CONSERVATION PERSPECTIVES

THE GCI NEWSLETTER

FALL 2019

CONSERVATION OF CONCRETE

The Getty Conservation Institute

A Note from the Director

Photo: Anna Flavin, GCI

Back in 2012, the Getty Conservation Institute established its Conserving Modern Architecture Initiative, a comprehensive, long-term, and international program to advance the practice of conserving twentieth-century heritage, with a focus on modern architecture. Growing out of that initiative is the GCI's more recent Concrete Conservation project, which was developed to respond to the new and distinct conservation challenges of reinforced concrete structures. Many of the important achievements in architecture during the twentieth century (some of which are now on the World Heritage List) were constructed with reinforced concrete. Today, many decades after their construction, these buildings confront a series of preservation challenges as they experience various forms of deterioration—challenges that are increasingly apparent and that urgently need to be faced.

In this edition of *Conservation Perspectives*, we examine the place that concrete structures occupy in our realm of built cultural heritage and the various ways we can endeavor to conserve these architectural landmarks. In her feature article, Susan Macdonald, head of the GCI's Buildings and Sites department, provides an overview of the importance of reinforced concrete in construction over the last hundred years and the complicated conservation issues involving structures built with this material. Adrian Forty, emeritus professor of architectural history at University College London, offers a historical perspective on the emergence of reinforced concrete as a material that enabled architects to achieve architectural expressions not previously possible. In another article, GCI fellow Ana Paula Arato Gonçalves lays out the elements of the GCI's Concrete Conservation project, which includes both fieldwork and laboratory research. Addressing the use of reinforced concrete for restoration at archaeological sites, Paola Pesaresi, the conservation architect with the Herculaneum Conservation Project, reviews how concrete was employed at Herculaneum during the first half of the twentieth century, and how the subsequent deterioration of the concrete elements incorporated into the site is now being handled by authorities there. Finally, we conclude with a spirited conversation among Elisabeth Marie-Victoire, Arun Menon, and Ruth Verde Zein, who illuminate the issues of conserving modern built heritage of concrete in their home countries of France, India, and Brazil.

The GCI's work in modern architecture and the Institute's Concrete Conservation project reflect an appreciation of the significance of the multitude of twentieth-century buildings constructed with reinforced concrete. If we are to preserve these architectural monuments of the modern age, we will need to be diligent in exploring approaches that can preserve both the structural stability *and* the aesthetic integrity of these remarkable structures.

Timothy P. Whalen
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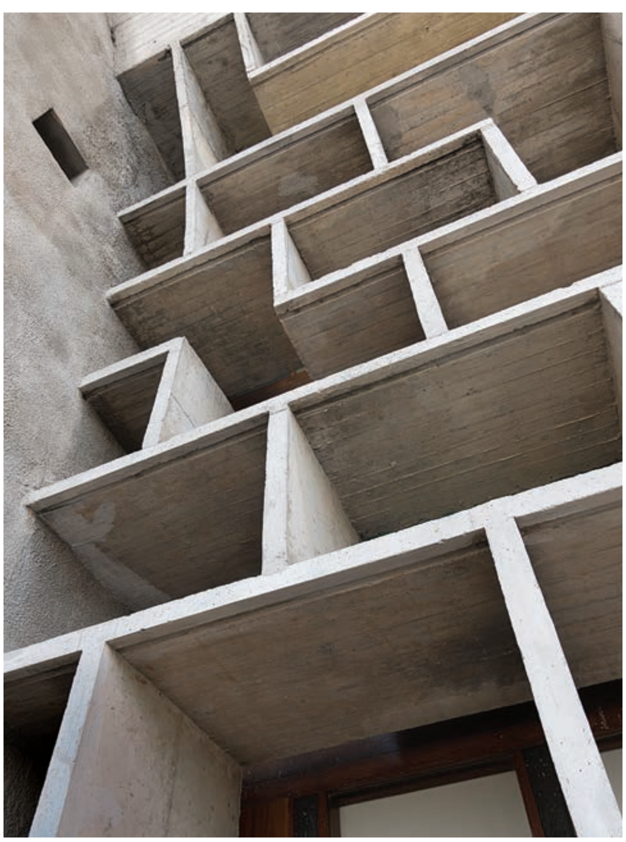
VOLUME 34 • NUMBER 2 • FALL 2019



ON THE COVER
A detail of the Palace of Justice building in Chandigarh, India, built in the 1950s. The Capitol Complex in Chandigarh, of which the building is a part, is among the seventeen sites around the world designed by Le Corbusier that collectively have been placed on the World Heritage List. Photo: Ana Paula Arato Gonçalves, GCI.

