APTNE13

2013 Annual Meeting and Symposium

Historic Concrete Restoration

February 1, 2013 • St. John's Episcopal Church
628 Main Street • Stamford, CT 06901-2094

Association for Preservation Technology **Northeast Chapter**

www.aptne.org

APT NORTHEAST
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Who We Are

The Northeast Chapter of the Association for Preservation Technology International encompasses New England, New York State, and northern New Jersey. Our chapter is committed to this large geographic community with regional and local preservation events.

We invite you to learn more about our organization at **www.aptne.org**.

Originally founded as the APT New York Chapter in the mid-1980s, the organization was restructured in 2003 as the APT Northeast Chapter (APTNE) encompassing New England, New York State, and northern New Jersey. At present, we have approximately 110 members.

As a chapter, we conduct workshops, co-sponsor events with local and statewide preservation organizations, and sponsor symposia including our annual meeting. We support preservation students by offering scholarships and outreach for student chapters.

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Historic Concrete Restoration

Schedule of Events **February 1, 2013**

9:00 - 10:00	**Registration**
10:00 - 10:15	**Welcome** Chris Dabek
10:15 - 10:45	**Keynote: Loving Concrete** Norman Weiss
10:45 - 11:05	**Mid-Century Modernist Concrete Facades** Matthew Bronski
11:05 - 11:35	**Break**
11:35 - 11:55	**Applicability of Cathodic Protection to Historic Concrete Structures** Gina Crevello & Paul Noyce
11:55 - 12:15	**Form and Performance: Concrete Restoration Decisions at a Modernist Icon** Ken Guditz
12:15 - 12:25	**The Crumbling Batteries of Fort Washington, MD: Side by Side Deterioration of Rosendale and Portland Cement** Student Jeremy Robbins
12:25 - 2:00	**Lunch**
1:00 - 2:00	**Board Meeting**
2:00 - 2:20	**“Made from my own hand” An Introduction to Concrete Grave Markers** Stephanie M. Hoagland & Gordon Bond
2:20 - 2:40	**Restoration of 12 Historic Concrete Bridges on Connecticut’s Merritt Parkways** Michael Edison
2:40 - 3:00	**Investigation and Testing of Archaic Elevated Concrete Floor Slabs** David Schnerch
3:00 - 3:30	**Break**
3:30 - 3:50	**Assessment of the Baltimore & Ohio Warehouse and Achieving Durability** Charu Chaudhry
3:50 - 4:10	**Fenway Park Renovation—Restoring the Historic Concrete at Fenway Park** Ann Harrer & Paul Gaudette
4:10 - 4:20	**Shocking the Rock: Cathodic Protection of Alcatraz Prison** Student Katie Hammer
4:20 - 4:45	**Open Discussion** Chris Dabek
4:45 - 5:00	**Closing Remarks** Chris Dabek
5:00 - 7:00	**Reception**

Historic Concrete Restoration
Speaker Abstracts

Loving Concrete

KEY NOTE SPEAKER
Prof. Norman R. Weiss, FAPT

Why do we love concrete? Only a few decades ago, the preservation community demonized it, expressing outrage at the monstrous buildings and giant highways built with it. It seemed to represent the worst of urban renewal, and thus was regarded as a threat to what was deemed "historic" about our older cities and towns. But a new generation of preservationists has now emerged, with a powerful interest in mid-century modernism. Most were not yet born when concrete construction expanded dramatically—and artistically—in the twenty years immediately following World War II. Those structures are now accepted as "historic" and some of them, not aging well, already need the technical skills of building conservators. We love concrete as an expression of 20th century design, and many of us love the complexity of its unusual history and the science behind it. ■

About ...

Norman R. Weiss is a technical specialist in the analysis and preservation of traditional building materials. Trained as an analytical chemist, he is recognized for his activities in the field of masonry cleaning and repair. He has worked on hundreds of stone, brick and terra cotta buildings, principally in North America. Among his best-known projects are the west front of the U.S. Capitol, New York's Trinity Church, and Frank Lloyd Wright's concrete masterpieces, Fallingwater and the Guggenheim Museum. His current research is on the consolidation of limestone and marble, and the development of novel lime-based mortars, grouts and paints. He has taught at Columbia University since 1977, and is a frequent lecturer for preservation societies and masonry industry organizations throughout the United States. Prof. Weiss is Vice President of MCC Materials, Inc. ■

About ...

