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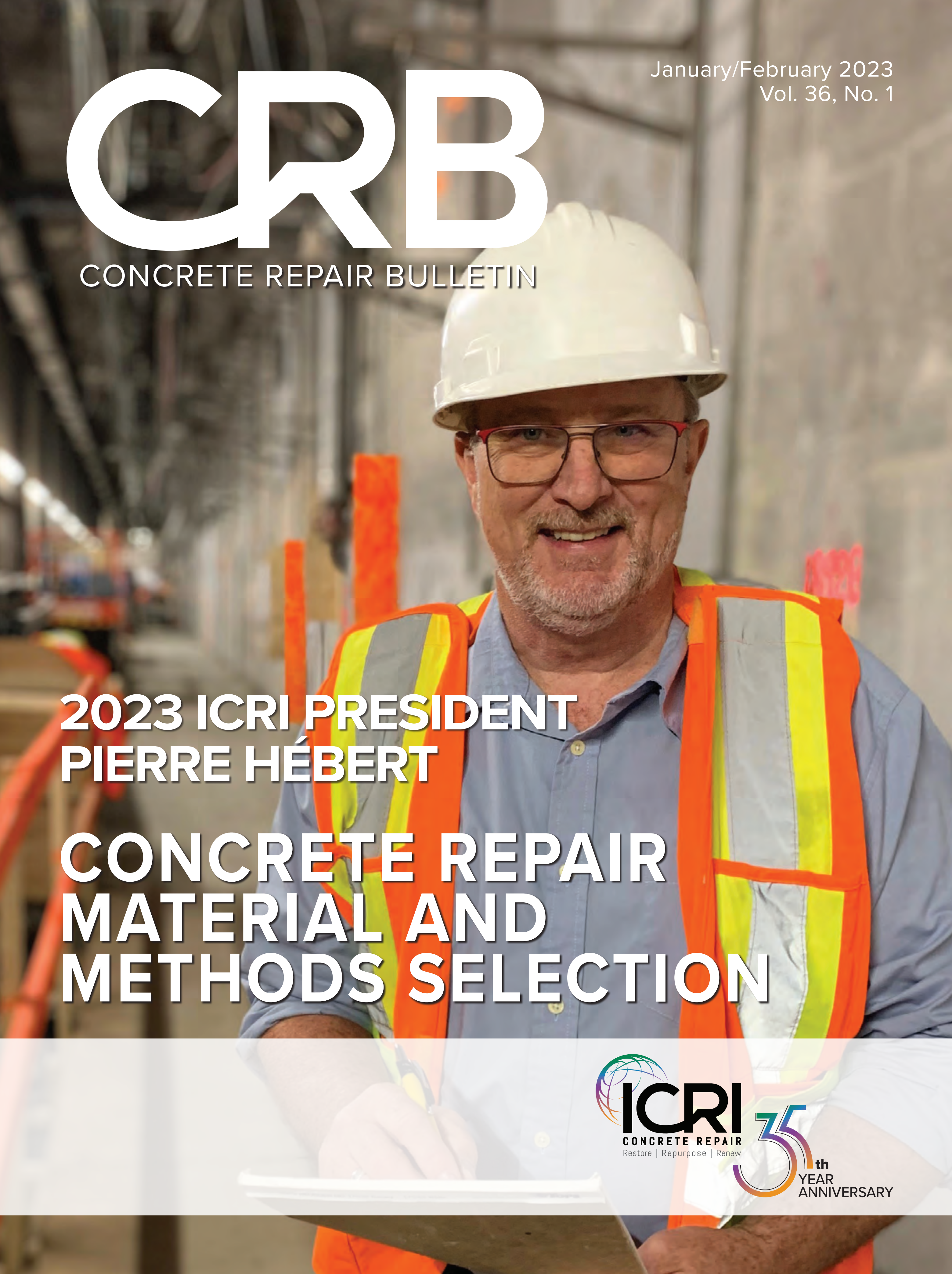
CRB
CONCRETE REPAIR BULLETIN



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ON THE COVER: 2023 ICRI President Pierre Hébert. See the President's Message on page 2.

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FEATURES

10 Looking Back to See Ahead—Using Historical Knowledge of Durability to Provide Clues for Concrete Repair
by David G. Tepke

22 Hamilton House Condominium—Restoring an Oceanfront Treasure to Its Original Beauty
by Elena Kessi

26 Increasing the Durability and Lifespan of Bridges with Ultra-High-Performance Concrete Repair Solutions
by Benjamin Birch

DEPARTMENTS

2 President's Message
4 TAC Talk
4 Women in ICRI
8 ICRI Supporting Members
32 Concrete Repair Calendar
32 Industry News
32 People on the Move
34 Association News
38 Chapter News
43 Chapter Committee Chair's Letter
44 Product Innovation
46 New ICRI Members
48 Index of Advertisers

NOTE FROM THE EDITOR

The new year starts off with a bang as ICRI celebrates its 35th anniversary in 2023. ICRI starts this anniversary year with its annual Kick-Off Party in conjunction with World of Concrete in Las Vegas. This year's event is hosted at the 1928 Prohibition Bar at Mandalay Bay. ICRI will host several certification programs thoughout the year, starting with the Concrete Slab Moisture Testing Certification Program at World of Concrete. Please check the event calendar on the ICRI website for the certification locations and dates in 2023.

The 2023 ICRI Spring Convention will be held at the JW Marriott Parq Vancouver in Vancouver, BC, April 17-19. ICRI Chapters will also be holding many events during 2023. Check the Chapter News section in the *Concrete Repair Bulletin* and the website for more information.

This issue of the *CRB* is themed "Concrete Repair Material and Methods Selection" and features articles on technology to increase the durability and lifespan of bridges with performance concrete repair solutions, using historical knowledge of durability to help design new concrete repairs, and a case study on the Hamilton House Condominium restoration. We will also meet 2023 ICRI President Pierre Hébert.

Please make sure you send Dale Regnier your upcoming chapter events and remember to check the ICRI website for the schedule of upcoming events.

I hope you all have a successful, safe, and healthy 2023!

Jerry Phenney
Editor, *Concrete Repair Bulletin*
RAM Construction Services

PRINT CORRECTION: NOVEMBER/DECEMBER 2022 *CRB*
The titles in the table of contents on page 1 of the printed version incorrectly stated "2021 ICRI Awards". It shoud have stated "2022 ICRI Awards." Also, the "On the Cover" message mistakenly identified the cover image. It shoud have read "2022 ICRI Project of the Year Award Winner: Mount Umunhum Radar Tower, Page 14." ICRI apologizes for the errors.

PRESIDENT'S MESSAGE

It's All About You!

PIERRE HÉBERT

ICRI is all about you, our members. With your membership in ICRI—Supporting, Company, and Individual members—you show your commitment to advancing this organization and our industry each and every day. Thank you!

To our Supporting Members: it takes someone that has vision and the willingness to support ICRI to foster employee involvement in the continuous development of this organization.

To our broader membership: it takes an extraordinary sense of commitment to take time to support this industry at the local chapter, national, and international level.

Becoming the president, as you can imagine, is not a one-year deal. The honor of serving as ICRI President is the culmination of a long journey that started when I first got involved with ICRI in 1999, assisting efforts to launch the Quebec Chapter. That first step led to many more, from local chapter activities to national committee participation, and ultimately the honor of serving on ICRI's Board of Directors and Executive Committee.

Each step of this journey showed me how important ICRI is to our industry and how many doors it opened throughout my career. It also created lifelong friendships with so many people across our great industry.

I'm very excited about the year ahead. ICRI is focused on building even more value for our members. Among the priority activities on deck, we're looking to launch:

- New application/field-focused training based on ICRI's Concrete Surface Repair Technician (CSRT) program.
- New online educational modules of ICRI's very successful Concrete Slab Moisture Testing program.
- New FRP learning modules.

We are also excited to launch ICRI's first digital mobile app to assist members and non-members on the jobsite! This app—designed to help assess rebar cleanliness—will be launched in the Apple Store and Google Play in early 2023, and shows that ICRI is continually looking for innovative ways to advance the quality of concrete repair and restoration.

Following John McDougall's presidency and a commitment made by the Board of Directors in 2022, we plan to take ICRI to the next level. Our big goal is to push ICRI to grow by 50 percent in membership over the next five years. We believe that this growth will happen by focusing on our value to the industry and growing our programs to better support you, our members.

We're also committed to growing our international membership. In late 2022, we welcomed the formation of ICRI's first Mexico affiliate and hope to have other international affiliates formed in 2023. We have a lot on our agenda and know that good things take time. But we also know that the commitment of you—our members—will help us realize these big goals.

Last and most definitely not least, 2023 marks ICRI's 35th anniversary. We look forward to celebrating this huge milestone throughout the year. We hope to see you at one our two national conventions in 2023 so we can celebrate this milestone together!

For now, I wish you safety and success in 2023.

Your President,

Pierre Hébert

Pierre (Pete) Hébert

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

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

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TACTALK


MATT SHERMAN

As I write this first of my TAC Talk columns, I must admit that I couldn't have imagined this when I first attended an ICRI conference. Following the likes of Jim McDonald, Fred Goodwin, and Mark Nelson is truly "standing on the shoulders of giants" and I hope to be up to the task. Fortunately, with Liying Jiang as Vice-Chair, Jeff Ohler as Secretary, and with Fred and Mark at the other end of the TAC hotline, we have a strong team.

In preparation for assuming the TAC chair, I have spent the last two conventions visiting committee meetings, sessions, and events to understand how ICRI has evolved and what we have learned through COVID. What I have seen is a lot of great adaptation and evolution—we have learned to leverage virtual meetings to allow more frequent interaction without the constraints of geography, we have produced more webinars and certifications, we have even delved into the world of digital apps. All of these are amazing and have helped us to better achieve our strategic goal of improving our industry.

We have also had to face new realities, and the most obvious of these, to me, is a change in the way people value time—our time has become much more treasured and valuable for us, our employers, and our families and loved ones. As such, watching committees struggle with how to efficiently create content, respond to comments, and develop new offerings has shown me that TAC can be a better resource.

Recognizing that the time of our members and committees has become so precious, my observations at conventions have shown me that the best thing that TAC can do is help our members do committee work in a more rewarding and effective way to honor the time committed.

To this end, our goals for the next year are all related to helping our technical committees. While TAC's role will always be to ensure the technical quality of ICRI's offerings, I hope that we can do that through TAC having a larger role in coaching and mentoring. In the same way that coaches and mentors in my life have always held me to high standards and taught me something at every opportunity, we hope that we can use the deep talent that we have on TAC to do the same with our committees.

To this end, we have set four goals for 2023:

1. *Improve TAC's internal processes.* We must better integrate our offerings with other teams like Marketing, Certification, and Education; we need to keep the great work we do at conventions moving between conventions; and we need to make the path to completion easier and clearer for our technical chairs.
2. *Make committee work more rewarding, with better and faster outcomes.* As coaches/mentors, TAC should be able to help our chairs through what can be an intimidating, discouraging, and slow process. With early input and suggestions, we can be better.
3. *Helping committees focus on industry needs.* ICRI's work is valuable and focused on what our members do. By keeping that focus, we can add value, move more quickly, and more directly impact our work world.
4. *Expanding our offering types.* The rebar cleanliness app has shown that ICRI is willing to think in new ways. We need to keep thinking about new ways to accomplish our mission while meeting our internal goals, remaining relevant and exciting to our members, and having a little fun along the way.

We look forward to what we hope will be an exciting and fulfilling year ahead.

Matt Sherman *is chair of the ICRI Technical Activities Committee (TAC).*

Volunteer

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

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

Visit www.icri.org for more information.

WOMEN IN ICRI

SPOTLIGHT— Julie Bolding

by Michelle Nobel

JULIE BOLDING

Julie Bolding is a structural engineer at Armstrong-Douglass Structural Engineers and one of ICRI's 2020 40Under40 Award Winners. Julie has been in ICRI for eleven years, is a past president of the North Texas Chapter, and is currently the Scholarship Chair for the North Texas Chapter. She's also on the ICRI Nominating Committee, 210 Evaluation Committee, 410 Masonry Committee, and soon to be Chair of the Women in ICRI Committee.

Julie's passion is historic preservation. She loves the challenge of coming up with creative solutions for what most people feel is a lost cause. Her inspiration comes from her Dad. He was a third-generation farmer who taught Julie the value of hard work, dedication, and working with her hands.

What Julie likes the most about her career is the wide variety of projects she works on and getting out into the field instead of being behind a desk all day. Conversely, what Julie likes the least is the insane deadlines and doing complete repair documents from nothing. The biggest challenge Julie has dealt with lately is post-installed anchors. Often, contractors improperly install anchors. One contractor installed them upside down on one project. Anchor spacing, edge distance, anchorage options, and substrate design requirements are problems that happen as well. She has gone to manufacturer reps to help with institute testing that is typical to old historic masonry.

Julie finds inspiration in her career by taking structures in disrepair and returning them to their original glory. She also finds it inspiring to make these structures safe for everyone. Other motivating factors in Julie's career are the ICRI networking events she attends with people from all over the world.

Julie's mentor is 2020 ICRI Fellow Mark LeMay. Mark introduced Julie to ICRI. She found it interesting to hear Mark's view as an architect, not an engineer. Mark ingrained in Julie to never do feather edge on a project. Though Julie doesn't have a mentee officially, she believes that you should try to remember that you were in the mentee's shoes at one time and that you should explain the why, not just the how. Julie sees preservation increasing in the next ten to twenty years. Repairing buildings instead of tearing them down will help the concrete repair industry. Concrete repair is a great and fascinating field.

Julie is married to Mark Bolding, a telecommunications engineer. They had a son, Will Bolding, in August of 2021. Julie and Mark enjoy traveling, hiking, riding bicycles, and spending time together as a family.

It was a pleasure speaking with Julie and getting to know her better. It's inspiring to see the future of this great organization in this young woman. I know she will help lead ICRI into the future. I see Julie making many friends and furthering her status in ICRI.

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Looking Back to See Ahead

Using Historical Knowledge of Durability to Provide Clues for Concrete Repair

by David G. Tepke

Fig. 1: Structures from the: top row: 1910s-30s; middle row: 1950s-70s; and bottom row: 1980s-2000s.

INTRODUCTION

Concrete buildings were constructed in the United States as early as 1835, but it wasn't until around 1870 that manufactured portland cement became available, 1875 until the first reinforced concrete house was believed constructed in the United States, and 1902 until the first "skyscraper" (the 210 ft tall Ingalls Building) was constructed in Cincinnati.[1] These developments started a new era of vast use of reinforced concrete as a durable and versatile construction material, but also brought the need for standardization, new materials, and research to promote safe construction. They additionally brought the need for more than 100 years of research to identify deterioration mechanisms and address them for making more durable construction. Indeed, research and advancement to these ends is still being conducted today, with new materials and methods being introduced perpetually as industry guides and codes are updated. Advancement forms the cornerstone of improvement and is described through the evolution of guides and codes.

While this evolution is healthy and productive, it can also make evaluation of older reinforced concrete structures, such as the ones shown in Figure 1, challenging, even for the most experienced professional. Often, information on the structure is limited and construction or maintenance records may be unavailable or incomplete. This places an engineer at a significant disadvantage for developing an effective evaluation plan. Given the year or approximate era of construction, how can one know:

- what should be expected,
- what was known in the industry at the time about degradation mechanisms,
- how best to understand the mindset of those responsible for construction,
- how to approach evaluation for developing appropriate maintenance and repair strategies, and
- what observed and evaluated distress and deterioration might be explained by the characteristic knowledgebase and state of practice when it was constructed?

