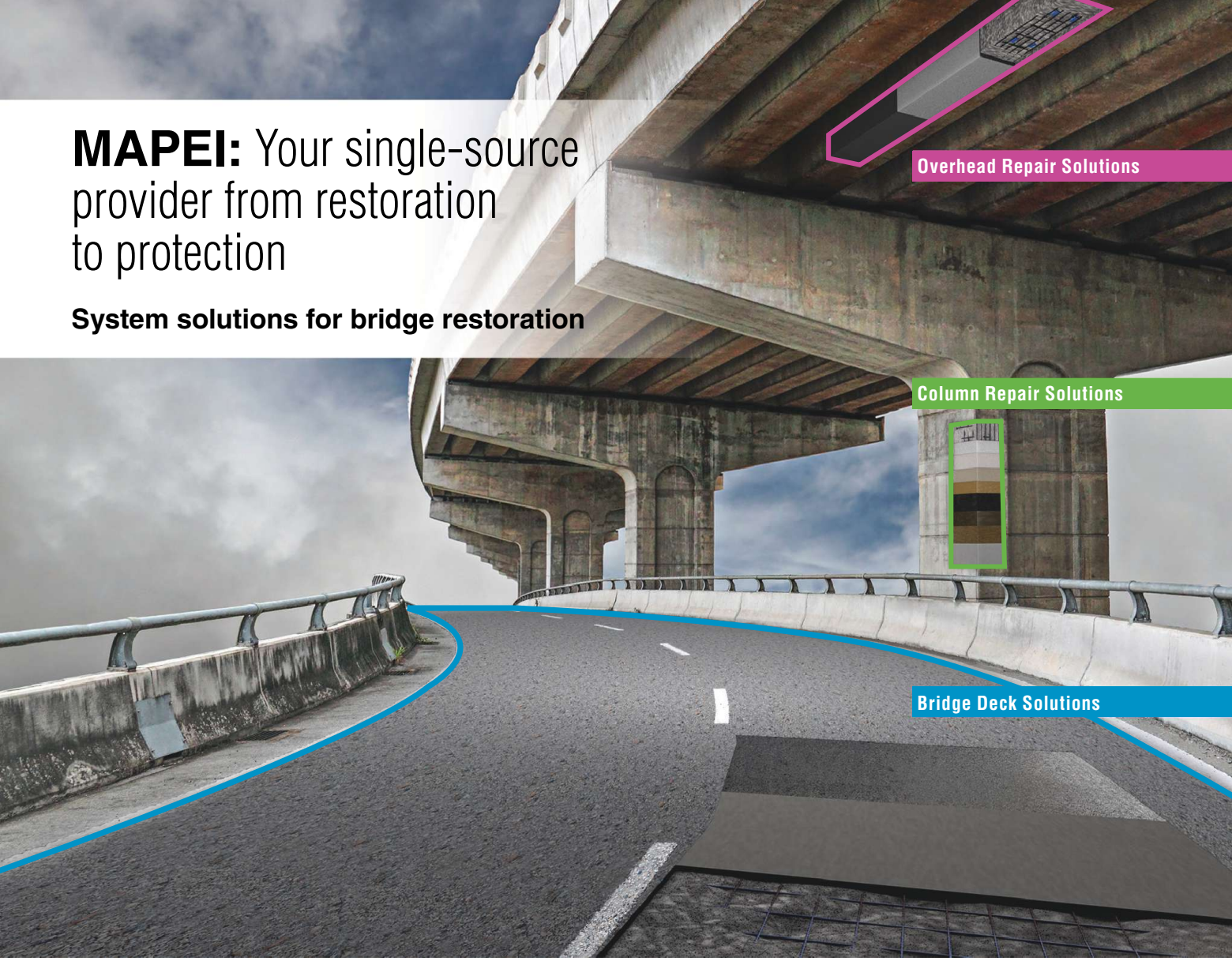

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