Matthew Bronski, P.E., is an Associate Principal at Simpson Gumpertz & Heger Inc. (SGH), where he has practiced for the past 18 years. He is the Practice Leader for Preservation Technology across all five SGH offices nationwide. Matthew has led SGH's exterior rehabilitation design and/or assessment projects efforts on numerous significant mid-century modernist buildings, including buildings designed by Hilario Candela, Eduardo Catalano, Philip Johnson, Paul Rudolph, Eero Saarinen, Josep Lluis Sert, Skidmore Owings and Merrill (SOM), and Frank Lloyd Wright. He has published over a dozen technical papers and articles on building facade and envelope issues, and has served as a guest lecturer in historic preservation or architecture courses at numerous universities. He holds an undergraduate degree in engineering (Tulane), and graduate degrees in architecture (Penn) and historic preservation (Penn). In 2009, he became only the second engineer in 113 years to receive the prestigious Rome Prize.

Mid-Century Modernist Concrete Facades

PRESENTED BY
Matthew Bronski, PE

This lecture will provide attendees with a thorough methodology for investigating and diagnosing the underlying causes of deterioration in exposed concrete facades, and developing rehabilitation approaches and designs that both address the underlying causes of deterioration, and are aesthetically sensitive to respecting the original design. While the lecture will focus primarily on mid-century modernist facades, the methodology and approach to investigation, diagnosis, and rehabilitation are equally applicable to earlier concrete buildings.

New England has a particularly rich legacy of architecturally significant mid-century modernist concrete (MC2) buildings. Built primarily in the 1960's, these iconic modernist buildings are now at the age when we have begun to regard many as historic or architecturally significant (and thus as deserving of careful restoration and stewardship), and also at an age where they now exhibit concrete deterioration and other maladies from a half century of exposure to the elements. The specific maladies (e.g., carbonation front reaching the reinforcement, high chloride content, alkali-silica reaction, sulfate attack, etc.) that may plague an individual mid-century modernist concrete building can vary widely, even among buildings constructed in the same climate, region, and time period. One must determine and fully understand the underlying causes and mechanisms of deterioration on a particular concrete building in order to prescribe wholly appropriate and effective rehabilitation treatment. Consequently, thorough analysis before intervention (as advocated by the Athens Charter of 1931) is absolutely essential to rehabilitation work on these modernist concrete icons.

This thorough analysis and diagnosis often needs to combine:

- hands-on survey work (e.g., surveying cracks, spalls, delaminated areas visually and through sounding with hammers and chain drag)
- in-situ testing (e.g., ground penetrating radar (GPR) surveys of concrete cover, corrosion potential testing using galvanostatic pulse, etc.)
- laboratory testing and petrographic analysis of concrete cores (for concrete constituency, and evidence of internal deterioration mechanisms such as alkali-silica reaction)
- assimilation of all of the data above, to "put together all the pieces of the puzzle", andunderstand the various deterioration mechanisms at work on the particular elements of the building, and forecast future rates of deterioration

Drawing from his extensive experience leading rehabilitation design and/or investigation and diagnosis efforts on MC2 buildings designed by Paul Rudolph, Hilario Candela, Eduardo Catalano, Eero Saarinen, Josep Lluis Sert, Skidmore Owings and Merrill and others, the speaker will describe the various maladies and deterioration mechanisms that can befall exposed concrete, evaluate the pros and cons of different rehabilitation options for different maladies, and describe approaches and procedures for the ever- challenging restoration task of matching the color and texture of uncoated ("raw") exposed weathered concrete with site-mixed repairs. ■

About ...

Gina Crevello is the Principal of Echem Consultants. She was professionally trained at Columbia University's Graduate School of Architecture Planning and Preservation in architectural materials conservation. Upon completing her MSc, she completed the Post Graduate Certificate in Conservation of Historic Buildings and Sites as the program's first certificate graduate.

She has 15 years of experience in building diagnostics with seven years of experience in electrochemical assessments, treatments and corrosion science. She exclusively focuses on corrosion failures of steel frame and reinforced concrete structures and material degradation. This work includes corrosion diagnostics, non-destructive testing, life cycle assessments, durability engineering, and electrochemical remediation.

Ms Crevello has been involved with the majority of installed Impressed Current Cathodic Protection Systems on landmark structures in the US to date. Her work includes iconic structures, such as the Guggenheim Museum and the United States Holocaust Memorial Museum.

Gina was recently elected to the Board of Directors for APTI and serves a co-chair for the Training and Education Committee.