Structural repair is governed by jurisdictional existing building codes, as well as industry standards they may reference. Repair often requires that engineers research structural requirements of the jurisdictional codes at the time of construction. Industry standards, such as ACI 562, *Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures*[2], provide direction regarding expected concrete and steel properties for historical concrete structures and provide direction regarding assessing existing buildings and designing repairs. However, it is beneficial to understand associated provisions of codes and guides contemporary to the time of construction as well as the mindset of the industry at the time of construction with respect to durability as this may impact how one views a structure and associated repair. For instance, for a particular structure, it may be helpful to know what the industry knew about freezing and thawing damage at the time of construction and how to mitigate it through durable design, when the industry became aware of alkali-aggregate reactivity, how the code addressed corrosion, or when certain types of materials were permitted in the code or in general use in the industry.

JURISDICTIONAL CODES AND INDUSTRY STANDARDS WITH DURABILITY PROVISIONS

The American Concrete Institute is generally considered the authority in the United States on concrete design and construction. Various guide documents and industry standard codes are developed by ACI. While ACI 318 and predecessors are sometimes referred to as "the Code" in this article, industry standard codes developed by ACI only become jurisdictionally enforceable or part of a national or local jurisdictional adopted building code if incorporated, in part or in whole, by reference. Codes are generally updated to reflect new information either determined within the code writing committee, or from incorporation of information from committees that prepare guide documents. Provisions in industry standard codes, such as the ACI 318 Building Code, generally lag information in industry guides, where the information is generally developed. National or jurisdictional codes generally lag industry standard codes, reflected by the time it takes for evaluation and incorporation by reference. For instance, for a building built in the year 1971 in Charleston, South Carolina, the 1955 National Building Code[3] was in effect. This code referenced ACI 318-51.[4a] This represents a 20-year lag between the time of construction and the state of the practice, as estimated through prevalent code provisions. It should be noted that synchronization of industry standards with jurisdictional codes has improved as it has become more consistent across jurisdictions. Also, the diligence of an engineer who may choose to use a more recent code with more restrictive provisions is possible, such that the overall lag may not be as pronounced as is possible. Thus, a historical look at the state of the industry is only an indicator of what may be expected on an existing building. Construction drawings may indicate more recent codes or design basis and are better indicators if available.

Durability is defined by the American Concrete Institute[5] as *"the ability of a material to resist weathering action, chemical attack, abrasion, and other conditions of service."* American Concrete Institute Committee 201, Durability of Concrete, has developed updated guides on durable concrete since 1962.[6a] Manifestations of some common deterioration mechanisms are shown in Figure 2. The reader is referred to ACI 201.2R-16[6] for discussion of these mechanisms, as it is beyond the scope of this article.

Fig. 2: Examples of materials-related distress top left to right: alkali-silica reactivity (ASR) and freezing and thawing damage (F-T); bottom left to right: corrosion, and chemical attack / corrosion

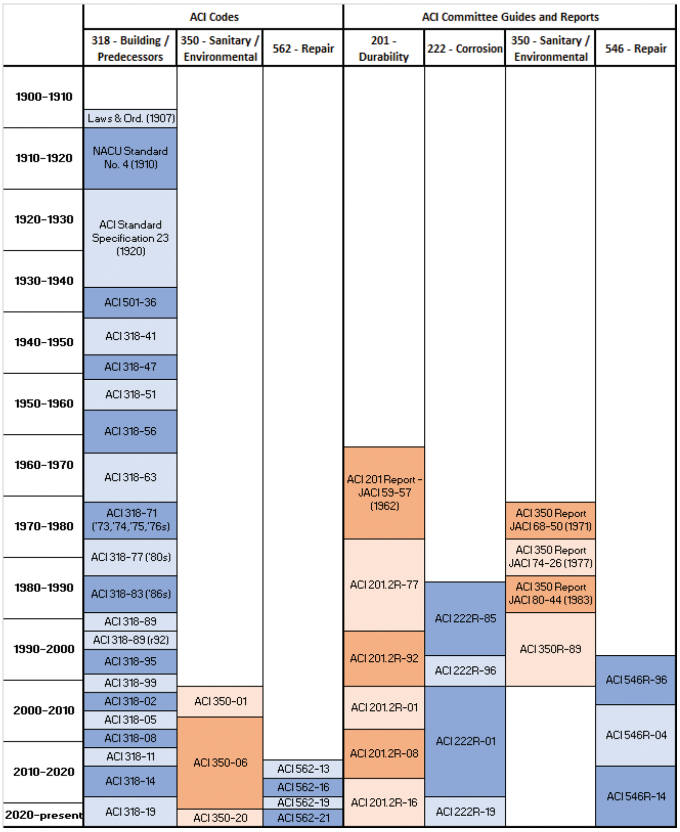


Fig. 3: Progression of industry standard ACI Codes and some durability-based guide documents (Refs 2, 4, 6-16). Documents prior included for additional reference

Figure 3 shows the general progression of ACI industry standard codes and some guide documents from the beginning of the 20th Century to today.[2,4,6-16] This can be a useful tool for understanding what was available to practitioners at the time an older building was constructed. The National Association of Cement Users (NACU) was organized late 1904 and early 1905[17-19] and developed regulations that served as predecessors to the ACI 318 Building Code (NACU became ACI in 1913[17]). Prior to NACU Standard Building Regulations for the Use of Reinforced Concrete in 1910[10], proposed ordinances had been developed and proposed in or before 1907[7], and then updated 1908[8] and 1909.[9] As has been pointed out by others, it is interesting that the NACU Regulations in 1910 were just 14 small pages.[17] The current ACI 318-19[4], after about 20 revisions, is 623 full-sized pages, though it does include commentary.

Durability guides were developed and maintained over the last half of the 20th Century. Of note is that the industry standard code for design of environmental structures was first published in 2001[13a], approximately 30 years after the first associated guide documents.[15a] Devoted initiatives with respect to concrete repair only became prevalent in the last part of the 20th Century. Information associated with concrete repairs or restoration were included in the ACI 201 guide from 1962 through 2001 but were not included in the 2008 version.[6a] The Association of Concrete Repair Specialists, later renamed the International Concrete Repair Institute (ICRI), was established in 1988[20], and the first ACI 546 repair guide was developed in 1996[16a], approximately 17 years prior to the first published version of ACI 562 Repair Code.[2a]

ADVANCEMENTS IN MATERIALS, UNDERSTANDING OF DETERIORATION MECHANISMS, AND DURABILITY PROVISIONS

A timeline of some of the major advancements in codes and industry knowledge is provided in Figure 4 and Figure 5. Figure 4 shows general provisional changes focused primarily on materials and standards incorporated into the ACI 318 Building Code and its predecessors. Figure 5 is separated into five major durability categories: alkali-aggregate reactivity (represented by green), sulfate attack (represented by red), freezing and thawing distress (represented by blue), corrosion (represented by orange) and other/general (represented by purple). Some of the more major advancements on understanding of mechanisms, as well as provisions for mitigations, are included. Figure 6 includes the primary abbreviations used in the timelines.

The timelines include consolidated information and are intentionally provided as such to represent a range of information within a small area. They are meant to be used as a reference tool for experienced practitioners, and to aid in the instruction of younger professionals when reviewing older existing structures. Where possible, relevant information was included in the tables. Because the change in cover requirements from ACI 318-71[19] was extensive, Figure 7 was prepared for illustration of the changes, as well as primary subsequent changes as noted.

A few notes regarding the timelines and their use:

- The tables are based on ACI documents that represent industry standards in the United States and do not account for local jurisdictional code adoptions that historically can be highly variable from location to location. Additionally, as described in the previous section, jurisdictional codes can lag industry standard codes and industry guidance by long periods, especially for older structures. Original construction drawings, research on jurisdictional code adoption dates and locations, and other available information should always be consulted for more specific context for the particular location and structure.

- The tables are primarily related to structures with design governed by ACI 318 (or predecessors). Thus, transportation structures and some environmental structures would not be directly applicable, though state of the practice contemporary to the time of construction is reflected and could be used in context for these structures in some cases, as determined by a licensed design professional.

- Some overlap exists in the figures, as is necessary to provide context, but Figure 4 and Figure 5 should be used in conjunction, as there was an effort to avoid duplication of information.

- While important provisions in the author's opinion have been included, the tables do not include all code provisions. Also, emphasis was placed on information when it first was discovered or first included in the Code. Thus, previous knowledge and provisions are sometimes, if not often, a precursor for subsequent information.

- Information should be interpreted by licensed professionals and verified for context within the referenced codes when used.

- The tables do not include developments and advancements with respect to structural design. They are focused on materials-related distress mechanisms and materials with primary concentration of the mechanism and materials referenced in the ACI 318 Building Code lineage. While abrasion, chemical attack, sulfides in aggregates, microbial-induced corrosion, freshwater attack, physical salt attack (other than scaling provisions in codes), and other mechanisms can lead to deterioration, they have not been emphasized. With respect to corrosion, some broad information associated with mitigation measures for existing structures (cathodic protection, corrosion inhibitors) has been included

- because it can be useful to understand when these technologies came into use for possible presence on a structure; however, their treatment in the figures is not comprehensive. The most current version of ACI 201 and other referenced documents should be reviewed by the reader for descriptions of mechanisms and current knowledgebase. Historical versions can be used as appropriate for investigating an existing structure.

- The reader is encouraged to review ACI 562-21.[2] This document includes provisions for estimating historical properties based on period of construction for use in structural evaluation.

SUMMARY OF MAJOR ADVANCEMENTS

The following sections summarize major durability requirements in ACI codes throughout the 19th and into the 20th Century for each focus category. Figure 8 illustrates a small selection of historical materials, documents, and advancements.

MATERIALS AND GENERAL

Considerable early changes focused on enhancing material provisions within the code (for instance aggregates), until ASTM Standard Test Methods were developed and adopted. Prestressed concrete was developed in the industry in the 1920s, but did not appear in Codes until the 1950s and 1960s. Early research on supplementary cementitious materials was conducted in the first half of the 20th Century and incorporated into codes in the last half. ACI Committee 201 was formed in 1957 and prepared the first report on durability in 1962.[6a] This report included discussion on alkali-aggregate attack, corrosion, freezing and thawing, chemical attack, abrasion, deicing salts, and repair. Though these materials had been commercially available for some time prior, epoxy coated reinforcing steel and galvanized steel were included in the code in the latter part of the 20th Century. Considerable advancements were made with respect to corrosion protection of post-tensioned steel late in the 20th Century.

In the time since the end of the 20th Century, a number of advancements have been made. Stainless steel was included in the Industry Standard Code in 2008. Provisions generally changed from using w/c as the basis for general quality to w/cm in ACI 318-02. A major organization of durability exposure classes in the code occurred in 2008. Corrosion inhibitors were included in the code in 2014, approximately 35 years after they became available commercially. Shotcrete and limestone cements have been some of the more recent materials addressed in ACI 318. ACI Committee 321, Concrete Durability Code, was formed in 2020 with the mission, per the committee webpage[51] to *"develop and maintain code requirements for the durability of concrete structures."* This represents a significant step toward the future of specifying and achieving durable structures. Indeed, ACI 440.11R-22[52], *"Building Code Requirements for Structural Concrete Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars—Code and Commentary"* has just been published and provides an avenue for design professionals to design with FRP in certain situations as it becomes adopted jurisdictionally.

ALKALI-AGGREGATE REACTIVITY

Alkali-silica reactivity (ASR) was identified in the late 1930s, first reported in 1940, and initially researched through the 1950s.[6,38,39] Alkali-carbonate reactivity was identified in 1957 and researched initially in the 1950s to 1970s.[6,38] Original ACI 318 provisions in the 1960s for ASR relied on limiting the alkali content in the cement by reference to ASTM C150 cements. Considerable effort has been made in the industry to identify test methods to evaluate ASR. In the early part of the 21st century, it has become increasingly realized that limiting alkali content in the cement does not adequately address the risk of ASR in all situations. ACI 318-19 is the first code that included provisions for mitigation per ASTM C1778, which is considered an improvement over the previous approach.

SULFATE ATTACK

Although the action of sulfate attack was known before the 20th century, early modern research for general identification of mechanisms was conducted between the 1910s and 1930.[6] The first code provisions for sulfate resistant cement were included in the 1941 Code[4a] via reference to ASTM C150. Codes in the 1970s evolved to include exposure classes and provisions for ensuring a low permeability concrete and sulfate resistant cement where needed. This continued into and beyond the 1980s. Use of ASTM C101² to evaluate concrete for sulfate resistance was introduced through the commentary and then into the Code late 20th Century and early 21st Century. Delayed ettringite formation (DEF) was identified as an issue in the 1990s[6], with provisions for specific maximum curing temperatures included in ACI 301 in 2010.[50]

FREEZING AND THAWING

The need for air-entrainment was accidentally discovered in the late 1930s.[29,30] Early research on the mechanisms and use of air-entraining additives occurred in the 1940s and 1950s. Early code provisions in the late 1940s and early 1950s addressed freezing and thawing durability by limiting the water-cement ratio (gallons of water per sack). The first ACI 318 requirement for reducing the water-cement ratio for non-air-entrained concrete was in 1956.[4a] ACI 318-63[4a] required use of air-entrainment, but did not specify amount or required air content. ACI 318-71[4a] provided requirements for total air content based on the aggregate size, and included provisions for w/c (normal weight concrete) and strength (lightweight aggregate concrete). These provisions were altered throughout the latter half of the 20th Century, but generally, it can be said that ACI 318 primarily addressed freezing and thawing transitionally to today's general approach between the 1950s and

FIGURE 4A: General material advancements up to the 1950s.

Blue and the suffix "C" after the year indicate Code provisions included in the indicated revision[4,7-12]. Green indicates industry advancement with references as appropriate. See Figure 6 for abbreviations.

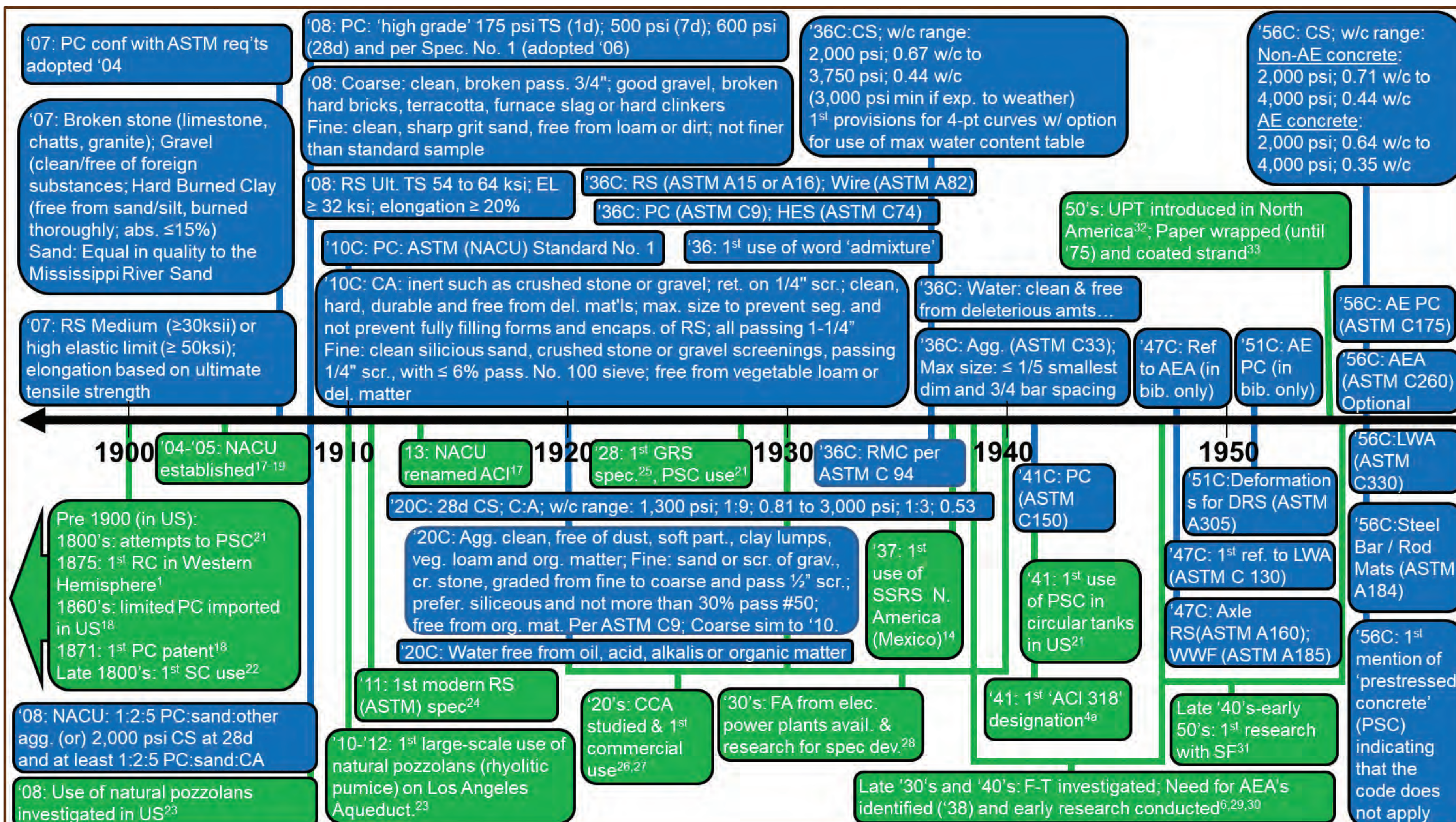


FIGURE. 4B: General material advancements from the 1950s to today.