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CONSERVING CONCRETE

"It does not seem likely, therefore, that the revival of the use of concrete will have any influence on the style of modern architecture properly so called."[1]

HENRY HEATHCOTE STATHAM, 1839–1924

Boston City Hall, completed in 1968 and designed by by Kallmann McKinnell & Knowles. The building received a 2017 Keeping It Modern grant from the Getty Foundation to evaluate the building and plaza, perform laboratory analysis of the concrete, and assess the building's systems in order to create a conservation management plan for the site. Photo: Gunnar Klack, licensed under the Creative Commons Attribution-ShareAlike 4.0 International license.

BY SUSAN MACDONALD

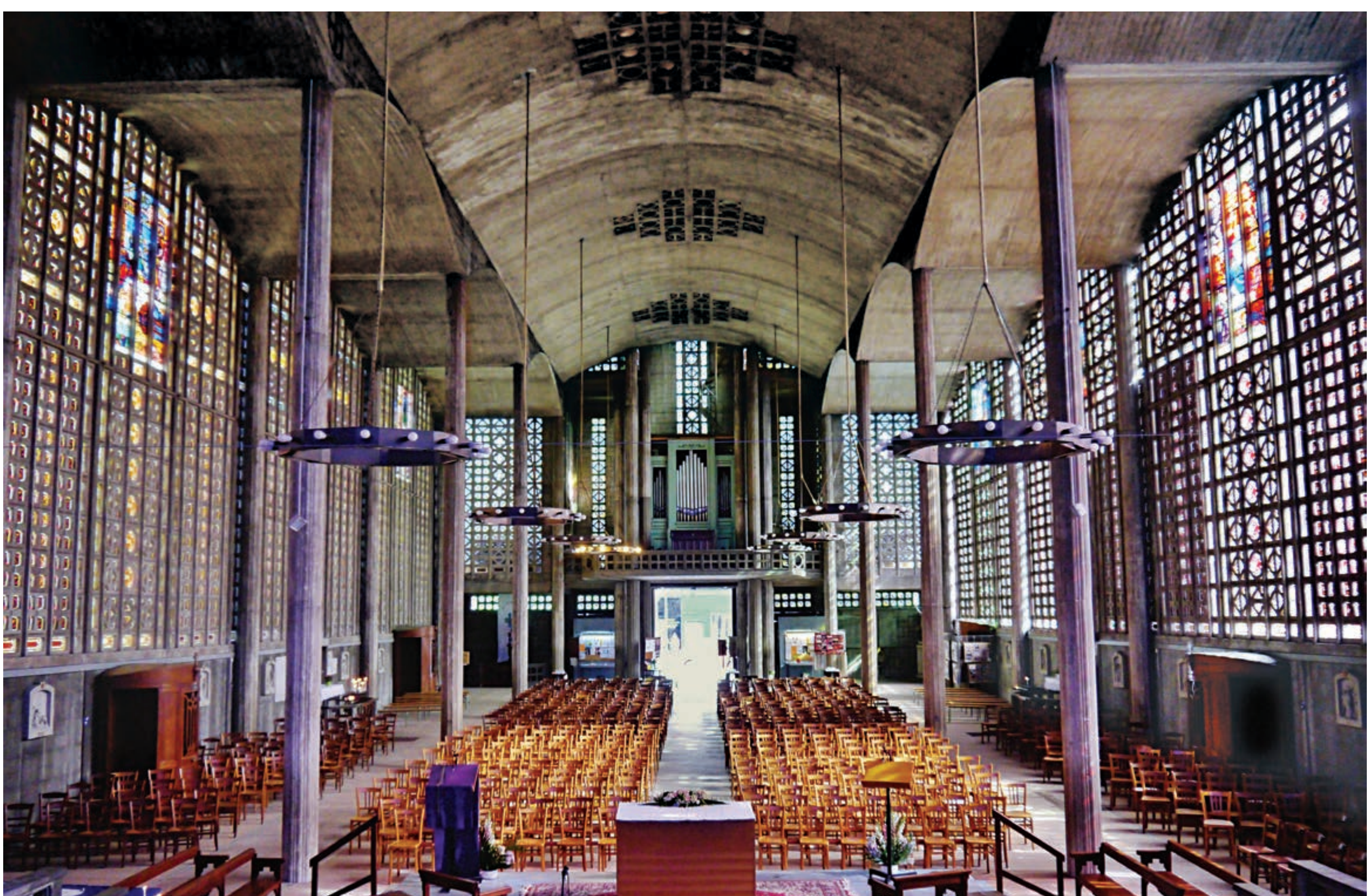
The influence of reinforced concrete on modern architecture was unimaginable to architect and critic Henry Statham, writing at the dawn of the modern concrete era. But there is no question that the gradual shift from traditional building materials such as brick, stone, earth, and timber, and their associated craft-based construction techniques, to concrete and steel over the course of the twentieth century has profoundly affected the built environment throughout the world.