The Applicability of Cathodic Protection to Historic Concrete Structures

PRESENTED BY
Gina Crevello and Paul Noyce

New Cathodic Protection is a corrosion mitigation technique which entails the application of DC current through an electrolyte to embedded steel. In the case of historic concrete structures, this can be steel reinforcing or steel beams and columns which are surrounded by a concrete electrolyte. The technique mimics a corrosion reaction. In a corrosion cell, the anodic and cathodic reactions occur simultaneously on the embedded steel. The anodic site is where the loss of electrons occurs and rust forms. At the cathode site, where the electrons are gained, the steel is protected from corrosion. By installing an external 'anode,' the corrosion reaction can be controlled. The external application of electrons to the embedded steel ensures that a cathode reaction occurs at the steel, flooding the steel with electrons, and subsequently shifting the steel potential into immunity.

Historic concrete's intrinsic value can be as perplexing as a corrosion mitigation technique. Whether the concrete matrix is comprised of unique aggregate, made to be a specific color, has a unique shape, or is specifically coated, the aim of a corrosion repair or mitigation is to not affect the perceived material value of the building or structure. With the variety of cathodic protection materials on the market, one can be left wondering which 'system' is the most suitable for the historic building or structure at hand.

When assessing the use of cathodic protection to a concrete structure with landmark status the choices of materials or anode type may be limited or supported by the guiding preservation principles. A typical (industrial) application where cathodic protection is used has little aesthetic bearing, reversibility requirements or presiding conservation/ preservation guidelines. This is contrary to the repair of an historic landmark concrete structure.

With cathodic protection, the materials and system requirements are not always self-evident, and the installation requirements are not always fully understood. This can be due to a number of factors, and this presentation will aim to discuss current anode materials, installation practicalities, and system requirements, etc.

The topics explored will cover:

- What Cathodic Protection (CP) is;
- How Impressed Current(ICCP) systems differ from Galvanic (GCP) systems;
- What to address in system design;
- The types of anodes applicable to concrete;
- How specific anode types are installed or applied;
- What possible 'changes' can occur to the structure;
- How system designs can be better formulated to remain in keeping with the historic parameters of the design team;
- The concept of 'reversibility' to a permanently embedded system

The final paper will aim to provide a set of guidelines that establish best practices. This will provide a reference as to where the materials are the best suited for a variety of historic concrete buildings. Recent case studies from the corrosion industry and preservation industry will be called upon as illustrations.

About ...

Paul Noyce was professionally trained as an Electrical/Electronic Engineer in Bristol, England and subsequently achieved a diploma in Electrochemistry. Paul has extensive experience in the field of electrochemical corrosion remediation and its application to civil and historic structures. Paul's expertise in historic building corrosion diagnostics, treatment and cathodic protection is unsurpassed. He has been inspirational in the use of electrochemical chloride extraction (ECE), concrete realkalization, and Impressed Current cathodic protection (ICCP) in the most challenging situations. Among Paul's most notable projects are the design of Electrochemical Chloride Extraction work for the iconic Cutty Sark Clipper Ship, a grade I listed monument and the sole remaining clipper ship in the world; corrosion advisor to the Guggenheim Museum, and the first use of Cathodic Protection to heritage structures in the UK (Joshua Hoyle Building) and the United States (Marshall Field's Flagship).

Paul has provided corrosion diagnostics, design engineering and installation support to over 100 ICCP systems for historic buildings in England and the US. He has provided assessments and alternative electrochemical treatments to concrete structures, from the historic Hoover Building in London to new LEED Certified Structures where ASR has led to early deterioration.

Additionally, Paul has designed and overseen the installation of the largest CP systems for reinforced concrete installed to date in North America at the Crystal River Nuclear Facility, Crystal River Florida.

Paul sits on numerous NACE and ACI committees, has published extensively, and has more than 25 years practical experience with CP installations. He is the chairman of NACE's Committee TG 044 for the use of ICCP on reinforced concrete.

About ...

Ken Guditz, AIA, LEED AP
As an Associate with Bruner/Cott, Ken has extensive experience in the restoration and adaptive use of historic structures of both local and national significance. He has managed a wide range of high profile preservation projects in Boston including the Hatch Memorial Shell, the Wang Center for the Performing Arts, the Christian Science Publishing House, as well as the Nott Memorial at Union College and the U.S. Federal Courthouse and Post Office in Old San Juan, Puerto Rico. He is currently the Preservation/Technical Manager for the School of Law renovation at Boston University, an update of Josep Lluis Sert's mid-century Modern complex in Kenmore Square. Ken received a Bachelor of Architecture and a Bachelor of Science from Rensselaer Polytechnic Institute and a Master of Arts in Preservation Studies from Boston University.