Blue and the suffix "C" after the year indicate Code provisions included in the indicated revision.[4,7-12] Green indicates industry advancement with references as appropriate. See Figure 6 for abbreviations.

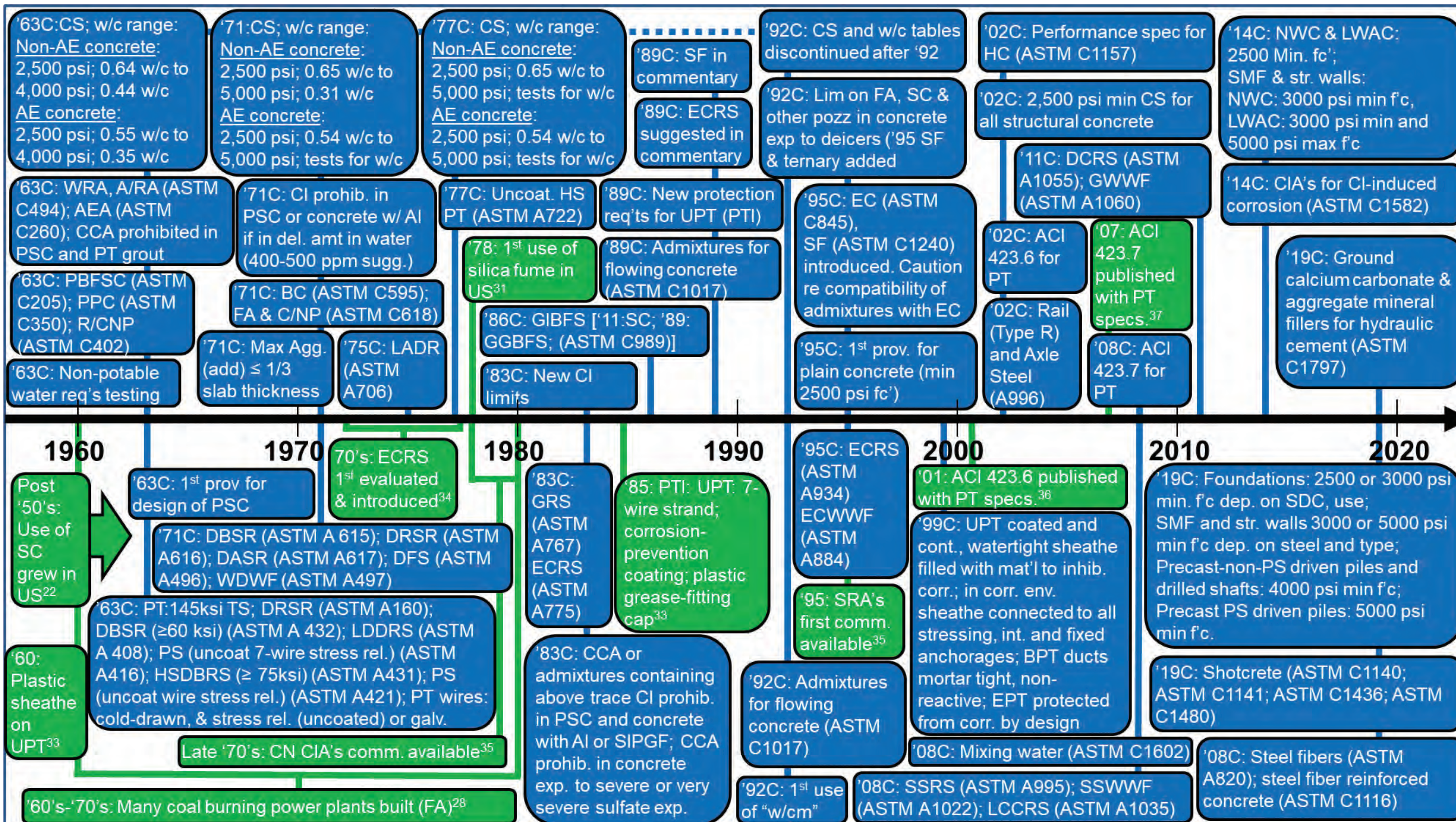


FIGURE 5A: Advancements in the knowledge and provisions for major durability categories addressed in the building code up to the 1950s.

Darker shaded boxes and the suffix “C” after the year indicate code provisions. Lighter shaded boxes indicate industry advancement. See Figure 6 for abbreviations. References in figure.

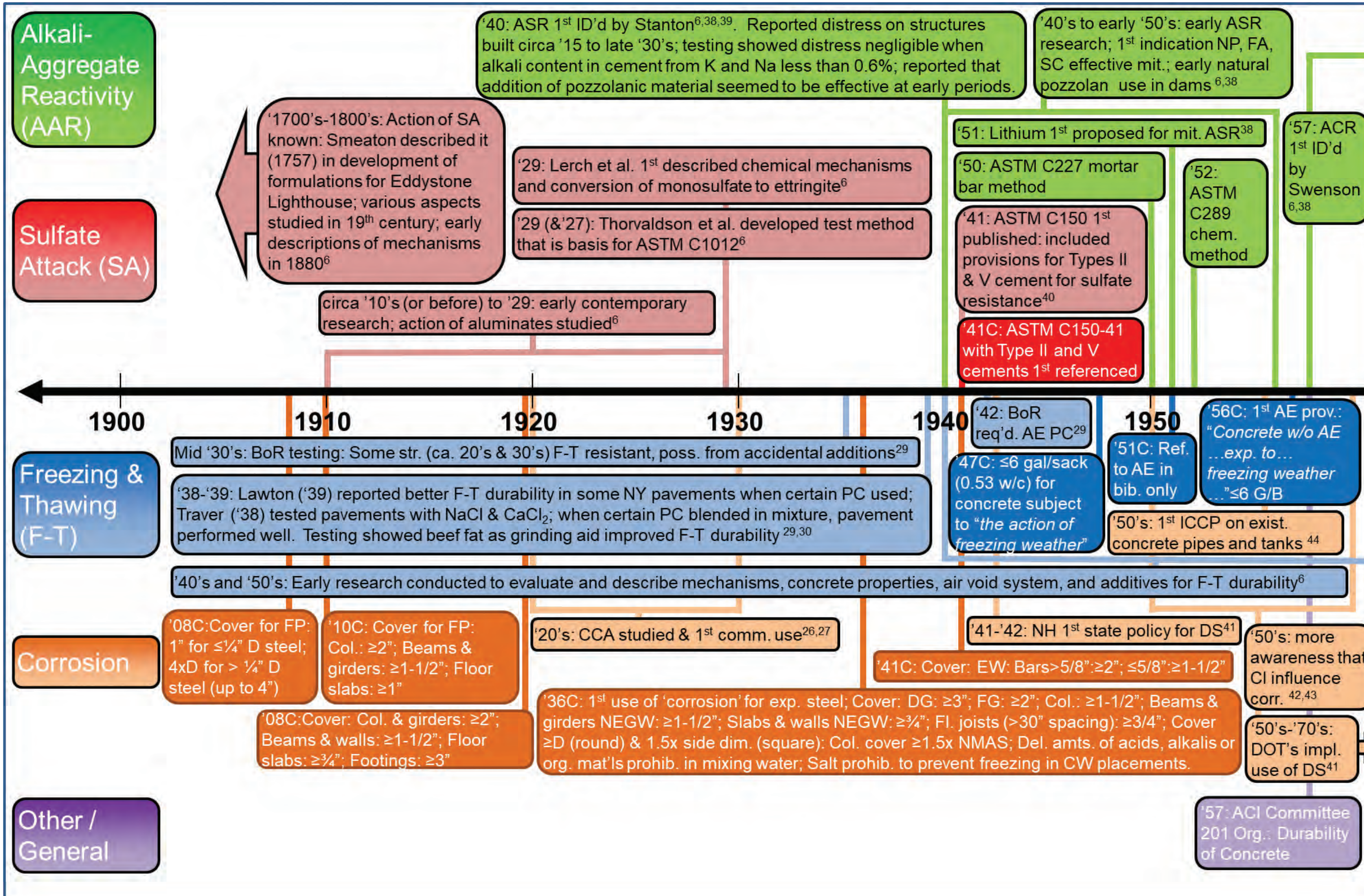
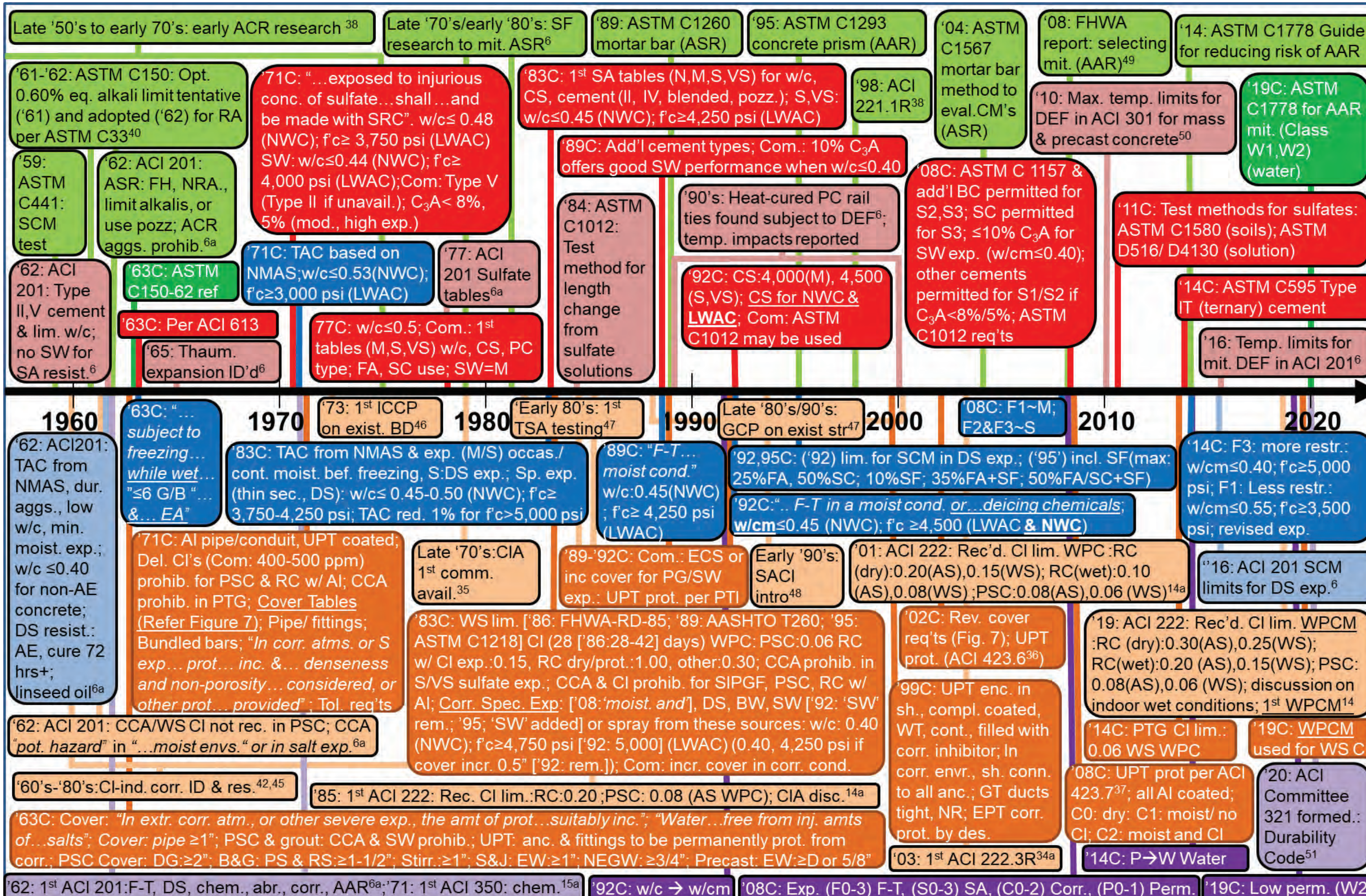


FIGURE 5B: Advancements in the knowledge and provisions for major durability categories addressed in the building code from the 1950s to today.

Darker shaded boxes and the suffix "C" after the year indicate code provisions. Lighter shaded boxes indicate industry advancement. See Figure 6 for abbreviations. References in figure



early 1970s. In 1992, the first provisions were included to limit the amount of SCM's in concrete exposed to deicing salts for scaling resistance.

CORROSION OF REINFORCING STEEL

Corrosion was not generally considered a major issue in concrete until it was better studied in the 1960s through 1980s.[42, 43, 45] Cover, originally included for fire protection in the code, was modified in early revisions regularly. The 1971 code[4a] organized cover requirements into the general form of the current ACI 318 (Figure 7). Focus has been on improving protection for post-tensioned steel, inclusion of alternative types of steel, and verbiage for increased protection of steel over standard cover requirements. Although calcium chloride admixture, first commercially available in the 1920s[26,27], and other chlorides had progressively been limited for use in prestressed concrete members and members with aluminum, the 1983 Code[4a] was the first to impose direct limits for chlorides in concrete on this basis. These limits were recognized in the commentary at the time as being *"more liberal"* than recommended by Committees 201 (durability) and 222 (corrosion), and per the commentary[4a] were *"…developed after consultation with Committees 201 on durability and 222 on corrosion, and are considered to represent the best information available at the time of adoption."*

Test methods for determining the chloride levels were refined in versions after the 1983 revision. Chloride limits in new construction have been the subject of recent debate in ACI Committee 222 meetings. The study of measuring and reporting chloride thresholds, as well as chloride limits for new construction, have been facilitated through the formation of a task group in ACI Committee 222. Recommended chloride limits have been modified in the ACI 222R-19 Guide[14], and along with ACI 201 recommendations remain more conservative than ACI 318 limits. ACI 318 requirements have largely been unchanged since 1983, except for permitting evaluation based on cementitious materials content instead of cement, as was adopted in ACI 318-19.[4] Required strength and w/cm has changed over the years, as have descriptions of exposure.