Arguably, concrete (used here as shorthand for reinforced concrete) "… is the foundation of modern development."[2] The industrialization of cement production and the development of new construction systems for steel and concrete in the latter half of the nineteenth century enabled pioneering architects, engineers, and contractors to build taller, faster, and on a scale not previously envisaged.

The plastic and structural potential of the material spurred development of a multitude of new architectural forms and expressions. The huge variety of concrete structures and buildings of the twentieth century demonstrates concrete's versatility and seemingly endless possibilities for creativity and, contrary to Statham's prediction, its undeniable influence on modern architecture and in the transformation of our built environment generally.

A MATERIAL FOR THE NEW AGE

Reinforced concrete comes in many forms: in situ, precast, prestressed, and posttensioned. It has been used in countless ways, depending on location and construction date (and thus on the period of industry development). Frank Lloyd Wright's sculpted concrete at Hollyhock House in Los Angeles (1919–21) is organic and solid, exploring its earthy quality through the use of exposed aggregate. In contrast, the streamlined European buildings of the interwar years, such as Berthold Lubetkin's early 1930s houses in England, emphasize reinforced concrete's potential for thinness and lightness, and have a machinelike quality created by smooth painted finishes. Le Corbusier's postwar use of *béton brut* (raw or exposed concrete) at Unité d'habitation, Marseille (1952) and the great concrete urban



The interior of Notre-Dame du Raincy, near Paris, built in 1922–23 by architects Auguste Perret and Gustave Perret. Photo: Zairon, licensed under the Creative Commons Attribution-ShareAlike 4.0 International license.

landscape of Chandigarh, India, exploit a handcrafted quality resulting from the use of timber formwork. Here the concrete is raw, monumental, and highly expressive; it influenced a generation of architects who became associated with brutalism. Oscar Niemeyer's work in Brazil, Jørn Utzon's Sydney Opera House, and Eero Saarinen's TWA Terminal in New York—all dating from the late 1950s into the 1960s—exploited new concrete technologies such as pre- and posttensioning methods in soaring, daring new forms to create fantastically elegant structures. The formalism of many civic buildings of this period is exemplified at Boston City Hall, by Kallmann McKinnell & Knowles (1968), which utilized precast components in combination with in situ work to create a rational but equally monumental new response to urban form.

Twentieth-century concrete was rendered, painted, exposed, board marked, bush hammered, stamped, acid-washed, mosaicked, and tiled. This endless array of surface treatments was sometimes used to hide the roughness of the material or relieve the monotony of its exposed finish, at times to protect it from the environment (as knowledge about environmental effects became better known), at other times for decoration, and, in some splendid examples, as integrated artwork.

In addition to reinforced concrete's role in defining a new architectural language, it was also seen as a versatile, universal, and everyday material that provided for cheaper, quicker construction and for repair projects. As such, it also began to be used on historic buildings and archaeological sites in the early twentieth century, such as Herculaneum (see page 15). Providing for economies of scale in reconstruction work, more readily obtainable and in some instances cheaper than traditional materials, and without needing skilled craftspeople, concrete's use at historic sites became more widespread by the second half of the twentieth century. In some countries, building codes prevent the ongoing use of traditional materials such as earth, thus favoring concrete. Its comparatively higher tensile strength means concrete continues to be specified as a means of improving unreinforced masonry's structural resistance to earthquakes and other risks.