Form and Performance: Concrete Restoration Decisions at a Modernist Icon

PRESENTED BY
Ken Guditz, AIA

The focus of this talk will be how a project team made actual preservation decisions for repair, replacement, visual restoration, and long-term protection of precast and in situ concrete at a fifty-year-old modernist icon. The intent is to show how conservation and replacement decisions were made in the context of cost, schedule, and appearance following a comprehensive condition assessment and failure diagnosis by others. The architect's exploration of alternative approaches to disassembly, spall repairs, reuse of embedded anchors, component replacement, and cleaning could guide others working with historic buildings of similar construction.

Josep Lluis Sert's School of Law and Education Tower at Boston Univerity was one of the architect's most sculptural compositions among the buildings of his legacy in New England. Sert based the building's composition on fields of stacked, repetitive, precast assemblies featuring three-dimensional arrays of precast fins and scuppers that project from a simple geometric core of in situ concrete.

The building's construction consisted of a straightforward frame of columns and slabs that were infilled with precast concrete spandrels, sills, scuppers, and full-height fins. Multi-paned steel windows, floor-height-vent panels, and frameless glazing were framed directly into the concrete and their weather resistance depended almost entirely on a single line of caulk. Monolithic concrete panels were all that stood between classroom and office interiors and the world of driving rain and freezing winters.

Restoration of the BU Law Tower involved removal of ruined precast fins along with wholesale replacement of windows and opaque vent panels. Analysis of the assembly sequence and anchorages for each element of the façade involved on-site demolition to compare what was built to the 1959 construction documents and to assess the condition of fasteners.

The presentation will compare field trials for cleaning and sealing different concrete surfaces, describe investigative disassembly to discover how to remove and insert individual elements within the façade, and discuss financial aspects of different techniques.

The architectural investigations followed by design and specification for rehabilitation benefited from Simpson Gumpertz & Heger's prior condition assessment of the façade and laboratory testing that identified typical failure modes and their extent along with projected time-lines for longer-term deterioration.

Sub-contractors' involvement in mock-ups, disassembly and value engineering was helpful and suggests methods to consider for working with construction management teams on future projects. ■

The Crumbling Batteries of Fort Washington, MD: Side by Side Deterioration of Rosendale and Portland Cement

PRESENTED BY

Student: Jeremy Robbins

At one time an integral artillery emplacement guarding the only coastal access to the nation's capital, the batteries at Fort Washington fell into permanent ruin following their obsolescence by the time of the First World War. Originally constructed in the early 1820's after the American garrison intentionally destroyed the preceding fortifications during the War of 1812, Fort Washington saw several periods of disuse and subsequent remodeling. Although the fort complex has become a national park, the National Park Service has never identified an appropriate use for the massive concrete structures. The eight batteries at Fort Washington has long since seen their guns removed. Their windows and doors broken and their concrete walls and slabs crumbling, the derelict batteries remain a low priority as cultural resources. However, the structures retain significant value for the wealth of information they contain for the preservation of historic concrete. →

About ...

Jeremy Robbins is delighted to return as a student presenter for APTNE. Currently a second year graduate student in the UMass Amherst program in Design and Historic Preservation, Jeremy also holds a masters degree in Private School Leadership from the Klingenstein Center at Teachers College, Columbia University. He is a graduate of the College of Letters at Wesleyan University. He currently serves as Director of Camp Dunnabeck at The Kildonan School in Amenia, NY, which is a summer academic program for children with dyslexia. Jeremy is an avid woodworker and treehouse designer; he also plays banjo and sings in a bluegrass band called Grass Fed. ■


In 1978, National Park Service historian Gary Scott authored a segment in the APT Bulletin titled “Historic Concrete Preservation Problems at Fort Washington, MD.” Scott cites a structural condition survey conducted by a consulting engineer James Madison Cutts, who determined the conservation issues and made recommendations for methods of preservation. The massive sections of the fortifications were designed to hold up against post-Civil War artillery fire. Less massive reinforced concrete components supported secondary functions. As the fort was constructed of both Rosendale and Portland cement elements, the deterioration various significantly, depending on the type of cement used. Water infiltration and freeze and thaw cycles have caused most of the concrete deterioration, resulting in spalling of the concrete surface and lateral movement of slabs. Corrosion of ferrous elements in reinforced sections and vegetative growth have also resulted in further cracking and splitting.

This paper will pick up on the work of Scott and Cutts some 35 years later, incorporating a turn of the century comparison between physical tests and chemical analyses of samples of Portland and Rosendale cements completed for the New York section of the Society of Chemical Industry of England, May 25, 1900, as well as documenting what remains of the hundred year old structures. While the massive concrete sections were designed to withstand the ravages of enemy fire, it is the forces of nature that are ultimately reducing the batteries to rubble. These crumbling structures have the potential to provide unparalleled insight into early concrete construction and its preservation. ■

"Made from my own hand" An Introduction to Concrete Grave Markers

PRESENTED BY
Gordon Bond & Stephanie M. Hoagland

Walk through some urban cemeteries and out back, beyond the fancy marble gravestones and grand granite monuments, you may find personal expressions of memorialization cast in concrete. Historians Gordon Bond and Stephanie M. Hoagland noticed these evidently homemade grave markers while exploring New Jersey's cemeteries and decided to research the stories behind them. What they discovered was a little-studied and under-appreciated form of funerary folk art.