A/RA = Accelerating and retarding admixtures
AAR = Alkali-aggregate reactivity
Abr. = abrasion
ACI = American Concrete Institute
ACR = Alkali-carbonate reactivity
AE = Air-entrained
AEA = Air-entraining admixture
Agg(s). = Aggregate(s)
Al = Aluminum
Anc. = anchorage or anchor (in context)
AS = Acid soluble
ASR = Alkali-silica reactivity
Atm. = atmosphere
B&G = Beams and girders
BC = Blended cements
BD = Bridge deck
BoR = Bureau of Reclamation
BPT = Ponded Post-Tensioned Steel
BW = Brackish water
C/NP = Calcined or natural pozzolans
CA = Coarse aggregate
C:A = Cement:aggregate
CCA = Calcium chloride (accelerating) admixture
Chem. = chemical attack
Cl = Chloride(s)
CIA = Corrosion inhibiting admixture
CM = Cementitious materials
CN = Calcium nitrite
Col. = Column
Com. = Commentary
Compl. = Complete or completely (in context)
Conc. = Concentration
Cond. = Conditions
Conn. = Connected
Cont. = Continuous
Const. = Construction
Corr. = Corrosion or corrosive (in context)
CS = Compressive strength
CW = Cold weather
D = Diameter
DASR = Deformed axle steel reinforcing
DBSR = Deformed billet steel reinforcing
DCRS = Dual coated (zinc and epoxy) reinforcing steel
DEF = Delayed ettringite formation
Del. = Deleterious
Des. = Design
Dev. = Developed / Develop (in context)
DFS = Deformed steel wire
DG = Deposited against ground
DOT = Department of Transportation
DRS = Deformed reinforcing steel
DRSR = Deformed rail steel reinforcing
DS = Deicing salts (or deicing chemicals)
EA = Entrained air
EC = Expansive cement
ECRS = Epoxy-coated reinforcing steel
ECWWF = Epoxy-coated welded wire fabric
EGW = Exposed to ground or weather
EL = Elastic limit
Enc. = Encased
Env. = Environment
EPT = External post-tensioning
EW = Exposed to weather
Exp. = exposure or exposed (in context)
Ext = External
Extr. = Extreme or extremely (in context)
FA = Fly ash
FG = Formed against ground
FH = Field history
FP = Fireproofing
F-T = Freezing and Thawing
G/B = Gallon per 94 lb bag (or sack)
GCP = Galvanic cathodic protection
GRS = Galvanized reinforcing steel
GT = Grouted tendons
GWWF = Galvanized welded wire fabric
HC = Hydraulic cement
HES = High early strength
HSDBRS = High strength deformed billet-steel reinforcing steel
ICCP = Impressed current cathodic protection
Inc. = Increased
Ind. = Induced
Inj. = Injurious
Int. = Intermediate
LADR = Low alloy deformed reinforcing
LCCRS = Low chromium carbon reinforcing steel
LDDRS = Large deformation deformed reinforcing steel
Lim. = limit
LWAC = Lightweight aggregate concrete
M = Moderate
Mit. = Mitigate or mitigation (in context)
Moist. = Moisture
N = Negligible
NACU = National Association of Cement Users
NEGW = Not exposed to ground or weather
NMA = Nominal maximum aggregate size
NP = Natural pozzolans
NR = Non-reactive
NRA = Non-reactive aggregates
NW = Normal weight concrete
PBFSC = Portland blast-furnace slag cement
PC = Portland cement
PCC = Precast concrete
Perm. = Permeability
PG = Parking garage (parking deck)
Pot. = Potential
Pozz. = pozzolans
PPC = Portland-pozzolan cement
Prohib. = Prohibit(ed)
Prot. = protect or protection (in context)
PS = Prestressing steel
PSC = Prestressed concrete
PT = Post-tensioned steel or post-tensioning (in context)
PTG = Post-tensioning grout
PTI = Post-Tensioning Institute
R/CNP = Raw and calcined natural pozzolans
RA = Reactive aggregates
RC = Reinforced Concrete
Rec. = Recommended
Rem. = Removed
Res. = Research
RMC = Ready-mix concrete
Rpt. = report
RS = Reinforcing steel
S = Severe
S&J: Slabs and joists
SA = Sulfate attack
SACI = surface-applied corrosion inhibitors
SC = Slag cement (also referred to as ground iron blast furnace slag (GIBFS) and ground-granulated blast-furnace slag) (GGBFS)
SCM = Supplementary cementitious materials
SDC = Seismic Design Category
Sec. = Section(s)
Sh. = Sheathing or sheathe (in context)
SIPGF = Stay-in-place galvanized forms
SMF = Special moment frames
Sp. = Special
SRA = Shrinkage-reducing admixture
SRC = Sulfate resisting cement
SSRS = Stainless steel reinforcing steel
SSWWF = Stainless steel welded wire fabric
Stirr. = stirrups
Str. = Structures
SW = seawater
TAC = Total air content
Thaum. = Thaumasite
Tol. = Tolerance
TS = Tensile strength
TSA = Thermal spray galvanic anode
UPT = Unbonded post-tensioning steel or unbonded post-tension (in context)
VS = Very severe
w/c = water-cement ratio by weight (mass)
w/cm = water-cementitious materials ratio by weight (mass)
WDWF = Welded deformed wire fabric
WPC = percent by weight (mass) of portland cement
WPCM = percent by weight (mass) of cementitious materials with SCM content not exceeding PC content
WRA = Water-reducing admixture
WS = Water soluble
WT = Watertight
WWF = Welded wire fabric

Fig. 6: Abbreviations used in Figure 4 and Figure 5, and throughout this article

Cast-in-place concrete (not prestressed)

Exposure	Member Type	Reinforcing Size	Min. Cover (in)
Earth or weather	Cast against/perm exposed to earth	All	3
	All others	#6 through #18	2
		#5, 5/8" wire and smaller	1-1/2
No weather or contact with ground	Slabs, walls, joists	#14 and #18	1-1/2
		#11 and smaller	3/4
	Beams, girders, columns (all)	All	1-1/2
	Shells and folded plate members	#6 and larger	3/4
		#5, 5/8" wire and smaller	1/2

Other Provisions:

Pipe and fittings:
1-1/2" for concrete exposed to weather
3/4" for concrete not exposed to weather or ground
Bundled bars:
Min cover: Equivalent diameter for the bundled bars, not to exceed 2"
['77: 3" minimum for concrete cast against ground]

Prestressed concrete members

Exposure	Member Type	Reinforcing Size	Min. Cover (in)
Earth or weather	Cast against/perm exposed to earth	All	3
	Wall panels, slabs and joists	All	1
	Other members	All	1-1/2
No weather or contact with ground	Slabs, walls, joists	All	3/4
	Beams, girders, columns	Principal reinforcement	1-1/2
		Ties, stirrups, spirals	1
	Shells and folded plate members	5/8" and smaller	3/8
		Other	3/4 ≤ D

Other Provisions:

Prestressed concrete
Non-prestressed reinforcement under plant control may be that for precast members
Cover increase of 50% for higher tensile stresses with exposure to weather, earth or corrosive environments

Precast concrete manufactured under plant conditions

Exposure	Member Type	Reinforcing Size	Min. Cover (in)
Earth or weather	Wall panels	#14 and #18; ['02: PS > 1-1/2"]	1-1/2
		#11 and smaller; ['02: PS ≤ 1-1/2", 5/8" wire and smaller]	3/4
	Other members	#14 and #18; ['02: PS > 1-1/2"]	2
		#6 through #11; ['02: PS 5/8" to 1-1/2"]	1-1/2
		#5, 5/8" wire and smaller; ['02: PS ≤ 5/8"]	1-1/4
No weather or contact with ground	Slabs, walls, joists	#14 and #18; ['02: PS > 1-1/2"]	1-1/4
		['02: PS ≤ 1-1/2"]	['02: 3/4]
		#11 and smaller; ['02: 5/8" wire and smaller]	5/8
	Beams, girders, columns	Principal reinforcement	5/8 ≤ D ≤ 1-1/2
		Ties, stirrups, spirals	3/8
	Shells and folded plate members	['02: PS]	['02: 3/4]
		#6 and larger	5/8
		#5, 5/8" wire and smaller	3/8

Other Provisions:

Tolerances included for cover for flexural, wall and compression members based on depth, d:
± 1/4" for d ≤ 8"; ± 3/8" for 8" < d < 24";
± 1/2" for d ≥ 24"; - 1/3 of min specified cover

['74 revised tolerances: - 3/8" for d ≤ 8"; - 1/2" for d > 8"; - 1/4" for formed soffits; - 1/3 of min specified cover]

Fig. 7: Cover requirements from ACI 318-714a as referenced in Figure 5. Primary modifications through revisions in 1974, 1977 and 2002[4a] noted and indicated in red.

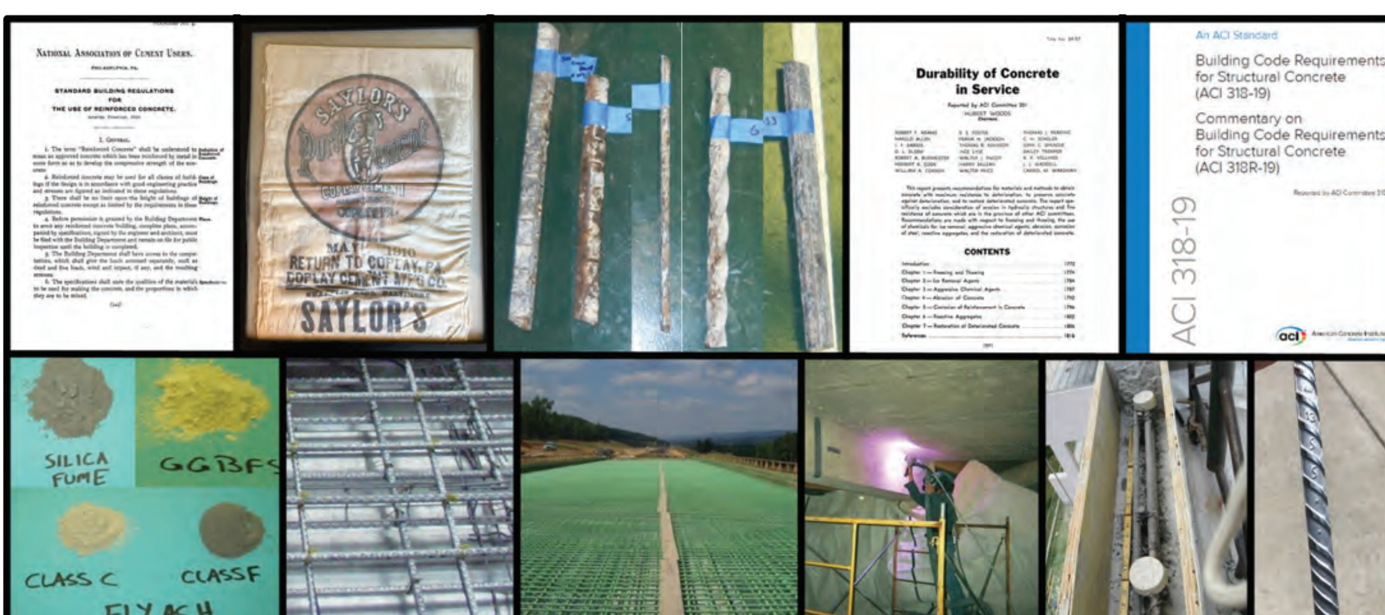


Fig. 8: Top row from left: 1910 NACU (predecessor to ACI 318), early cloth cement bag, reinforcing steel bars from buildings constructed in the 1910s-20s, 1962 ACI Committee 201 Durability Report, ACI 318-19 (current Industry Standard Code); Bottom row from left: examples of SCMs incorporated into codes in the 20th century, galvanized reinforcing steel and epoxy coated reinforcing steel, thermal spray on existing concrete structures, galvanic anodes in patch repairs; and stainless steel

This article is not focused on technologies for existing structures, but the presence of corrosion mitigation technologies can impact how one might approach a repair project. Impressed current cathodic protection was used on concrete pipes and tanks in the 1950s[44] and was first installed on a bridge deck in 1973.[46] The development and use of galvanic cathodic protection occurred in the late 1980s and early 1990s[47] with a number of patents being issued thereafter for patch repair anodes and different surface-applied and embedded systems. Surface applied corrosion inhibitors were introduced in the early 1990s and a large amount of research has been conducted on them in the decades that followed.[48]

SUMMARY AND CLOSING

This article provides general discussion on the use of information in historical codes and industry standards to aid condition assessments for evaluating and repairing structures. Major changes and advancements in codes with respect to durability and deterioration mechanisms, as well as industry practice, were provided. It is hoped that the information may be of use to practitioners as they evaluate existing structures and train new professionals.

ACKNOWLEDGMENTS

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Hamilton House Condominium—Restoring an Oceanfront Treasure to Its Original Beauty

by Elena Kessi

Fig. 1: After an extensive $6.9M restoration project, the Hamilton House Condominium Building shines on Florida's coastline. Built in 1962, it features 24 units, each with unobstructed ocean views

PROJECT INTRODUCTION

Built in 1962, Hamilton House Condominium is a unique 5 story oceanfront property in Delray Beach, Florida, with each of its 24 units having unobstructed, magnificent oceanfront views. It is just minutes away from downtown Delray Beach, Florida, a small and intimate beachside town with big-city sophistication. Years of exposure to the salty ocean air wreaked havoc on the concrete structure. In May 2019, the Condo Association undertook what should have been a routine project to repair and waterproof some of the building's concrete balconies and walkways. However, once investigation and work began, the engineer quickly found that the damage was much more extensive and would require a significant change to the scope of work. The project was initially budgeted at $1.1M with a 6-month targeted time frame. The final project cost soared to $6.9M and took 2 years to complete. Although the time and budget increased extensively, the owners were left with a property not only restored to its original beauty, but with updated amenities that rival the newer properties in the area (Figure 1).

INVESTIGATION

Initial investigation of the building utilizing standard sounding practices revealed what could be considered "expected" deterioration based on the age and location of the structure. However, once the contractor started removing concrete to begin patching work, much larger problems were exposed.

The original concrete mix contained seashells and other debris characteristic of concrete batched using beach sand and ocean water (Figure 2). Most of the reinforcement steel was corroded beyond repair, and it appeared that many areas of the original construction were fabricated with concrete with far too little reinforcement. Many areas of the building did not have continuous reinforcement bars throughout sections that should have called for it (Figure 3). Carpeting on the balconies had also retained moisture over many years and masked the fact that most of the balconies were not properly sloped to encourage water runoff during storms.

Another factor that contributed to the deterioration included the multiple avenues for water to get into the structure that were not necessarily noticeable to the owners. The roof needed repair and provided multiple points of ingress for water to enter the concrete and CMU structure.

The extent of the concrete deterioration and corrosion of the reinforcing steel was staggering, and it quickly became evident that the scope of work needed to change drastically.

REPAIR PLAN

After extensive onsite investigation that included both destructive and non-destructive evaluation methods, the repair team comprised of the engineer, contractor, and building inspector, presented an extensive plan to the Board of Directors that included concrete repair, waterproofing, roofing, and façade work. The Board of Directors understood the severity of the work required and not only supported the project with full approval but decided to expand the project to include additional needed work to bring the building back to its full glory.

All balconies, walkways, and columns were sounded using industry accepted methods and areas in need of repair were identified (Figure 4). Repairs included partial depth, full depth, form and pour, re-sloping and overhead application methods. Many areas also required additional reinforcement. New reinforcement bars and any existing bars that could be accessed were properly cleaned and treated with a topically applied corrosion resistant coating. The material used was a cementitious material that had the added benefit of longer open times and pot life, making it easier for the contractor to install. The repair materials installed all contained a migrating corrosion inhibitor that provides additional protection against future corrosion-induced deterioration.