However, the problems associated with introducing reinforced concrete into traditional building systems have become apparent. The consequential damage to brick, stone, or earth caused by introducing less porous and harder cementitious mortars or renders into a system, and the potential for catastrophic failures during seismic events resulting from inserting heavy, stiff beams in earthen or brick structures for seismic mitigation, are problems now well understood by conservation practitioners. As the impact of concrete's use on historic sites became better understood in the 1980s, conservationists worked to reinvigorate know-how about traditional materials and advocate for their sustained use. Introducing concrete on historic sites has been viewed as downright villainous by many conservation practitioners, despite the fact that there are appropriate instances of its use. There is a legacy of interventions on many archaeological sites and historic buildings, which are now starting to decay. Removal is not always an option without major intervention. This issue is likely to demand more attention.

A decorative detail of Hollyhock House, 1919–21, designed by Frank Lloyd Wright and located in Los Angeles. Photo: Kyle Normandin, GCI.

Concrete's major role in achieving rapid and widespread urban expansion, postwar reconstruction, and new infrastructure demands—and in meeting aspirations for rising living standards—has resulted in some extraordinary concrete ensembles. But concrete is also associated with the processes of urban renewal that catalyzed the preservation movement in places, and thus it has negative connotations for many communities. High-density urban renewal projects, once the flagship of modernity, were not always successful. The term "concrete jungle" is associated with the worst aspects of urban life.

Concrete as an architectural material is a symbol of modernization and progress, but conversely it is also associated with modernism's architectural and social failures. Thus it is both loved and loathed. Nevertheless, as the heritage of the twentieth and twenty-first centuries is increasingly valued and protected, calls for its conservation will multiply. Anyone engaged in the conservation of twentieth-century places will inevitably need to be equipped to deal with concrete.

RISING POPULARITY

In some places, concrete buildings were appreciated for their cultural value early on. For example, France—home to many pioneers of concrete, such as the architect, engineer and contractor Auguste Perret, the architect Le Corbusier, and the contracting company Freyssinet (founded by engineer Eugène Freyssinet, the inventor of prestressing)—started protecting its concrete heritage in the 1940s, when architectural development of the material was in its infancy. Le Corbusier's Unité d'habitation in Marseille was listed in 1986, merely thirty-four years after completion. Today, France has over eight hundred concrete buildings protected as

The National Theatre in London, which opened in 1976 and was designed by Denys Lasdun. Photo: Ana Paula Arato Gonçalves, GCI.

classement au titre des monuments historiques (nationally significant monuments). However, in most countries the road to appreciation, recognition, protection, and conservation has been much bumpier, more contentious, and considerably slower.

In the closing decades of the twentieth century, many high profile modern buildings began to be threatened and ultimately demolished, prompting debates on the cultural value of modern heritage, and thus of concrete buildings. The considerable energy, effort, and enthusiasm of the professionals and organizations focused on conserving modern heritage in the late 1980s led to the first groundswell of interest in the heritage of the modern era, resulting in the emergence of a distinctly new area of conservation practice. Docomomo International was formed in 1988, catalyzed by the threat of the demolition of Zonnestraal sanatorium (the Netherlands, by Jan Duiker, ca. 1931)—its elegant, thin walls a testament to early reinforced concrete's architectural potential. English Heritage's postwar listing program of the early 1990s advocated for "a change of heart" in an effort to shift public opinion about postwar Britain's often detested urban landscapes of endlessly gray, dull, monotonous brutalist concrete.[3] Carefully selected as the best architectural exemplars for listing, under an academically rigorous and thematically organized program, the buildings were celebrated as part of Britain's heroic, innovative postwar development that was both socially and architecturally aspirational. Many of them were exposed concrete structures, such as the National Theatre by Denys Lasdun (1976), the Barbican Estate by Chamberlin, Powell and Bon (1976), and Ernö Goldfinger's public housing block, Balfron Tower (1967). The public's affirmative response to this initiative was encouraging; the program signaled a shift towards greater appreciation and positive perceptions for the heritage of this era, with public support for concrete heritage growing slowly but steadily.

The Central Library of the National Autonomous University of Mexico. The building, designed by architect and artist Juan O'Gorman with architects Gustavo Saavedra and Juan Martinez de Velasco, opened in 1956 and includes O'Gorman's mural, *Representación histórica de la cultura*, a splendid example of integrated art and architecture. Photo: Susan Macdonald, GCI.