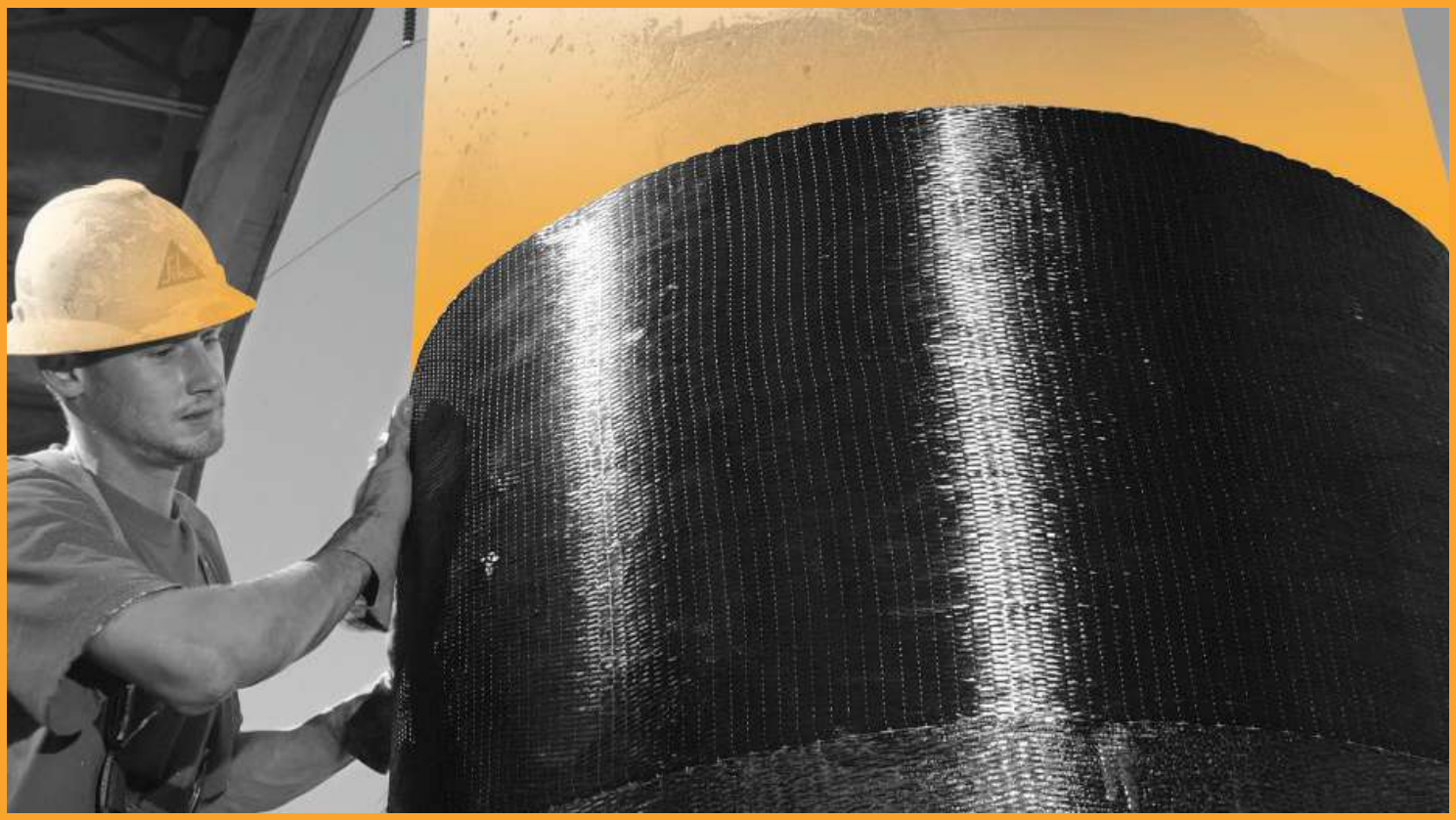

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