As the balconies were being demoed for repair, the repair team discovered that the underlying corrosion had actually “invaded” each unit and common area by about 3 feet (.91 meters). To properly encompass and address all the deteriorated concrete and corrosion, repairs had to be carried inside each unit (Figure 5). This was a massive initiative involving weather wall construction for every opening and individual unit restoration. The engineer redesigned all the openings to provide proper tie-ins to the waterproofing while incorporating all new impact resistant windows and doors. Several units had unique “bump outs” or balconies that were formerly enclosed; they required separate architectural plans and individual permits. All of the railings on the building were replaced with new glass railings to further enhance the oceanfront view.

As part of the project, the roof was removed and replaced with a new built-up asphalt roof (Figure 6). The East-facing façade finish was also removed and waterproofed with a flexible cementitious waterproofing membrane, then refinished with an architectural coating. The remaining fa-

Fig. 2: A close-up of one of the seashells found within the concrete matrix of the building structure

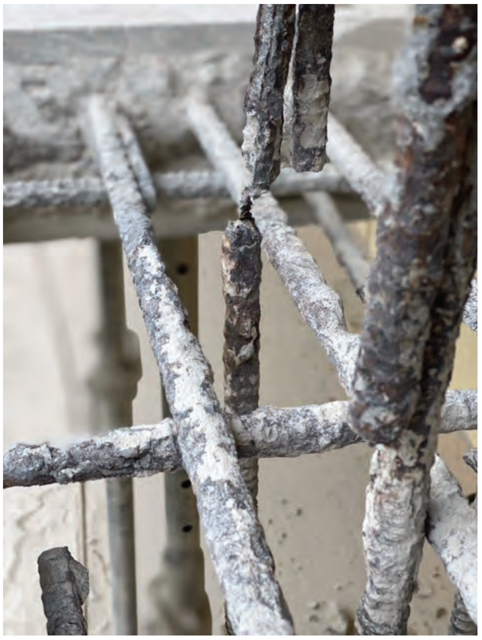


Fig. 3: The rebar in many of the repair areas were found to be unbonded and corroded beyond repair

Fig. 4: Repair areas marked after NDT such as hammer tapping and chain dragging were performed to determine extent of required repairs

çades were covered with a skim coat to refresh the many years of past "patching" throughout the building.

The building's porte cochere required all new waterproofing after repairs were completed that included adding larger columns and reinforcing existing columns with more rebar. Not only was the structure reinforced, but the Board took advantage of the work being done in this area and had the contractor square off both the columns and facia to add to the modernization of the building's overall appearance (Figure 7). Sections of the carport were deemed beyond repair and posed imminent danger to occupants and visitors. As a result, those structures were removed, and the parking area repaved and completely refurbished along with new LED light fixtures and poles that added further scope to an already extensive restoration project.

To complete the extensive project, the pool and pool deck were completely remodeled. All ground floor walkways were replaced with high quality marble and the outdoor space was further enhanced with a summer kitchen. The landscaping was completely redone to achieve proper grading in all areas to ensure longevity of the structure by directing water away from the building and finished off with new fencing and irrigation.

CHALLENGES

The original project scope was budgeted for completion within 6 months. However, many challenging situations were thrown at the repair team that required them to explore ways to help mitigate the impact on timing. Due to the extreme extent of damage and scope of work, residents decided to move out for the duration of the project so the contractor could work unimpeded.

Approximately 6 months into the project, Hurricane Dorian threatened the Florida East Coast, forcing all work to stop. With the project in full swing, the building was wide open to the elements and exposed to the potential impact of the storm, forcing the contractor to move fast in preparation. The massive effort to prepare for Dorian started with a full demobilization of equipment and materials that were staged onsite and couldn't be properly secured and protected (Figure 8). Once everything was safely removed from the site, and with all existing hurricane shutters removed from the site, the contractor had to scramble to find

Fig. 5: All window and door openings were redone, and additional waterproofing was added to ensure future protection from leaks

Fig. 6: The roof was replaced with a new built-up asphalt roof

Fig. 7: The building's porte cochere was repaired and modernized to enhance the building's overall appearance

Fig. 8: Hamilton House had to be completely boarded up as Hurricane Dorian threatened the Florida East Coast during the height of repair work, creating many logistical challenges

enough plywood to properly board up every unit's openings. Thankfully, Dorian did not inflict too much damage on the region; however, storm clean-up from downed foliage coupled with extensive power outages and supply shortages created logistical delays that slowed down progress.

As the project rolled into 2020, most of the repair work was completed and it was time for the windows, doors, and other exterior finishing touches to start. The COVID-19 pandemic brought the project to a grinding halt in March 2020. As a result of the pandemic, permitting and inspections were delayed and supply chains became increasingly challenging even after the contractor was able to get back on site. It required tight coordination with material vendors and trucking companies to ensure product delivery and accessibility.

Prior to the pandemic, the repair team held extensive on-site meetings with the Board of Directors to ensure they were well informed of progress and any developing conditions that needed to be addressed. Once the initial "lockdown" ended, the new challenge of how to work safely with the virus spreading rapidly created further delays as most of the world moved to remote work with limited, if any, allowance for in-person meetings. Necessary on-site meetings were strictly held outdoors with only essential personnel present while others quickly transitioned to virtual options to have "eyes" on current progress and jobsite conditions. The success of this project was largely due to the collective approach taken by everyone involved under these unique circumstances.

CONCLUSION

While fully modernizing a 60-year-old building, it was important to the Board of Directors that the building's unique Art Deco appearance was not lost, so every repair was designed to enhance the aesthetic. In addition to the extensive concrete repair work, the Board spared no expense in addressing potential future safety concerns for residents. Some of the additional work incorporated in the project included a complete revamp of the fire alarm system, installation of a state-of-the-art electronic entry and security system with video surveillance, massive electrical rework and upgrading, installation of new metal hurricane-rated doors on stairwells, common laundry and trash chute rooms, and new code compliant stairwell handrails in each stairwell.

With the significant change in the scope of the project and unique challenges encountered by the project team, this restoration project could have ended in disaster. Instead, with the collaboration and creativity of the stakeholders involved, the project led to an enhanced, modernized structure with its unique Art Deco design fully intact. The project was finally completed in 2021 and residents eagerly moved back into their fully restored homes. The extensive restoration work resulted in Hamilton House becoming a shining example of not only what Florida coastal living is all about—but how with the right team, structures can be restored in a sustainable fashion rather than being destroyed and replaced, giving the owners back their beachfront paradise.

Hamilton House Condominium—Restoring an Oceanfront Treasure to Its Original Beauty

OWNER
Hamilton House Condominiums
Delray Beach, FL

DESIGN PROFESSIONAL
Bunker Engineering
Lake Worth Beach, FL

GENERAL CONTRACTOR
Hartzell Construction
Pompano Beach, FL

MATERIAL MANUFACTURER
Aquafin, Inc.
Elkton, MD

Elena Kessi is the President of Aquafin, Inc. She has over 15 years of experience in the concrete repair industry and is a recent past president of ICRI. Elena has been active on numerous committees within ICRI and enjoys being in the field to see firsthand how products are applied.

Increasing the Durability and Lifespan of Bridges with Ultra-High-Performance Concrete Repair Solutions

by Benjamin Birch, PE

Corrosion of steel reinforcement embedded within concrete due to the ingress of chlorides from deicing salts or salt air is a major cause of bridge deterioration

Typical steel fibers used in UHPC (photo courtesy of CTLGroup)

According to the American Society of Civil Engineers, 42 percent of the 617,000 bridges in the U.S. are at least 50 years old and 46,154 are structurally deficient.[1] Moreover, the American Road & Transportation Builders Association states that at the current pace of rehabilitation it will take 40 years and an estimated $42 billion to make all the necessary repairs.[2] With climate change making weather conditions more extreme, the magnitude of deterioration will escalate and become an overwhelming challenge.

As the nation's transportation infrastructure continues to age and deteriorate, owners are paying greater attention to life-cycle costs and relying on more durable preservation and repair materials. This includes long-lasting, high-strength materials such as ultra-high-performance concrete (UHPC).

Promoted and supported by the Federal Highway Administration (FHWA), UHPC is steadily gaining traction in regions susceptible to extreme weather environments. It is in such environments that "weak links" of structures often need more frequent repair.

CAUSES OF DETERIORATION

Bridges subjected to extreme exposure conditions face several key technical challenges, including corrosion resistance, freeze-thaw durability, and surface abrasion.

Corrosion of steel reinforcement embedded within concrete due to the ingress of chlorides from deicing salts or ocean breezes is a major cause of bridge deterioration. As the metal corrodes, the resulting expansive pressure causes the concrete to crack, accelerating the penetration of chlorides, moisture, and other corrosive contaminants. Uncontrolled, corrosion can lead to complete separation and failed structural components, resulting in high maintenance costs and possibly unsafe conditions.

Cyclical freezing and thawing of water is another critical concern. Because water expands when frozen, the expansive forces create hydraulic pressures within the concrete that can result in significant cracking and scaling. If moisture reaches embedded steel reinforcement, the metal corrodes and its volume expands, further fracturing the concrete and accelerating moisture ingress. Deicing salts increase the potential for freeze-thaw damage because they absorb moisture and keep the concrete more saturated.

Abrasion damage occurs when surfaces are unable to resist wear caused by vehicular traffic. Today's bridges are increasingly subjected to heavier truck loads that threaten to overstress bridge elements and cause fatigue and cracking. Tire chains and studded snow tires also cause considerable wear to surfaces. Compressive strength is the principal factor controlling the abrasion resistance of concrete.

UHPC PERFORMANCE ADVANTAGES

There is more to UHPC than the extremely high strength it can achieve. Its toughness and durability rank at the top of its advantages. Significant benefits of the material include its relative impermeability, low shrinkage, crack resistance, and high abrasion resistance even under the most extreme climatic and chemical conditions.

UHPC is a cementitious composite material with mechanical, durability, and bonding properties that far exceed those of conventional concrete. The mixture has an extremely low water content, contains a high percentage of steel fibers, and can be made without air entrainment. The product's incredibly low porosity paste matrix is exceptionally durable, and macrocracking will not occur but remain as well distributed microcracks that will inhibit the penetration of corrosive chlorides. Because the mix is so dense and moisture cannot get in, UHPC will not freeze and expand, thus avoiding freeze-thaw damage.

There are currently 3-4 major U.S. manufacturers of UHPC materials. While formulations are proprietary, mixes commonly consist of Portland cement, silica fume, fine quartz sand, water-reducing admixtures, steel fibers, and a water to cementitious materials ratio of less than 0.25. The material has a minimum specified compressive strength of 17,000 pounds per square inch (120 MPa) with specified durability, tensile ductility, and toughness requirements.

PRESERVATION AND REPAIR APPLICATIONS

There are a wide variety of bridge locations where UHPC is used to mitigate deterioration, reduce maintenance requirements, and extend the service life of the structure. Following are some widespread problem areas in the superstructure that are addressed with UHPC repairs solutions.

Expansion joints. The leakage of water and deicing chemicals through cracked expansion joints causes deterioration of steel girder ends below the bridge deck. Because UHPC is crack resistant, it offers a maintenance-free, permanent solution to joint problems.

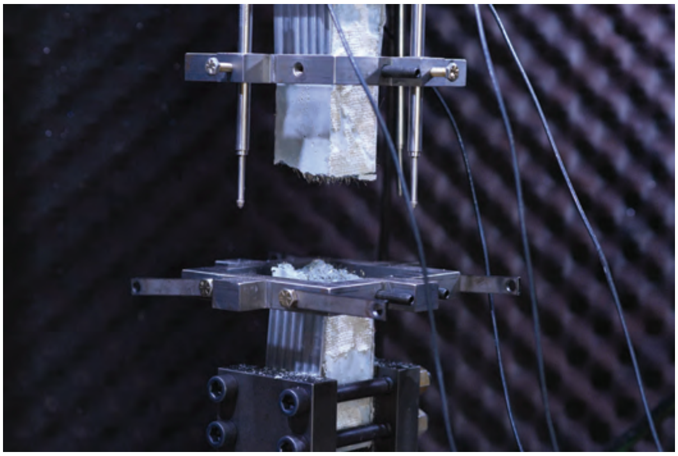
Link slabs. Another approach to addressing leaking joint problems is to eliminate the joint altogether and replace it with a durable UHPC link slab. After the joint is removed by placing UHPC across the joint as a thin slab, the UHPC

UHPC cylinder sample fabrication. UHPC contains properties similar to self-consolidating concrete (SCC) (photo courtesty of CTLGroup)

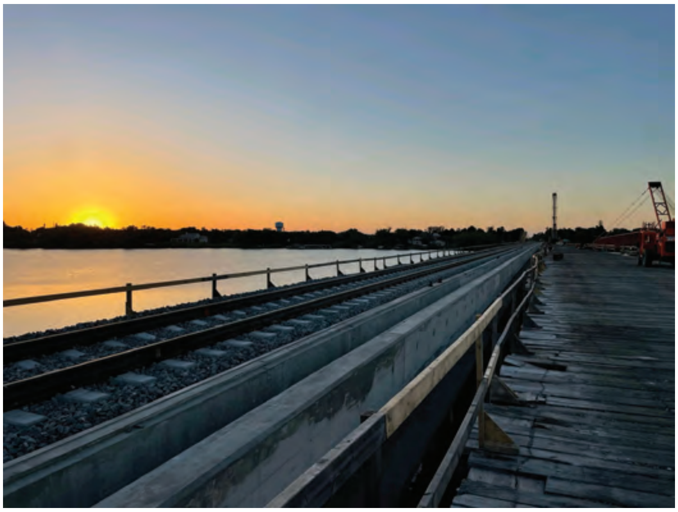
Field placement of UHPC (photo courtesy of Steelike)

Bridge deck overlays using UHPC can protect underlying structural concrete from chloride ingress (photo courtesy of Steelike) link slab is ground to match the profile of the existing deck and grooved for skid resistance. This approach is common for linking precast elements as they have a history of durability issues related to longitudinal cracking along key connections. UHPC creates robust and durable connections between prefabricated deck elements that exhibit deterioration or leakage.

Field placement of UHPC on bridge (photo courtesy of Steelike)



UHPC is known for its incredible mechanical and durability properties, including sustained post-cracking tensile strength. However, quantifying the improvement of these tensile mechanical properties over conventional and fiber-reinforced concrete has been a challenge. The Federal Highway Administration (FHWA) developed a testing method followed by the in-progress standard by the American Association of State Highway and Transportation Officials (AASHTO) (photo courtesy of CTLGroup)



UHPC is gaining usage as existing rail tracks are converted to high-speed rail (photo courtesy of Steelike)

Deck overlays. UHPC is a promising solution for enhancing the durability of worn deck surfaces. This thin-bonded UHPC topping layer can be used as a strengthening technique to increase the load-carrying capacity of the structure and provide a surface that is both abrasion resistant and virtually impermeable.

Damaged steel girder ends. To mitigate the deterioration of beams, engineers are encasing the ends of the girders in a jacket of UHPC to strengthen and protect them from further corrosion. This enhances the structural capacity and durability of the girder with minimum traffic interruption and at a lower cost.

Low concrete cover. The American Concrete Institute recommends a minimum cover thickness of 2 – 2.5 inches (5.1 – 6.3 cm) over steel-reinforced concrete in harsh marine and weather environments. A UHPC overlay will provide a more durable cover to prevent the ingress of moisture and other corrosive agents.

Beyond repairing the weak links in the bridge superstructure discussed above, there are also promising substructure rehabilitation applications of UHPC. This includes retrofitting structures to enhance their seismic performance and upgrading deteriorated bridge columns and piers. For more information on these applications, see the FHWA document on UHPC bridge preservation and repair solutions.[3]

PROVEN RECORD OF SUCCESS

The proven performance of UHPC in withstanding the extreme environments bridges experience has increasingly made it a material of choice for keeping this vital infrastructure in good condition. Since its first application more than 15 years ago, 35 states plus the District of Columbia have employed UHPC in bridge projects, and 13 have relied on it for bridge preservation and repair.[4]

In recent years, state departments of transportation (DOTs) have used multiple techniques and strategies to repair or strengthen bridges with UHPC.[5] While many of these projects used UHPC to repair connections between precast slab units, other successful applications included bridge deck overlays, link slabs, and beam-end repairs.