Some early entries to the World Heritage List of twentieth-century sites were also exemplars of concrete's technological development. Oscar Niemeyer's splendid concrete designs for Brasilia, which experiment with bold new forms on a monumental scale, put Brasilia on the list in 1987, less than thirty years after its completion. The 2005 World Heritage listing of the city core of Le Havre, reconstructed between 1945 and 1964 by Auguste Perret, cited it as "an outstanding post-war example of urban planning and architecture based on the unity of methodology and the use of prefabrication, the systematic utilization of a modular grid, and the innovative exploitation of the potential of concrete."[4] Centennial Hall in Wrocław, Poland, by Max Berg (1913) was included on the World Heritage List in 2006 as a milestone in the development of reinforced concrete technology.[5] Many countries now have listing or inventory programs in the works to identify and assess their concrete heritage.

CHALLENGES TO CONCRETE CONSERVATION

Despite increasing professional and public interest in the subject, there remain many challenges to conserving modern heritage generally and concrete heritage specifically. Over the last five years, a number of high profile demolitions and irreparable alterations to important concrete buildings have demonstrated that we have a way to go to secure the future of concrete heritage. A disappointing inventory of recent losses includes the Hall of Nations, New Delhi, India, by Raj Rewal (1972); Prentice Women's Hospital, Chicago, by Bertrand Goldberg (1975); and Alison and Peter Smithson's Robin Hood Gardens, London (1972). The future of many fine concrete buildings lies in the balance.[6] Lack of appreciation is the primary cause, but there is also a lack of confidence that there are appropriate, economically viable solutions to some of the technical challenges that these concrete buildings pose, despite an increasing number of good examples that confirm the viability of conservation.[7]

Prentice Women's Hospital in Chicago. Designed by Bertrand Goldberg, the building opened in 1975 and was demolished in 2013–14. Photo: Ana Paula Arato Gonçalves, GCI.

As is the case for many modern materials, reinforced concrete has raised new and distinct conservation challenges. These include the lack of appropriate techniques and materials to meet conservation needs, a lack of knowledge on the efficacy and durability of existing repair solutions, a shortage of practitioners skilled in repairing historic concrete, inadequate professional training opportunities, and the lack of technical resources available to professionals.

Although there are many well-constructed, carefully crafted concrete buildings, there are also many that are deteriorating because of poor-quality materials or construction. Reinforced concrete as a construction material has distinct periods of development, each with different technical challenges and implications for conservation. For example, early twentieth-century concrete often used patented construction systems; the cement was quite different, in terms of strength or quality, from what is available and in use today. Concrete construction proliferated in the post–World War II era, when materials were scarce. There was pressure for accelerated construction, and often there was little quality control. The innovative nature of the material and associated construction techniques also caused problems, owing to the limited understanding of durability, the dearth of experienced workers, and the lack of industry standards and regulations. The use of additives—such as calcium chloride in concrete mixes to speed up the setting process—was subsequently understood to hasten reinforcement corrosion. Moreover, owners of concrete buildings often mistakenly believed that reinforced concrete was maintenance free. The result is a large stock of culturally significant, reinforced concrete buildings in need of focused and careful attention.

Despite the ongoing development of a multibillion-dollar concrete repair industry, the niche conservation market has been unable to stimulate industry interest in the development of materials and methods that help meet typical conservation principles of minimum intervention and maximum retention of original fabric. This is particularly damaging to the significance of sites where the concrete is integral to the aesthetic value of the place, such as exposed concrete buildings, characteristic of brutalism, where surface color and texture were carefully specified and may now be critical elements of the building's significance. Achieving durable patch repairs that are a good aesthetic match has been challenging those responsible for the conservation of significant concrete buildings for decades. The typical off-the-shelf repair products may secure the product manufacturer's warranties but are unlikely to be good matches for exposed concrete. Concrete repair is a specialized activity, requiring skill and experience in both specifying and undertaking the work, and there is only a very small community of practitioners qualified and equipped for it.

With the pioneering concrete structures of the early modern period now approaching one hundred years of age and the second wave of architectural concrete exemplars—particularly the brutalist buildings of the 1960s—now needing repair, addressing the challenges to conserving concrete is vital to the preservation of these structures' cultural significance. Securing a critical mass of professionals adequately skilled in concrete conservation is essential to sustaining the heritage of the last century and earlier.