Calling them "folk grave markers," Bond and Hoagland found that they were primarily created in the first half of the 20th century, peaking between the 1910s and 1930s, despite the long-established availability of commercially manufactured markers. While encompassing a variety of materials, such as wood, metal, terra cotta, etc., the majority were made from concrete. They reflect a vernacular history of then-recent European immigrants, with most examples found in Catholic cemeteries and largely urban, working class communities. A combination of established funerary traditions and economic stresses likely account for the choice to make their own markers. But once determined, it is probably not coincidence that so many opted to use concrete. The early 20th century saw concrete emerge as a respectable construction material in its own right. Architects no longer felt they had to hide their use of it. Concrete was economical, available, and workable, yet also durable, making it an attractive option.

While folk grave markers were made by amateurs, these people were sometimes skilled or semi-skilled working in masonry. Forms range from simple, unadorned tablets or crosses to complex designs incorporating inscribed and embedded decoration. Some are highly artistic, reflecting the skill and creativity of the makers. By paying attention to tell tale marks or asymmetries introduced by the wood molds used in casting, Bond and Hoagland noticed the same molds had been used for different families. Overall shapes are found to have been copied from professionally made markers as well as other folk markers, lending community-specific flavor to designs within cemeteries.

Concrete folk markers are not exclusive to New Jersey, however. Examples have been found throughout the northeast United States (and elsewhere) as well as up into Canada. While the cultural backgrounds may be different, the same economic dynamics appear to be at work as well as the availability of concrete. →

About ...

Gordon Bond is the ePublisher of www.GardenStateLegacy.com, a quarterly online magazine dedicated to New Jersey history. As an independent historian, author, and lecturer, he has written many New Jersey related articles and two books, "James Parker: A Printer on the Eve of Revolution" (Garden State Legacy, 2010) and "North Jersey Legacies: Hidden History from the Gateway to the Skylands" (History Press, 2012). He is presently working on a book about the 1951 Woodbridge, NJ train wreck and "Hidden History of South Jersey: From the Capitol to the Shore" (History Press, Fall 2013). Other areas of research include New Jersey's folk grave marker traditions and leading a team proposing an archeological exploration of the Thomas Mundy Peterson house site in Perth Amboy, NJ. A proud native of the Garden State, he lives with his wife, Stephanie M. Hoagland and their two cats in Union Township, New Jersey.

Stephanie M. Hoagland is a partner at Jablonski Building Conservation, Inc. where she has worked for the last 9 years. She graduated from Columbia University with a Masters Degree in Historic Preservation. After graduation she worked at ARCH2 in Metuchen, New Jersey where she surveyed and wrote the multiple property and historic district nomination forms for the *Wildwood Shore Resort Historic District* which at the time included a collection of over 200 1950s and 60s-era motels. At JBC she was worked on conserving structures →

About ...

Stephanie M. Hoagland, *continued*

across North America from the Colonial Building in St. John's Newfoundland to gold rush-era cemeteries at Marshal Gold Discovery State Historic Park in Coloma California. When not working to preserve historic architecture, she is collaborating with her husband, Gordon Bond, on a survey of New Jersey folk grave markers.

Unskilled makers, however, often introduced unintentional flaws that would result in eventual condition issues. Use of ferrous materials as reinforcement—or no reinforcement in the first place—presents unique preservation and conservation issues. Bond and Hoagland have noted multiple markers where the conditions have rapidly deteriorated within just the few years that they have been studying them.

Bond and Hoagland's presentation will introduce the historic use of concrete as a material for grave marker creation and the preservation/ conservation issues associated with the practice.

Restoration of 12 Historic Concrete Bridges on Connecticut's Merritt Parkway

PRESENTED BY

Michael P. Edison

The Merritt Parkway in southeastern Connecticut is a 37-mile long historic highway constructed in the late 1930's. It is listed in the National Register of Historic Places. Of particular architectural significance are the Parkway's concrete bridges and overpasses, each of which was designed to be unique in appearance. In February, 2009, restoration of twelve of the Parkway's historic concrete bridges was begun with funding from the American Recovery and Reinvestment Act, the federal economic stimulus program. Work was completed in late summer 2012.