Thin-bonded UHPC overlays that were first applied in Iowa in 2016 have generated much interest to rehabilitate and provide long-term protection to bridge decks. In 2020 and 2021, Delaware and New Jersey implemented this solution to extend the service life of multiple bridges throughout both states.

New York was the first state to use a UHPC link slab in 2013 and, to date, has completed the most UHPC link slabs in the U.S. As of 2020, UHPC link slabs have been installed on at least 35 additional bridges in six states.

Connecticut was the first state to use UHPC to repair deteriorated steel girder ends on an I-91 bridge in 2018. UHPC repairs of damaged bridge beams—aimed at tackling the ever-growing challenges of bridge maintenance—soon followed in Rhode Island, Michigan, Florida, and Texas.

APPLICATION CONSIDERATIONS

A well-written material specification includes testing criteria for verifying target performance levels. Regardless of the UHPC application, it is important to specify the use of ASTM C1856[6] modified test methods. This guidance document details necessary alterations to standard quality-control tests for measuring the properties of fresh UHPC and for making and testing specimens of hardened UHPC. The use of AASHTO-accredited laboratories that employ trained and certified personnel with extensive experience in performing ASTM C1856 modified test methods is highly recommended. Additionally, citing the standard will key the local labs into the different requirements for testing this material and, hopefully, prevent them from going into the project blindly.

Product placement is an additional consideration when working with UHPC. Cleaning and abrading the surface to ensure a good bond between the UHPC and the substrate is critical to ensuring high-quality results. Specialized training is not necessary as the fluid material is self-consolidating and requires no vibration. In essence, the manufacturer manages all the production and batch mixing requirements on the job site and provides oversight of the small-volume pours.

While UHPC has many performance advantages, its cost is substantially higher than conventional concrete in a direct volume comparison. As such, UHPC repair applications are focused on critical bridge locations to mitigate deterioration concerns and improve life-cycle costs. The initial cost increment in using UHPC connections for prefabricated bridge elements, for example, is relatively low because the quantity of material required is small. However, the potential long-term cost savings are high when factoring in extended service life, reduced maintenance requirements, and fewer traffic disruptions.

MOVING FORWARD WITH UHPC

For those who own and maintain bridges throughout the U.S., it makes good engineering and financial sense to use advanced preservation materials that are stronger, are more durable, and offer life-cycle cost advantages. As such, many state DOTs are increasingly specifying UHPC for bridge repair projects to lower maintenance requirements, reduce traffic delays, and extend service life.

In 2020, the FHWA selected UHPC as one of the technologies to be included in its Every Day Counts (EDC) initiative. Under the EDC banner, the FHWA will provide assistance in using UHPC in bridge preservation and repair projects.

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Benjamin Birch, PE, is a senior engineer and laboratory engineer for concrete and mortar at the CTLGroup. He is an expert in the mechanical properties of concrete and a member of the American Concrete Institute, Transportation Research Board, American Society of Civil Engineers, American Concrete Pavement Association, and ASTM International. He received his BS and MS in civil engineering from the University of Illinois at Urbana-Champaign and is a licensed professional engineer in 10 states.

The CTLGroup's team of engineers and material scientists can provide additional assistance in evaluating the cause of problems, developing UHPC repair strategies, and producing material test results that are accepted by state DOTs. Contact Benjamin at bbirch@ctlgroup.com.

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CONCRETE REPAIR CALENDAR

JANUARY 16, 2023
2023 ICRI Kick-Off Party
Las Vegas, NV
Website: www.icri.org

JANUARY 16–19, 2023
World of Concrete
Las Vegas, NV
Website: www.worldofconcrete.com

JANUARY 31–FEBRUARY 2, 2023
The International Surfaces Event
Las Vegas, NV
Website: www.intlsurfaceevent.com

APRIL 2–6, 2023
ACI Concrete Convention
San Francisco, CA
Website: www.concrete.org

APRIL 17–19, 2023
2022 ICRI Spring Convention
Vancouver, BC, Canada
Website: www.icri.org

PEOPLE ON THE MOVE

VECTOR CORROSION TECHNOLOGIES NAMES LIAO HAIXE, PE, P.ENG, SENIOR ENGINEER AND REGIONAL MANAGER FOR ONTARIO AND ASIA

Vector Corrosion Technologies is pleased to name Liao Haixue as Senior Engineer and Regional Manager for Ontario and Asia. Haixue has over 25 years of experience in post-tensioning installation, evaluation, rehabilitation, and structural strengthening, and 20 years of experience in evaluating and mitigating corrosion of reinforced concrete structures.

Haixue is a professional engineer registered in New York, United States of America and Ontario, Canada. He is a qualified presenter for the American National Council of Structural Engineers Associations, a certified continuing education program, "Evaluation, Repair, Protection and Strengthening of Existing Concrete Structures."

He is an AMPP (formerly NACE) Certified Cathodic Protection Specialist, a member of Post-Tensioning Institute committees CRT60, DC55 and DC80 and is a founding member and President of the Canada Structural Engineers Association. VectorCorrosion.com/liaoseniorengineer

CTLGROUP IS PLEASED TO ANNOUNCE THAT THREE KEY INDIVIDUALS HAVE JOINED THE FIRM TO GROW SERVICE OFFERINGS AND ENHANCE CORE CAPABILITIES

David Corr, Ph.D., P.E. has joined the firm as Principal Engineer & Group Director. As one of the nation's leading experts related to structural performance and the materials science of porous infrastructure materials,

he has studied the durability of concrete and timber, the rheology and fresh-state behavior of concrete, and fracture and cracking in cement-based materials. Dr. Corr will oversee CTLGroup's materials consulting group and will be responsible for growing the firm's capabilities in emerging materials.

Marcello Tronci, P.E. has joined the organization as Senior Structural Engineer. Tronci has extensive experience in structural engineering design in the U.S. and Italy. His expertise includes performing feasibility studies, risk analysis and investigations in connection with the repair and rehabilitation of buildings and structures, and for new construction consulting. Tronci brings local structural engineering expertise to CTLGroup's New York City presence and will help grow relationships with a variety of clients.

David Waratuke, S.E. joined CTLGroup as a Senior Structural Engineer and has broad engineering experience on a national and global scale. With nearly 30 years' experience, Waratuke's work is diversified and spans forensic investigations, building renovation and repair, construction engineering support, high rise structures, convention centers, sports facilities, aviation facilities, residential structures, and unique projects including the glass observation boxes at Willis Tower. He is adept at developing creative solutions for clients and will help grow CTLGroup's structural practice.

INDUSTRY NEWS

BAKRIE AND COBOD INTERNATIONAL ESTABLISH JOINT VENTURE FOR 3D CONSTRUCTION PRINTING IN INDONESIA

Leading 3D construction printing technology supplier COBOD International A/S ("COBOD") has entered into a Joint Venture agreement (JV) with PT Modula Sustainability Indonesia ("Modula"), a subsidiary of PT Bakrie & Brothers Tbk (BNBR). The JV partners will establish a dedicated Indonesian joint venture company aimed at developing the 3D construction printing business in Indonesia.

PT Bakrie & Brothers Tbk (BNBR) is one of Indonesia's foremost corporations and Bakrie & Brothers is the first and lead company of the Bakrie Group, an 80-year old business group boarded a world-class corporate platform in Indonesia. The group controls and operates businesses in multiple industries. Modula Sustainability Indonesia is a subsidiary of BNBR, focusing on offering and providing solution for housing backlog problems currently encountered by the country.

Teaming up with COBOD, the company is now set to adopt the latest 3D construction printing (3DCP) technology and ready to offer the Indonesian market a new and better solution to the housing constructions.

The signing of the agreement was carried out in Jakarta, capital of Indonesia by the CEO of Modula, Indra Ginting and Co-Founder & Head of Asia-Pacific COBOD International, Simon Klint Bergh.

For more information visit https://cobod.com/.

ASSOCIATIONNEWS

AMERICAN CONCRETE INSTITUTE ANNOUNCES INTERNATIONAL PARTNERSHIP WITH THE GLOBAL CEMENT AND CONCRETE ASSOCIATION

While exhibiting and participating in PROCEMCO in Cartagena, Colombia, the American Concrete Institute (ACI) and the Global Cement and Concrete Association (GCCA) were able to formalize their cooperative efforts by signing an International Partnership Agreement (IPA). This new agreement formalizes the desire to collaboratively develop and disseminate information on concrete, concrete structures, and especially on concrete sustainability. International Partners work with ACI to increase access to concrete information worldwide.

GCCA is the key driver of sustainability in the cement and concrete industry, working towards the goal of carbon neutral concrete. Representing 80% of global production outside of China, as well as key Chinese producers such as CNBM, the GCCA launched its 2050 Net Zero Roadmap in 2021, outlining the levers, milestones, and pathways to achieve a decarbonized industry. This includes new technologies, innovations, and importantly—improving efficiency in design and construction. Here, the contribution of design and construction professionals to delivering carbon reductions through concrete projects is crucial. This partnership will support dissemination of best practices to enable specification of sustainable concrete and design of lower carbon concrete elements and structures.

Visit www.concrete.org for more information.

THE WINNERS OF THE 8TH ANNUAL ACI EXCELLENCE IN CONCRETE CONSTRUCTION AWARDS

The eighth annual ACI Excellence in Concrete Construction Awards showcased dozens of innovative concrete projects from around the world.

The "Overall Excellence" award was presented to Chau Chak Wing Museum, located in Sydney, New South Wales, Australia. The winning concrete project also received first place in the mid-rise structures category at the ACI Excellence in Concrete Construction Awards during the ACI Concrete Convention on Monday, October 24, 2022.

The Chau Chak Wing Museum at The University of Sydney is the culmination of many years of strategic planning that consolidates the University's Nicholson, Macleay, Power, and University Art collections and showcases some of Australia's most significant artistic, scientific, and archaeological artifacts. With a specified design life of more than 100 years, the aspiration for the Museum was to be as highly regarded as the iconic Great Hall and Quadrangle, the symbolic and ceremonial heart of the University. The construction of the museum involved bulk excavation, construction of a six-level building (including a plant level and two basement levels) with 7740 m^2 (83,300 ft^2) of gross floor area.

For more information visit https://www.concrete.org.

AMERICAN CONCRETE INSTITUTE ANNOUNCES NEW BUILDING OFFICIALS WEBINAR SERIES

The American Concrete Institute (ACI) announces the availability of a new series of webinars, the ACI Building Officials Webinar Series, beginning in November 2022. The webinar series will focus on highlighted topics specifically for building officials that have been approved for professional development hours from the International Code Council (ICC).

The first webinar in the series, Fundamentals of Quality Concrete, will be available November 8, 2022, and will discuss basic fundamentals of concrete that are necessary to produce quality construction materials. The webinar will also cover the basic materials used in concrete and the essentials required to design and control concrete mixtures for a wide variety of applications and exposures.

Additional programs in the ACI Building Officials Webinar Series will continue throughout 2023, and details will be released in the coming months.

For more information and to register for the ACI Building Officials Webinar Series, visit concrete.org.

NEU REALIZES FAST MEMBERSHIP GROWTH DURING FIRST MONTHS

NEU: An ACI Center of Excellence for Carbon Neutral Concrete–a uniquely positioned center providing access to technologies and the knowledge needed to effectively and safely produce and place carbon neutral concrete in the built environment—is seeing rapid growth in membership during its first few months. This exciting progress has resulted in an inspiring initial membership.

Joining as Sustaining Members of NEU are Breakthrough Energy and Meta. Founded by Bill Gates, Breakthrough Energy is dedicated to helping humanity avoid a climate disaster. Through investment vehicles, philanthropic programs, policy advocacy, and other activities, Breakthrough Energy is committed to scaling the technologies the world needs to reach net-zero emissions by 2050.

Meta, the parent company of Facebook, recognizes the urgency of climate change and continues to build on more than 10 years of work to minimize its impact on the environment. Since 2020, Meta's global operations have been supported by 100% renewable energy and achieved net zero greenhouse gas emissions.

Additionally, Baker Concrete Construction has joined as a Supporting Member. Affiliate Members include Advancing Organizational Excellence (AOE), American Concrete Institute Foundation, Atlantis Holdings Ltd. d.b.a. AtlantisFiber™, Ash Grove Cement/CRH, CeEntek, Stone Coat Global, Ozinga, CarbonBuilt and Lehigh Hanson. American Concrete Institute is a founding member.

For more information visit www.neuconcrete.org.

TACA MEMBERS GATHER FOR ENVIRONMENTAL & SAFETY SEMINAR

The Texas Aggregates & Concrete Association (TACA) welcomed 112 attendees to its Environmental & Safety Seminar on Oct. 27-28 at the Marriott Riverwalk in San Antonio, Texas.

Industry professionals delivered topical presentations on managing environmental and safety regulations and other issues facing TACA members today. One conference session, "Responsible Sourcing: Pathway to Sustainable Manufacturing," explored how the world will double its building stock by 2060, demanding responsible sourcing, carbon neutrality, and a circular economy to fulfill societal needs.

"Today, to stay competitive with other building materials, the cement and concrete industries must continue to embrace the language of measuring and demonstrating carbon neutrality," said Lionel Lemay, P.E., S.E., LEED AP, Executive Vice President/Division Head, Structures and Sustainability, National Ready Mixed Concrete Association (NRMCA).

Lemay outlined various local, state and federal "buy clean" initiatives – including General Services Administration (GSA) standards that became effective in March 2022 – that consider social and environmental considerations when choosing suppliers.

"The technology has caught up and we are able to collect more easily the environmental information that customers are now demanding," he said. "Using these certifications, measurements and data enables you to better compete as you demonstrate that you are environmentally responsible for the materials you are providing."

For more information visit www.tx-taca.org.

NEX AND ICC-ES SIGN ALLIED ORGANIZATION MEMORANDUM OF UNDERSTANDING IN SUPPORT OF NONMETALLIC BUILDING MATERIALS

NEx: An ACI Center of Excellence for Nonmetallic Building Materials is pleased to welcome ICC Evaluation Service as a new Allied Organization. NEx has signed a MOU with ICC Evaluation Service (ICC-ES) to create a partnership in advancing the use of nonmetallic building materials.

ICC-ES is the leading evaluation service for innovative building materials, components, and systems and is a member of ICC-ES solutions. This agreement will support NEx'S vision to provide the industry with better materials and solutions and accelerate adoption of nonmetallics in codes and standards. The agreement will create a platform for more collaborations to advance sustainability, quality, and integrity of nonmetallic building materials.

This exciting new collaborative effort means that ICC-ES will join NEx on its mission to collaborate globally to expand and accelerate the use of nonmetallics in the built environment to drive innovation, research, education, awareness, adoption, and deployment. This also includes development of Acceptance Criteria to promote the use of nonmetallic materials in construction.

NEX ANNOUNCES PARTNERSHIP WITH OWENS CORNING INFRASTRUCTURE SOLUTIONS, LLC

NEx: An ACI Center of Excellence for Nonmetallic Building Materials, announces Owens Corning Infrastructure Solutions, LLC as a new Bronze Supporting Member. NEx is excited to welcome Owens Corning to its expanding list of partners who are collaborating globally to drive the NEx mission of collaborating globally on the use of nonmetallic building materials, driving research, education, and adoption.