ADDRESSING THE CHALLENGES

Effectively tackling these issues demands leadership, strategic research, and brokering with industry to develop appropriate materials and repair techniques that translate research into practice and achieve conservation aims. In 2012, in response to the challenges, the Getty Conservation Institute (GCI) launched the Conserving Modern Architecture Initiative (CMAI), with the goal of advancing the practice of conserving twentieth-century heritage through research and investigation, the development of practical conservation solutions, and the creation and distribution of information through training programs and publications.

From CMAI's outset, the challenge of conserving the fabric and materials of twentieth-century buildings, including concrete, has been a priority. This interest was prompted by the perception that the material conservation of many twentieth-century buildings is sometimes compromised in the pursuit of conserving architectural or design significance. Much has been written on this debate about preserving the authenticity of modern buildings, given the significant challenges related to conserving modern materials. However, there has been little work specifically targeting material conservation needs. The GCI is actively engaged in scientific and materials-related research and is well placed to contribute to such work.

In 2017 the GCI launched the Concrete Conservation project with the purpose of addressing the various challenges and identified needs of this growing area of practice, to stimulate collaborations and complement other burgeoning efforts. This work takes a multifaceted approach, identifying and filling knowledge gaps through publications and training, and advancing much-needed technical research, all in an effort to build a community of practice sufficient to meet the needs of the field (see page 12).

Recently, concrete conservation has garnered greater attention. High profile advocacy campaigns around specific buildings such as Boston City Hall, Robin Hood Gardens in London, and Pier Luigi Nervi's Flaminio Stadium in Rome have stimulated exhibitions, films, and public discourse. Brutalist architecture is riding a wave of popularity—no longer universally reviled, it is now often celebrated. New research projects are emerging from academia, research institutes, conservation organizations, and, occasionally, government departments. Perhaps the cause of concrete conservation has at last gathered enough momentum to make real progress.

Meanwhile, the concrete industry is being challenged to respond to concerns about the impact of cement and concrete on the environment, with the colossal contribution to current CO_2 emissions and construction waste, and the unsustainability of continuing concrete construction at the currently accelerating pace. The potential for recycling and adaptive reuse of existing buildings is part of this discussion. The concrete repair industry has been criticized as well, for the high failure rate of repairs; it has been urged to develop better products and improve standards of practice to sustain existing concrete buildings. Hopefully, these issues will help focus attention on the development of a repair industry attuned to long-term solutions for more durable new concrete and for repairs, with the improvements in both benefiting the conservation of our present and future concrete heritage.

As time passes and more and more of our heritage involves concrete in some form or other, the demands to develop a community of practice and appropriate methods to conserve it can only become more widespread and urgent. The year 2024 will mark two centuries since Joseph Aspdin patented Portland cement and the modern era of concrete began. It is the GCI's hope that as we move towards this milestone, there will be greater appreciation for our collective concrete heritage and an improved and shared understanding of how to conserve it.

Susan Macdonald is head of Buildings and Sites at the GCI.

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1. Henry Heathcote Statham, *Modern Architecture* (London: Chapman & Hall, LD.), 271.
2. Jonathan Watts, "Concrete: The Most Destructive Material on Earth," *The Guardian* (February 25, 2019), https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth.
3. English Heritage Royal Commission on the Historical Monuments of England, *A Change of Heart: English Architecture Since the War: A Policy for Protection* (Swindon, UK: English Heritage, 1992).
4. World Heritage, "Le Havre, The City Rebuilt by Auguste Perret," World Heritage List (2005), https://whc.unesco.org/en/list/1181.
5. World Heritage, "Centennial Hall in Wrocław," World Heritage List (2006), https://whc.unesco.org/en/list/1165.
6. See for example, Docomomo International, which devotes a section of its website to *Heritage in Danger*, https://www.docomomo.com/heritage.
7. See Catherine Croft and Susan Macdonald with Gail Ostergren, eds., *Concrete: Case Studies in Conservation Practice* (Los Angeles: Getty Publications, 2019). This book provides examples of careful conservation projects at important concrete buildings in different parts of the world.