The goals of the restoration project included not only functional stabilization, as all but one remain traffic-bearing structures, but also retention of the unique aesthetic characteristics of each of the bridges. To this end, the project began with petrographic analyses of →

cores taken from each of the bridges, from which variable depth repair mortars and replication mixes for sections of replacement concrete could be designed.

Special consideration also had to be given to matching of colors, textures and weathering patterns, and a series of custom-matched stains and coatings were developed to aid in achieving aesthetic objectives. The wide variation in concrete colors, including distinct carbonation stains on some structures, presented particular challenges. Yet another consideration was the integration of replacement elements into partially remaining original structures. On-site worker training was a critical component in actualizing the intended aesthetic results.

Other challenges encountered in the course of the work included frequent graffiti attacks on cleaned structures. Ongoing graffiti management issues had to be addressed in a manner feasible for CTDOT maintenance personnel, while preserving the historic fabric of the bridges to the maximum extent possible.

While the project was successful, lessons were learned in the course of its execution and are to be incorporated into the program to restore the next group of historic Merritt Parkway bridges, scheduled to begin in 2013. ■

About ...

Michael P. Edison, chemical engineer, is Founder and President of Edison Coatings, Inc. in Plainville, CT. Over the past 32 years the Company has formulated and produced customized repair mortars and coatings for thousands of concrete and masonry restoration projects on 6 continents.

Edison is a Past President of the Connecticut Chapter of the International Concrete Repair Institute, a past Director of the Association for Preservation Technology Northeast Chapter and a former Chairman of the Central New York Section of the American Institute of Chemical Engineers. He is currently Vice President of the Society for the Preservation of Historic Cements and Chairman of ASTM Task Group C1.10.04 on Natural Cement. ■

Investigation and Testing of Archaic Elevated Concrete Floor Slabs

PRESENTED BY
David Schnerch, PhD, SEd

Numerous types of innovative floor construction systems were developed in the early 1900s when fire protection of buildings became a critical issue and structural design with reinforced concrete was relatively new. The present adaptive reuse of buildings constructed in this period has resulted in the need to evaluate these early systems to determine if they are suitable for current code-mandated floor loads. Investigation and testing is often the best way to confirm their capacity, particularly when drawings showing the floor construction and indicating material strengths are not available. A case study will be used to discuss these topics as they are related to a four-story, steel-framed building with concrete floor slabs that was constructed in the early 1900s. This building is currently being restored for use as office and retail space in Boston's Back Bay neighborhood. →

Initial investigation of the concrete used to construct floor slabs found that the compressive strength is relatively low and would not be adequate for the required floor loads currently required. Non-destructive techniques were used to determine the configuration of the existing reinforcing in the slabs. Several locations where there are existing pipe penetrations through the floor were reviewed and an additional small opening was made to determine the floor construction. It was found that the floor was constructed of cinder concrete, containing ash from the burning of coal as part of its composition. Unlike modern slabs with deformed reinforcing bars or wire mesh, the reinforcement consists of flat bars oriented on edge at 16 inches on center. This system is consistent with an early form of reinforced concrete floor construction known as the Roebling Flat Slab Floor.

Proof load testing was performed at the ground and second floors to confirm the strength of the floor slab in accordance with the requirements set forth in ASTM E196-06 S*tandard Practice for Gravity Load Testing of Floors and Low Slope Roofs.* Uniform loading was applied in the test area using wood tanks that were filled with water in increments up to a load of 200 pounds per square foot (twice the desired specified floor load) and maintained on the slab for a period of twenty-four hours. Electronic instrumentation consisting of cable extension transducers and dial gauges were located on the floor below the tested floor to continuously record the deflection of the slab during each increment of load application. Deflection of the floor system was found to be small and elastic, such that the floor returned to its original position after removal of the load. The results of testing were compared to empirical formulas developed by Columbia University and the Bureau of Buildings in New York for this type of floor system. This method presents a possible approach to evaluate floor load in project of similar construction to the case study project. ■

About ...

Dr. David Schnerch, since joining WJE in 2005, has completed a wide range of structural evaluations, failure investigations, load tests, and repair designs of buildings, bridges, parking garages, tunnels, and other structures. This work has included the evaluation of reinforced, prestressed, and post-tensioned concrete, as well as masonry, steel, and wood structures.