Owens Corning is a global leader in building and construction materials. Their mission is building a sustainable future through material innovation and a wide array of products including roofing, insulation, composite solutions, geosynthetics, and more. Owens Corning was formed in

1938 through a partnership between glassworks companies Corning Glass Works and Owens-Illinois when the two groups wanted to share innovative knowledge in fiberglass development. The company is currently based in Toledo, Ohio, and has approximately 20,000 employees worldwide.

To learn more about how NEx is advancing nonmetallics and to get involved, visit nonmetallic.org.

NEX ANNOUNCES PARTNERSHIP WITH GATORBAR/NEUVOKAS CORPORATION

NEx: An ACI Center of Excellence for Nonmetallic Building Materials, announces GatorBar, also known as Neuvokas Corporation, as the newest Bronze Supporting Member. The organizations will work together to help drive NEx's mission to collaborate globally on the use of nonmetallic building materials driving research, education, awareness, and adoption. As a new member, GatorBar will join NEx sustaining members Aramco and the American Concrete Institute (ACI), as well as a growing team of supporting members in achieving NEx's mission.

GatorBar® is an industry changing, glass fiber reinforced composite rebar (GFRP), that is 100% made in the USA using 100% USA made materials. GatorBar operates out of Ahmeek, MI in the Upper Peninsula. The company was founded in 2013 when founders Erik Kilunen and Ken Keranen realized that FRP (Fiber Reinforced Polymer) rebar could compete with steel and increase manufacturing speed significantly.

To learn more about how NEx is advancing nonmetallics and to get involved, visit nonmetallic.org.

AMERICAN CONCRETE PUMPING ASSOCIATION ANNOUNCES NEW SAFETY DIRECTOR

The ACPA is pleased to announce the association's first dedicated safety director: Tabah Nez. This inaugural position was created to further ACPA's safety and certification programs for concrete pumping professionals.

As ACPA Safety Director, Nez will be responsible for developing and overseeing all safety and risk management activities, including safety programs, committees, bulletins and resources. His role will be instrumental in developing the training curriculum for ACPA University, an online training platform to be launched January 2023.

Nez brings to this position 23 years of professional hands-on experience in the areas of occupational, safety and health management; environmental health and safety management; risk prevention programs; management of construction emergencies; safety training and worker's comp claims management. He has served on the American Society of Concrete Contractors Executive Safety Committee. He holds a Bachelor of Science degree in occupational safety and health from Columbia Southern University and is OSHA-certified from the University of California, San Diego.

For more information about the ACPA, visit www.concretepumpers.com.

AMERICAN CONCRETE INSTITUTE PUBLISHES CODE REQUIREMENTS FOR GLASS FIBER-REINFORCED POLYMER (GFRP) BARS

The American Concrete Institute, through the work of ACI Committee 440, has released ACI CODE-440.11-22: Building Code Requirements for Structural Concrete Reinforced with Glass Fiber-Reinforced Polymer (GFRP) Bars. The code was developed by an ANSI-approved consensus process and addresses structural systems, members, and connections, including cast-in-place, precast, nonprestressed, and composite construction.

This is the first comprehensive building code covering the use of nonmetallic, GFRP reinforcing bars in structural concrete applications. GFRP reinforcement has been in use for decades as an alternative to steel reinforcement because of its non-corrosive, non-magnetic, and lightweight properties. This code represents a milestone for this technology, and mirrors ACI 318-19 with provisions for designing GFRP reinforced concrete beams, one-way and two-way slabs, columns, walls, connections, and foundations. Other model codes and standards can directly reference ACI CODE-440.11-22 to allow for widespread, responsible use of this important technology.

ACI Committee 440's mission is to develop and report information on fiber reinforced polymer for internal and external reinforcement of concrete. Committee 440 has written and maintains a number of design guides, materials and construction specifications, reports, and technical notes on the use of FRP in structural concrete applications.

To learn more visit concrete.org.

CIM ANNOUNCES SIGNATURE DONATIONS FOR ANNUAL AUCTION AT WORLD OF CONCRETE

The Concrete Industry Management (CIM) program is pleased to announce that the signature item for their annual auction at World of Concrete is a truck-mounted 38M concrete pump donated by Alliance Concrete Pumps, NORCAL Kenworth and Kenworth Truck Company.

CIM program is pleased to announce the donation of a 2023 Peterbilt Model 567 with a Con-Tech Manufacturing extreme duty mixer for the annual auction at World of Concrete.

CIM is pleased to announce that one of the signature items for their annual auction at World of Concrete is a 2023 Mack® Granite® GRFR donated by Mack Trucks and equipped with a McNeilus® FLEX Controls™ Bridgemaster™ Mixer donated by McNeilus Truck and Manufacturing.

The annual auction will be held Wednesday, Jan. 18, 2023 in the North Hall Room N262 of the Las Vegas Convention Center. For a full list of items, please visit www.concretedegree.com/auction.

AMERICAN CONCRETE PAVEMENT ASSOCIATION ANNOUNCES 2022 LIFETIME ACHIEVEMENT AND DISTINGUISHED SERVICE AWARD

The American Concrete Pavement Association (ACPA) is pleased to announce the winners of several prestigious industry awards, presented alongside the Excellence in Concrete Pavement Awards at their Annual Meeting held Nov. 29 – Dec. 1, 2022 in Nashville, Tenn.

The Hartmann-Hirschman-Egan Award recognizes individuals or organizations for unparalleled commitment, dedication, participation, and leadership in the concrete pavement community. The 2022 Hartmann-Hirschman-Egan Award winner is Stephen Jackson of Cedar Valley Corporation (CVC).

The Harold Halm Presidential Award is awarded at the discretion of ACPA's President to an individual who has made significant contributions to the concrete pavement industry. Jim Mack, Director of Market Development at CEMEX, received this award this year for his tireless advocacy for the concrete pavement industry and his unparalleled work in the sustainability space.

The Marlin J Knutson Award for Technical Achievement recognizes individuals who have made significant contributions to advancing the development and implementation of technical innovations for the design and construction of concrete pavements. This year's recipient is Tara Cavalline, Ph.D., of the University of North Carolina at Charlotte.

The Outstanding Promoter Award is given annually to a person who has made significant contributions through promotion efforts or programs to advance the awareness, specification, and/or placement of concrete pavements. Angela Folkestad, P.E., is the Executive Director of the Colorado/Wyoming Chapter of ACPA and was selected as the 2022 Outstanding Promoter Award winner.

For more information visit www.acpa.org.

DEAN FRANK NAMED EXECUTIVE DIRECTOR FOR CENTER OF EXCELLENCE FOR CARBON NEUTRAL CONCRETE

NEU: An ACI Center of Excellence for Carbon Neutral Concrete–a uniquely positioned center providing access to technologies and the knowledge needed to effectively and safely produce and place carbon neutral concrete in the built environment– announces the appointment of Dean A. Frank, P.E., to serve as executive director of NEU.

Frank previously worked as director of validation for NEU and as program developer for the American Concrete Institute (ACI). He brings extensive experience in sustainability, International Standards Organization (ISO) standards, and certification development of personnel, products and manufacturing plants. Prior to joining ACI, Frank gained a comprehensive working knowledge of resilience and sustainability as an employee at Wiss, Janney, Elstner Associates Inc., the National Precast Concrete Association, Precast/Prestressed Concrete Institute, and through his consulting company. He also has experience in working as an assessor with ISO standards governing the operations of conformity assessment bodies and is a licensed P.E. in Indiana and Colorado.

"NEU has been growing quickly and I'm excited about our opportunities to make a difference in reducing the carbon emissions of concrete," said Frank. "I have enjoyed the work I've been doing with NEU so far in setting up the validation program, which we believe will have a big impact on the industry." said Frank.

To learn more, visit www.neuconcrete.org.

INTERESTED IN SEEING YOUR NEWS IN THIS COLUMN?

Email your 150-200 word association news to editor@icri.org. Content for the March/April 2023 issue is due by February 1, 2023, and content for the May/June 2023 issue is due by April 1, 2023. ICRI reserves the right to edit all submissions.

ICRI**CHAPTER**NEWS

CHAPTER CALENDAR

ICRI Chapters are hosting events in 2023. Be sure to check with individual chapters by visiting their chapter pages to determine if they have made any plans after this publication went to print. You can also contact a Chapter Leader from any chapter to ask if they have added events.

FLORIDA WEST COAST
January 4, 2023
CHAPTER CIGAR SOCIAL
Wilson Printing
Clearwater, FL

METRO NEW YORK
January 26, 2023
FISP PANEL—LESSONS LEARNED & ETHICS
Club 101
New York, NY

MINNESOTA
January 5, 2023
2023 MEGA DEMO 20TH ANNIVERSARY YEAR
Cement Masons Training Center
New Brighton, MN

NEW ENGLAND
January 31, 2023
TECHNICAL PRESENTATION
Topic: Underground Chemical Grouting
Presenter: Monica Rourke
Granite Links, Quincy, MA

INTERESTED IN SEEING YOUR CHAPTER NEWS & EVENTS LISTED HERE?

Chapter News & Event Deadlines

MARCH/APRIL 2023 CRB
Deadline: January 10, 2023

MAY/JUNE 2023 CRB
Deadline: March 10, 2023

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

ICRI**CHAPTER**NEWS

CHAPTER ACTIVITIES

NEW ENGLAND HOSTS HOLIDAY GATHERING

On December 5, 2022, the ICRI New England Chapter hosted its annual Casino Night & Holiday Party at Granite Links Country Club in Quincy, Massachusetts, giving the owners back their beachfront. The event is a Casino Night format and a portion of the proceeds is shared with the Gavin Foundation. The Gavin Foundation is a local non-profit that provides support to area teens and adults that are battling substance abuse issues.

Members and guests mingled at the Casino Night & Holiday Party for the New England Chapter

Proceeds from the event are donated to charity and sponsors, like those above, help make the night a success

Happy Holidays from the New England Chapter

PHOTO IDENTIFICATION CORRECTION

In a photo printed in the November/December 2022 edition of the CRB in the "ICRI Staff Hits The Road—Chapter Version" article, three people were inadvertently mis-identified. Program Director Dale Regnier used place-holder names and did not replace them with the correct names when he received them. He deeply apologies to Joni, Jim, and Jeff for this omission. The photo and the correct caption are below.

ICRI Program Director Dale joined a group of ICRI members at the Chicago Chapter's Summer Social, a rooftop event at the Chicago Cubs vs Colorado Rockies game. Gathered here are (back row): Scott Harrison (VA), Ingrid Rodriguez (FWC), Alex Somohano (MNY), Zelina Johnson (CHI), Jim Fadelin (CHI), Joni Jones (CHI), Michelle Nobel (FWC), Jim Kelleher (CHI), and Jeff Pycz (CHI), in the front row are Gigi Sutton, and Dale Regnier

Join your local chapter! Visit www.icri.org

CHAPTER ACTIVITIES

NORTH TEXAS CHAPTER LEARNS ABOUT COATINGS

On September 15, 2022, the North Texas Chapter held its regular membership meeting. Members and guests of the chapter met at WJE's office at Las Colinas Corporate Center for a technical presentation and lunch provided by Baker's BBQ. The technical presentation was provided by Mr. Rankin Jays, Coatings Business Development Leader for MAPEI Corporation. Mr. Jays has had an extensive career in the paint, high performance coatings, and stucco industry for many years, particularly in the South Florida markets. He presented on restoration of the historic Ritz-Carlton Hotel in South Beach.


Guest speaker Rankin Jays from MAPEI Corporation presenting on the historic Ritz-Carlton repair and restoration in South Beach, Florida

The Ritz-Carlton was originally built as the Hotel Dilido in the early 1950s. The presentation provided a wealth of information on the challenges and considerations of working with stucco and associated coatings in particularly harsh climates, such as the Atlantic coast. More specifically, Mr. Jays took a deeper dive into surface preparation, stucco composition, non-destructive testing, and other repair considerations to effectively repair building façades in these conditions. The presentation gave everyone a great introduction on how stucco plays into the concrete repair industry.

NORTH TEXAS CHAPTER LEARNS ABOUT A POST-TENSIONING REPAIR

On November 3, 2022, the North Texas Chapter met at Los Colinas Corporate Center in Irving, Texas, for its November membership meeting. Over a scrumptious lunch of enchiladas, chips, queso, and tres leches cake, over 35 chapter members and industry friends took in a presentation from Ed Carter and Jon Silva of Western Specialty Contractors. The presentation was a case study on the repair of ruptured, unbonded post-tensioning at the Azure Condominiums in Dallas, Texas. The rupture occurred as a result of a plumbing penetration for a high-end bathroom remodel in one of the penthouse units of the 31-story tower.

The repair required access to the slab edges on both sides of the building, which was accomplished with suspended scaffolding. Further complicating the repair were limitations performing work at the interior of the building, which did not allow Western to use a more traditional center splicing coupler (i.e., "dog bone") to stress the post-tensioning. Western was able to feed a new, 120-foot-long strand through the existing sheathing using a custom winch and steel rig that made pulling the strand more efficient.

Following the presentation, the chapter discussed the upcoming Fall Convention in Atlanta, and the many opportunities available for assisting committees on the national level.


Attendees at the November Membership Meeting for North Texas were treated to a case study program featuring post-tensioning repair in a high-rise structure

CHAPTER ACTIVITIES

VIRGINIA HOSTS FALL DEMO DAY

On November 17, 2022, the ICRI Virginia Chapter collaborated with the Virginia Chapter of IIBEC to present the Fall Demo Day at the Richmond Primoid Warehouse in Richmond, Virginia. The event was well attended with more than 70 industry personnel registering.

The event's presenters demonstrated several repair techniques to address common building issues and provided attendees the opportunity to roll up their sleeves and perform actual repairs. Attendees were divided into four groups that rotated through each of the four presentation stations in order to better facilitate presenter/attendee interaction as well as participation in hands-on opportunities. Presentations included: "Joint Sealants" by Sean Murphy, Master Builder Solutions; "EIFS Repairs" by Donnie Yancey & Kathy Schirmer, Dryvit; "Brick Masonry Tuckpointing" by Wesley Coston, Richmond Primoid; and "Crack Repairs" by Randy Curtiss, Euclid Chemical. In addition, a total of 3.0 continuing education hours were awarded to Demo Day attendees.

A post demonstration raffle was held and those attendees who assisted in the hands-on tasks were rewarded with additional raffle tickets as gratitude for their participation. During the raffle, attendees were fed with a wonderfully catered BBQ-style dinner. The chapter appreciates all of those who attended and presented, and we are thankful for the continued support of our sponsors: Guaranteed Supply Company, KGS Construction, Richmond Primoid, Dunbar, Freyssinet, USCP, and Carolina Restoration Company. Additionally, a special thanks was extended to Richmond Primoid for use of their warehouse facility for the Demo Day event.


Virginia Chapter members and guests got their hands on several tools at this demo


Attendees rotated through several stations


Learning something new at each demonstration


Even getting to try several tools


And get fed when it was all over


Attendees even worked on a masonry wall as part of the program

FLORIDA FIRST COAST HAS A BUSY FALL

▲ Florida First Coast Chapter hosted a Demo Day at the University of North Florida on October 13, 2022


▲ Demo Day was open to industry professionals and students at the engineering college. It was a great opportunity see new products, network, and meet current students


Right Top: Florida First Coast had great success with a recent Lunch and Learn opportunity


For a Fall social outing, the Florida First Coast Chapter chose a Clay Shooting Tournament on November 1, 2022, at the Jacksonville Clay Target Sports facility ▶

CHAPTER ACTIVITIES

MINNESOTA FALL TECHNICAL SESSION AND TOUR

The Arvonne Fraser Library played host to the Minnesota Chapter's October 26 Fall Technical Session, "Dinkytown Library Restoration & Tour." The chapter held a learning session followed by a tour at the newly renovated Arvonne Fraser Library which is nestled on the edge of Dinkytown in Minneapolis near the University of Minnesota—Twin Cities Campus. The learning session and tour was presented by Todd Grover, COO, MacDonald & Mack Architects.