CHALLENGES TO CONSERVING CULTURALLY SIGNIFICANT CONCRETE

Repair of historic concrete is, in theory, no different from repairing concrete generally, but there are additional considerations and challenges arising from the cultural significance of the structure and the conservation principles that guide intervention.

CONFLICTS WITH TYPICAL HERITAGE VALUES (AESTHETIC, HISTORIC, MATERIAL, AND SCIENTIFIC) AND CONSERVATION PRINCIPLES

- Impact of replacement of damaged material on the appearance (aesthetic significance) and authenticity of the building due to loss of original fabric and the resulting change in surface finish (coatings, matching patch repairs, decorative finishes, and textures);
- Difficulties of replacing (owing to lack of information and material availability) with like-for-like materials (aggregates, cement types, etc.);
- Impact of repair on existing patina;
- When repair is not enough: preventing ongoing deterioration without impacting the building's appearance (coatings, cathodic protection systems, etc.).

TECHNICAL CHALLENGES

- Availability of sympathetic repair materials (original aggregates, cements, and proprietary mortars);
- Advisedness of replacing like-for-like materials (inherent problems with the original materials, such as aggregates) and achieving durable repairs;
- Access to necessary craftsmanship;
- Destructive nature of diagnostic, testing, and monitoring techniques;
- Use of protection systems that are irreversible (detrimental appearance) and retreatability issues.

KNOWLEDGE GAPS

- Lack of information on long-term effects and lifespan of repair methods and materials, problems of their reversibility, and unknown retreatability;
- Inability to diagnose rate of ongoing deterioration to determine what level of intervention is necessary;
- Lack of knowledge and skill of contractors: convergence of craft and technical know-how;
- Maintenance implications: access, costs, and uncertainty whether repair materials will be available in the future.

OTHER ISSUES

- Cost of conservation work: more labor intensive than standard repairs.

CONCRETE AND MODERNITY

BY ADRIAN FORTY

FOR MOST OF THE FIRST HUNDRED YEARS AFTER ITS MODERN rediscovery in the 1820s, architects disdained concrete. There were exceptions, principally in Great Britain and the United States, but in general concrete construction remained firmly the province of the builders and contractors who had been responsible for its development as a construction medium. This did not change much even after the technique of adding steel reinforcement was perfected in the 1890s, making concrete, for the first time, a widespread and versatile material. Patents taken out by the specialist firms who developed the technique gave them a monopoly over concrete construction; anyone wanting to build in concrete had to go to them, and they would "translate" into the new medium a design that might previously have been built in masonry.

Although the internal structure of these concrete buildings was unlike anything seen before, from the outside they were mostly indistinguishable from buildings constructed using traditional methods. When the young Swiss architect Charles-Édouard Jeanneret applied in 1916 for a patent for a concrete system—the Dom-ino—it was to have been used for houses that externally looked very much like conventional French suburban villas of the time. Only later, in the 1920s, did Jeanneret—by then known as Le Corbusier—take advantage of the Dom-ino frame to promote the idea that a new kind of architecture was the logical outcome of the method of concrete construction.