Before joining WJE, Dr. Schnerch studied the repair of concrete and steel structures using ultra-high modulus fiber reinforced polymer (FRP) materials. This work focused on the development of practical solutions for repair and strengthening of existing structures and has been published in the *ASCE Journal of Bridge Engineering, Transportation Research Record: Journal of the Transportation Research Board,* and other publications. ■

Assessment of the Baltimore & Ohio Warehouse and Achieving Durability

PRESENTED BY
Charu Chaudhry, LEED AP

Concrete often undergoes significant alterations in its microstructure and mechanical properties while interacting with its immediate environment. The consequences are adverse and if left unattended, can lead to cracking and delamination of the material. The concrete mineralogy is sensitive to temperature and thermal cycling, particularly during the early hydration period. As a result, the durability of the concrete system and their constituent phases is compromised. Many intrinsic factors and external weathering agents have contributed to the active corrosion and large scale concrete deterioration at the Baltimore and Ohio terminal warehouse. The building was built in 1910 in an industrial neo-classical style and was intended to streamline the operations of the Baltimore and Ohio Railroad along the Hudson River waterfront. At the time of its opening, it was said to be the largest concrete framed structure in New York City and the first to employ flat slab construction (with no interior beams) technique. Today the building is still being used as a storage facility and is a surviving example of the industrial architecture and freight-related activity in West Chelsea during the early-twentieth century. During the investigative phase, the exterior concrete was carefully sound-tested with a small hammer to detect voids associated with sub surface cracking, delamination, freeze-thaw damage and →

About ...

Charu Chaudhry, LEED AP is an expert member of the International Scientific Committee on Earthen Architectural Heritage, ICOMOS ISCEAH. She is also a member of sustainable preservation technical committee of Association of Preservation Technology International. She was awarded Charles Wallace Conservation Fellowship for conservation training in advanced applications of lime technology and stone conservation in the UK and USICOMOS internship in the U.S. She currently serves as an architect in the Building Performance Group at Thornton Tomasetti in New York. She has experience in design and management of preservation projects, including conditions surveys, historic research, materials conservation, testing and technical specifications. She has authored several peer-reviewed papers in the field of earthen architecture, climate change and grouts.

spalled areas and previous repairs. A pigmented coating was also observed throughout the extent of the building. Many cracks and spalls in the coating were also observed. Research was undertaken to identify original construction through drawings and historic photographs. Following, a laboratory testing program was devised to understand the properties of the historic cement and aggregate and restoration strategies were formulated. The investigative phase also revealed concentration of cracks and spalls along the window heads, sills and jambs. This cracking was caused due to expansive forces caused by corrosion of embedded reinforcing steel. The corrosion of the reinforcing steel in concrete occurs when chlorides enter the concrete and cause a breakdown of the passive oxide film around the steel. A second form of corrosion through carbonation was also identified. Carbonation has subsequently reduced the alkalinity in the concrete. Other type of cracking and delamination observed was adjacent to previously conducted repairs. Most of the previous concrete repair areas were found to be cracked, delaminated or debonded revealing the embedded reinforcing steel. The reinforcing bars were twisted square bars commonly used in 1910s. The reinforcing steel was used with minimal cover permitting the steel to be exposed to the moisture in the carbonated concrete and therefore permitting it to corrode even further. A concentration of calcium carbonate was also observed along the south façade around the cornice level, indicating that water migrating through the concrete body has leached out calcium carbonate and deposited on the surface. The paper will present the findings of the survey, various stages of deterioration revealed and subsequent restoration strategies formed. ■

Fenway Park Renovation—Restoring the Historic Concrete at Fenway Park

PRESENTED BY

Ann Harrer and Paul Gaudette

Fenway Park, opened in 1912, is the oldest stadium in Major League Baseball. Fenway was designed by Osborne Engineering Company, one of the premier stadium designers of the early twentieth century and the firm that also designed the original Yankee Stadium (New York) and Wrigley Field (Chicago). Since the opening of the stadium in 1912, there have been several additions and modifications, some due to fires similar to those that plagued other early stadiums. →

The investigation and development of repair techniques for Fenway Park included a collaboration of architects, engineers, conservators, contractors, and craftsman. The results of the investigation and laboratory analysis were applied in the development of multiple mix designs, shop samples, cleaning samples and trial repairs prior to the construction phase.

The presentation will focus on renovation of the original seating bowl (1912), grandstands (1934), and bleachers (1934). The project was conducted as part of four-year phased repair program that is part of a master plan for renovating the stadium. The master plan was developed by the new ownership in 2002 in lieu of replacement of the stadium. The repair program was completed in time for the 100th anniversary of Fenway Park in 2012.

The seating bowl is constructed of concrete tread and riser sections supported by concrete framing. Structural steel framing supports the upper levels of the stadium, which consist of metal deck and concrete. The underside of the sections constructed in 1934 is a tread and riser system, while the 1912 original seating bowl was constructed with a sloped concrete slab with a visible formboard finish. During the repair program the historic concrete of the concrete seating bowl, including the color, profile, and formboard finish, was to be repaired to match the original concrete.