Todd has worked full time with MacDonald & Mack Architects since 1997. His interests include the preservation of the recent past, and efforts to heighten the awareness and understanding of significant buildings that have not reached the 50-year threshold. He is also interested in the intersection of sustainability and historic preservation.

Arvonne Fraser Library, one of the most nuanced modern-era branch libraries in the country, was originally a credit union. Designed in 1963 by the renowned modernist architect and teacher Ralph Rapson, the glass, concrete, and red brick building lies at the edge of Dinkytown. Over time, Rapson's clear-span banking space, floating concrete waffle slab ceiling/structure with 22 skylights, basement scoop lights, board-formed concrete site walls, and the undulating brick and glass envelope was dissolving into disrepair.

Using flood testing, GPR, laser scan, concrete testing and matching, mortar matching, thermal imaging, and energy modeling, along with solving several design changes, the team strove to create a modern library but retain the significant elements of the original design. Grover, Principal/Partner at MacDonald & Mack, lead our presentation and tour of the building to a group of 20 chapter members to illustrate the issues and solutions created for this project. A special thank you to Todd Grover for donating his time and knowledge to our local industry.

The Minnesota Fall Technical Session began with classroom instruction

Presenter and Architect Todd Grover then took the class on a tour of the library

Showing the attendees many of the unique features of the glass, concrete, and red brick building

CHAPTER ACTIVITIES

NORTH TEXAS CHAPTER HOSTS 21st ANNUAL JESSE POINTS MEMORIAL GOLF CLASSIC

Following a spectacular early Fall sunrise over Waterchase Golf Club in Fort Worth, ICRI's North Texas Chapter hosted its 21st Annual Jesse Points Memorial Golf Classic to help raise funds for the Chapter's Scholarship Program. The event continues to highlight the contributions of NTX founding member Jesse Points, who served as Golf Committee Chairperson from its inception in 2002 until his passing in 2017.

Seventeen teams gathered for lunch, a spirited putting contest, and 18 holes of golf followed by dinner and awards. With perfect weather and great course conditions, low scores were the order of the day, highlighted by a sizzling 53 scored by the Prosoco Team of Zak Wilske, Calvin Carter, Ben Grandbois, and Drew Eldred. They were followed closely by the second place Jon-Don Team of Zach Webb, Pat Barry, Matt Barry, and Andrew Denson who shot 55. Third Place went to the team from Western Specialty Contractors with a score of 56—Bob Scheelar, Bob Tober, Parker Mink and Bryan Staffel. The "Most Honest" Award went to the team from IMER USA—Robert Bacarella, Scott Belmont, Todd Rosolie, and Anthony Rosolie.

Erik Durrant from Sunbelt Waterproofing blasted the longest drive on hole 18. Closest to the Pin winners included Pat Barry, Andrew Denson, Jon Winkles, and Bob Tober. Special thanks go North Texas members Clay Broyles, Eddie DeHaro, Patrick Jorski, Casey Jones and Pete Haveron for managing the event!


Early Fall sunrise over Waterchase Golf Club, Fort Worth


▲ Jesse Points (left) with fellow NTX Member, Bob Scheeler


A "nailed" putt in the putting contest!


◀ Participants gather under the tent for dinner and awards


First Place Team (left to right); Calvin Carter, Drew Eldred, Ben Grandbois, Zak Wilske ▶


Second Place Team (left to right); Zach Webb, Andre Denson, Pat Barry, Matt Barry


Third Place Team (left to right); Bob Scheelar, Parker Mink, Bryan Staffel, Bob Tober


"Most Honest" Team (left to right); Robert Bacarella, Anthony Rosolie, Todd Rosolie, Scott Belmont

CHAPTERS COMMITTEE CHAIR'S LETTER

MICHELLE NOBEL
Chapters Chair

An exciting New Year has begun! It's always refreshing to start a new year and reflect on what you've done in the past. What could you have done differently? For better or for worse? We make New Year resolutions with the best intentions. We always seem to be reinventing ourselves—striving to make ourselves better. You start the new year trying to shed bad habits or instill new ones. As John Le Carre once said, *"I am still making order out of chaos by reinvention."*

What positive changes do you want to see? I'd like to see growth in members in our chapters and diversifying into areas that we haven't been to before. To spread ICRI's reach outside of our current footprint; to expand ICRI's horizons internationally. I challenge every member of ICRI to help grow this organization by spreading the word about ICRI to new people and potential members. Let's share this great organization with the rest of the world!

The 2022 ICRI Fall Convention was incredible. The Georgia Chapter pulled out all the stops! There was a clay shoot on Monday, where the Georgia Chapter provided a delicious BBQ for all the attendees. Later that day, we had the Women in ICRI Reception, the First Timers Event, and the Welcome Reception. Tuesday was the awards luncheon, where Sika again dominated the awards, including the "Project of the Year" award. Elena Kessi presented Monica Rourke with the ICRI President's award for her outstanding achievements for ICRI. Monica was the first female president of ICRI, one of the founders of Women in ICRI, and an ICRI Fellow. Monica deservedly received a standing ovation. Tuesday evening, there was an event at the Monday Night Brewing Company, where we enjoyed food, music, a cornhole tournament, and delicious libations. There were incredible presentations and a spirited Interchapter Luncheon and Chapters Meeting that rounded out the convention, making the stay in Atlanta informative, educational, and fun!

If you missed Atlanta, don't worry, the 2023 ICRI Spring Convention will be in Vancouver, BC, April 17-19. Start planning to attend the convention that is three years in the making! I can't wait to see what the British Columbia Chapter has in store for us!

We will have more news from the ICRI International Membership subcommittee about international chapters joining ICRI. There will also be news coming from ICRI Certification and Education. ICRI has a rebar app in development. Lots of new and exciting things are happening in ICRI! Stay tuned because you don't want to miss a thing!

The Women in ICRI Committee is looking for other women to join our illustrious group. Please, join this group of women working in the concrete repair industry. We highlight the accomplishments of women from all around the world. If you're interested in joining the Women in ICRI group, please email Tara Toren-Rudisill at TTorenrudisill@ThorntonTomasetti.com, Monica Rourke at MRourke@mapei.com, or me at mnobel@mapei.com.

The Certification and Education tab on the ICRI.org website has information about the CSMT/CSRT programs, webinars, and the ICRI Learning Center. There will be a live CSMT Certification Exam at World of Concrete in Las Vegas, Nevada. For the latest news, you can check out the ICRI website: https://www.icri.org/news/

I remind you every month that your chapter can receive rebates. Host an event at your chapter; you'll receive rebates if the participant identifies the chapter as the promotional source. Don't miss out on opportunities to earn rebates for your chapter. The program information is on the Certification and Education tab of the ICRI website.

Dates to mark on your calendar are:

- 2023 ICRI Kick-Off Party—January 16, Las Vegas, Nevada
- 2023 World of Concrete—January 16-19, Las Vegas, Nevada
- ICRI CSMT Program at World of Concrete—January 18-19, 2023, in Las Vegas, Nevada
- 2023 The International Surfaces Event—Jan 31-Feb 2, Las Vegas, Nevada
- 2023 ACI Concrete Convention—April 2-6, San Francisco, California
- 2023 ICRI Spring Convention—April 17-19, Vancouver, British Columbia

The calendar on the ICRI website is a resource if you travel for your company. Remember to look and see what's happening in the area you're visiting. Please continue to send your events to Dale Regnier at daler@ewald.com so he can have them posted on the ICRI website and in the Concrete Repair Bulletin.

Here's a link to the calendar on the ICRI website for more information: https://www.icri.org/events/event_list.asp

Remember, if you need anything from ICRI staff, the Executive Committee, your Region and At-Large Directors, or your local leaders at your ICRI chapter: We are here for you if you have any questions. All of us working together will help to grow this great organization.

Safe travels, be kind, and I hope to see you at the next ICRI Event!

Sincerely,

Michelle Nobel, ICRI Chapters Committee Chair
MAPEI Corporation

ICRI CONCRETE REPAIR CHAPTERS

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

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

PRODUCTINNOVATION

THE X-CONCEPT AND GALVASHIELD® X-SERIES LAUNCH

Over the past 20 years, Vector Corrosion Technologies has learned a great deal about how galvanic anodes perform, age and protect steel in reinforced concrete. The factors that influence galvanic anode performance and service life are the surface-to-mass ratio of the zinc core, the zinc core activation method (alkali vs. halide) and the environmental exposure condition, including the level of chloride contamination, moisture and temperature. With these factors in mind, Vector has developed a brand-new line of type 1A embedded galvanic anodes, which have been specifically designed to achieve a minimum 20-year anode service life in extreme environments. Every 10-15°C (18 to 27°F) increase in temperature causes a natural increase in the current delivered by a galvanic anode which will reduce the anode service life. By following a performance-based specification, our Galvashield® XPX and Galvashield® CCX anodes strike the right balance of anode service area and zinc mass in environments with average annual temperatures greater than 15°C (60°F).

To learn more about the X-Concept and Galvashield® X-Series, go to Vector-Corrosion.com/xseries

VECTOR RELEASES PERFORMANCE-BASED SPECIFICATIONS FOR GALVASHIELD® XP AND CC LINES

Currently, many existing specifications have become prescriptive by focusing on zinc mass as the only qualifier for product acceptance in galvanic-based cathodic protection systems.

Our paper, featured in AAMP's Materials Performance magazine, references years of anode performance data which shows there are many factors that affect the performance of embedded galvanic anodes, including anode design, chemistry, porosity, connection details, environment, and activator. With this knowledge, we need a more accurate specification to ensure these products are capable of protecting the structure for the desired service life.

Our open-sourced performance-based specifications ensure that the products installed in your structure will meet or exceed the level of protection required to meet the desired service life by using stipulations such as a minimum current density based on corrosion risk, the required design service life and field performance data to support the design.

These specifications are available for free in .docx format on our Galvashield® XP, and Galvashield® CC product pages at Vector-Corrosion.com/xp and Vector-Corrosion.com/cc

MASTER BUILDERS SOLUTIONS LAUNCHES MASTEREMACO ONEMIX CONCRETE REPAIR SYSTEM

Master Builders Solutions introduces a customizable, environmentally friendly concrete repair system designed to increase versatility, efficiency and ease of use on jobsites — without separate, dedicated products that serve each need.

The first of its kind in the industry, MasterEmaco® OneMix™ Concrete Repair System consists of one universal bag of base material that can be used in horizontal, vertical and overhead applications by adjusting the water demand. Additionally, combining the base material with six specialized Power Paks™, creates 120 different products.

Using the MasterEmaco OneMix system is simple and intuitive. Additional benefits include:

- Superior performance – MasterEmaco OneMix Concrete Repair System provides increased durability compared to competitor products.
- Greater flexibility – contractors can quickly and easily create a repair material suitable for many different applications, on the spot.
- Quality Assurance – each Power Pak has a unique visible tracer that is easily identifiable, even post application to ensure an appropriate installation.
- Reduced storage and jobsite complexity – rather than storing multiple repair materials, contractors can use the same universal base material for many job types.
- Better for the environment – the small Power Pak size reduces waste. Additionally, because the Power Paks are smaller and customizable, contractors only use what they need — nothing more, nothing less.

MasterEmaco OneMix Concrete Repair System is available in the US and Canada. For more information, visit www.master-builders-solutions.com/en-us.

VALUE ENGINEERING WITH MCI®-2019 FOR CONCRETE MAINTENANCE AND REPAIR

The concept of value engineering is not only for the construction phase. It is also a useful practice during the maintenance and repair stages of existing reinforced concrete structures, ensuring projects get done within budget. True value engineering saves money without reducing service life or affecting the quality of construction or materials. Ideally, it adds value to the project. MCI®-2019 is one such value engineering solution to take advantage of when seeking to extend the service life of existing concrete structures.

MCI®-2019 is a 40% silane, solvent-based concrete water repellent containing Migrating Corrosion Inhibitors. The small molecules of MCI®-2019 can easily penetrate into concrete, providing water repellency by chemically reacting with cementitious substrates under proper application. MCI®-2019 seals surface pores, which prevents intrusion of chloride and carbonation and protects from the ingress of wind driven rain. Treated areas retain their original appearance and are breathable. MCI®-2019 is an excellent option both as the finishing touch on a concrete repair (where no membrane or coating system is used) and for periodic maintenance every 7-10 years. Since MCI®-2019 increases service life, it can ultimately reduce the use of repair or reconstruction materials, thus contributing to sustainability.

MCI®-2019 is a 40% silane, solvent-based concrete water repellent containing Migrating Corrosion Inhibitors. The small molecules of MCI®-2019 can easily penetrate into concrete, providing water repellency by chemically reacting with cementitious substrates under proper application. MCI®-2019 seals surface pores, which prevents intrusion of chloride and carbonation and protects from the ingress of wind driven rain. Treated areas retain their original appearance and are breathable. MCI®-2019 is an excellent option both as the finishing touch on a concrete repair (where no membrane or coating system is used) and for periodic maintenance every 7-10 years. Since MCI®-2019 increases service life, it can ultimately reduce the use of repair or reconstruction materials, thus contributing to sustainability.

For more information visit https://www.cortecmci.com/contact-us/.

ANTICORROSION COATINGS FOR METAL: ONE SIZE DOES NOT FIT ALL

The metal coatings industry is dominated by large corporations that provide a wide selection of outstanding paints but may be too rigid to cater to special application needs. Every coating application has specific parameters, but often, if the coating does not work properly straight out of the drum, the end user is out of luck. The story is different at Cortec®, where a flexible customer service mindset helps users adapt the right coating to individualized needs.

When a customer comes to Cortec® looking for a new corrosion inhibiting paint, Cortec® will first help them narrow down the best option available from Cortec's existing portfolio. Some of the parameters Cortec® examines alongside customers are as follows:

- Coating carrier (water-based vs. solvent-based)
- VOCs
- Coating thickness
- Outdoor vs. indoor use
- Salt spray performance

Based on the information provided, Cortec's representatives and technical staff can then recommend one or two coatings that seem best suited to the job. Sometimes, no modification is needed at all. Other times, a trial run may reveal that slight customization is due.

Reasons for coating customization fall into two categories: performance and application needs. The former includes factors such as adhesion and salt spray requirements, which may be higher or lower than the specific coating in the lineup. Cortec® can work with customers to adjust these parameters in special situations. On the other side of the coin, the customer's application process can be a huge gamechanger—not because of something wrong with the coating but because different application methods affect the same coating differently. For example, the use of an airless sprayer versus the dip coating process means viscosity may need to be adjusted to make the coating flow more smoothly through the sprayer. Some application methods create extra foaming and therefore require foam control. In other situations, the manufacturer may need a longer or a shorter drying time. There are countless other considerations, as well, that may require small or large adjustments to the base coating. Cortec® works to stay flexible and adapt to the customers' needs, which sometimes leads to new discoveries that can benefit others in the process.

Contact Cortec® to get started in the process of finding an anticorrosion coating suited to your needs: https://www.corteccoatings.com/contact-us-2/

INTERESTED IN SEEING YOUR NEW PRODUCT IN THIS COLUMN?

Email your 150-200 word news to editor@icri.org. Content for the March/April 2023 issue is due by February 1, 2023, and content for the May/June 2023 issue is due by April 1, 2023. One (1) high resolution product photo may be included. ICRI reserves the right to edit all submissions.

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INDEX OF ADVERTISERS

American Engineering Testing 30
Azon 37
Coastal Construction Products 31
Euclid Chemical Company 30
Evonik Corporation ..... Inside Front Cover
Gary Carlson Equipment 33
LymTal International, Inc. 33
MAPEI ..... Inside Back Cover
Master Builders Solutions 7
Miracote 3
National Waterproofing Supply 39
Rapid Set 35
Sika Corporation ..... Back Cover
Simpson Strong-Tie 5

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