Renovations to the seating bowl include underside concrete repairs to replicate and match existing adjacent concrete. As part of the presentation, discussion will address assessment techniques, restoration strategy, and repair of architectural and historic elements of the park. The presentation will include discussion and examples of repair techniques used, including matching of repair work to original materials, field repair trials, the cleaning program, and various approaches to repair of the historic elements high. ■

About ...

Ann Harrer, PE, is a Senior Associate with Wiss Janney Elstner Associates, Inc., in Los Angeles, California (previously of Boston, Massachusetts). Her work focuses on investigation of historic and contemporary masonry and concrete, materials assessment, and repair and rehabilitation design. She is a member of APTI, APTNE and ACI Committee 546, Repair of Concrete.

Paul Gaudette, FACI, FAPT, is a Principal at Wiss Janney Elstner Associates, Inc., in Chicago, Illinois. His work focuses on investigation of historic and contemporary concrete concrete materials assessment, and repair and rehabilitation design. He is co-author of *Preservation Brief 15: Preservation of Historic Concrete*, and is recent past Chair of ACI Committee 546, Repair of Concrete. He has led five workshops for the Association for Preservation Technology International on Repair of Historic Concrete. ■

Shocking the Rock: Cathodic Protection of Alcatraz Prison

PRESENTED BY

Student: Katie Hammer

The use of cathodic protection as a corrosion mitigation technique for reinforced concrete structures is becoming increasingly prevalent as society realizes the importance of preserving our nation's heritage. For aging structures, exposure to natural elements over a long period of time can lead to corrosion. Eventually the corrosion can lead to a variety of failures to the loss of structural integrity of the building. As historic buildings have a higher intrinsic value, minimizing loss and damage to the original fabric should be the driving force of a repair. The application of a cathodic protection system can assist in minimizing these damages, as seen in the recent work at Alcatraz.

Alcatraz Prison, a landmark rich in American history, is seeing the damaging effects of a lifetime of exposure. Alcatraz was first constructed in the 1850's, and has since been used as a military fortress, a prison holding America's worst criminals, a Native American Reserve, and is currently a historic landmark governed by the National Park Service. Alcatraz Island, located in the San Francisco Bay is constantly exposed to seawater, marine mist, wind, and rain. The deterioration has led to spalling, cracking and delamination of the concrete. The installation of a cathodic protection system will prevent further corrosion of Alcatraz's cellblocks and shower cells, which in turn protects the unique and historic qualities of the prison.

Corrosion is an electrochemical process that occurs when external environmental factors break down the protective layer that naturally surrounds steel embedded in concrete. Carbonation and chloride attack are the two processes which break down this passive layer: both caused by water or salt reaching the steel. The corrosion reaction involves the →

About ...

Katie Hammer is a fourth-year student at the University of Maryland where she is majoring in Civil Environmental Engineering. She is interested in studying how environmental factors affect our existing infrastructure, and what measures can be taken to preserve the structural integrity of these buildings for the future. She has had the opportunity to study abroad in New Zealand and China, which has given her a broader perspective of issues dealing with civil engineering. Katie has worked with ElectrotechCP and Structural on projects dealing with performing corrosion surveys and designing cathodic protection systems. Some projects include Alcatraz Prison in San Francisco, CA; Dockside Condominiums in Charleston, SC; and the coal dock at Progress Energy Power Plant in Crystal River, Florida.

movement of an electrical charge from an anode (positively charged area of the steel) to a cathode (negatively charged area of the steel), resulting in rust at the anode site.

Cathodic protection provides an external anode, which leads to all of the reinforcing steel becoming the cathode. In an impressed current cathodic protection system, a power supply applies a direct current (DC) to the steel via a permanent anode fixed to the surface of the concrete. This current stops the anodic reaction (rust-forming reaction), forcing the cathodic reaction at the steel. Continuous application of this current protects the embedded steel from future corrosion. The installation of a cathodic protection system requires little-to-no destructive measures, can be easily hidden to protect the aesthetics of the structure, and protects the masonry and concrete from further corrosive damage.

The prison cells on Alcatraz Island are just one of the many examples of historic reinforced concrete structures that need protection against corrosive elements. As the modern masterpieces of the 1950s and 1960s become landmark structures, this technology has a wide range of applicability to irreplaceable historic concrete buildings.

The poster or talk will further illustrate the problems at Alcatraz, the type of cathodic protection system designed, and the benefits of cathodic protection for historic concrete buildings. ■

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