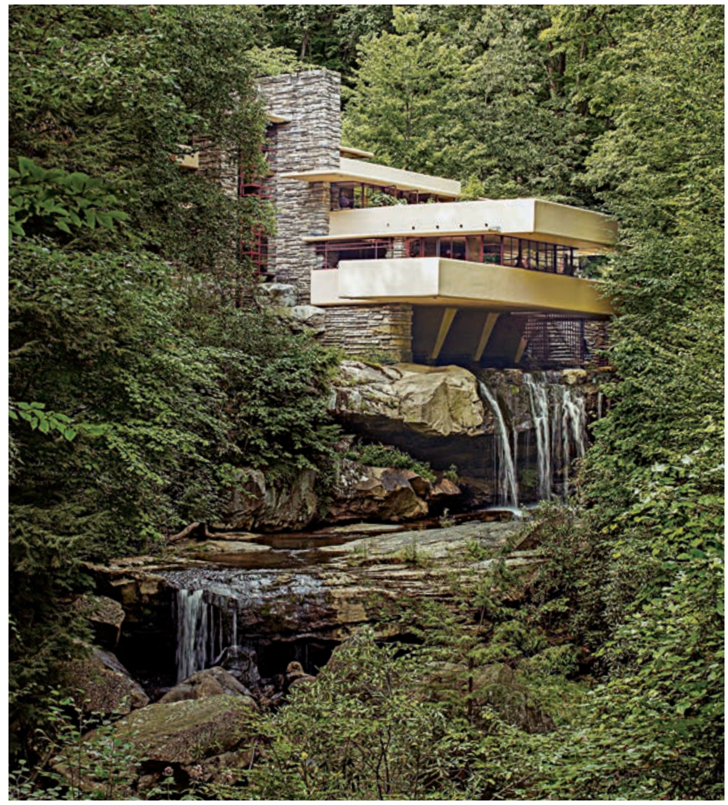
Having previously been ignored, concrete's sudden vogue during the 1920s was a surprise. Everywhere, architects casting around for ways to represent the modern seized on concrete as, in the words of one French critic, "the raiment of modernity." Le Corbusier's claim that the appearance of the new architecture flowed inexorably from the use of concrete was merely one episode in the general transformation of architects' attitude toward the medium. Previously, most attention to the question of how to signify modernity had focused on steel. The Eiffel Tower, the Forth Rail Bridge in Scotland, and the Chicago skyscrapers, all made of steel, had been the prime symbols of modernity. But architects had reservations about steel and felt that its relative transparency did not provide sufficient opportunity for architectural expression. Concrete opened up a different path, one that connected with architecture's traditional concerns with mass and solidity, while simultaneously making new expressions

Centennial Hall, constructed 1911–13 in what was then Breslau, Germany, and is now Wrocław, Poland, by architect Max Berg. This reinforced concrete structure is on the World Heritage List and received a 2014 Keeping It Modern grant from the Getty Foundation to develop a conservation management plan. Photo: mauritius images GmbH / Alamy Stock Photo.

possible. To many architects, it seemed that concrete would allow them to do things they had always wanted to do but had been unable to achieve because of the intractability of materials. Concrete, it seemed, would enable architecture to fulfill its historical destiny.

Even before 1914, there were some examples that set a precedent for this change in architectural values. At Breslau, Germany (now Wrocław, Poland), the Centennial Hall achieved with apparent ease, and considerably less material, the kind of colossal interior space for mass gatherings of people that previously had been achieved only with great difficulty by the Romans in buildings like Hagia Sophia in Istanbul. Spacious market halls in Breslau and Munich similarly attained lightness of construction and uninterrupted floor space by means of concrete arches and frames, used to architectural effect. In France, the architect Auguste Perret, whose practice was linked to his brother's contracting business, made it his personal mission to "ennoble reinforced concrete." Buildings like his automobile showroom at the rue de Ponthieu in Paris demonstrated how this might be done.

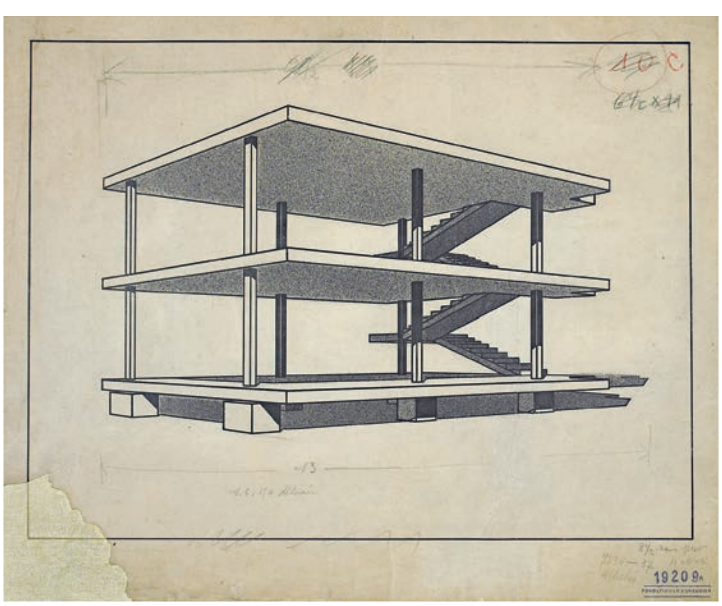
When, after the First World War, the question of how architects were to make the new medium represent the modern led to a whole variety of alternative strategies. For Le Corbusier, the logic of the concrete frame was to allow buildings to be lifted off the ground, opening space under them, and, by putting an end to load-bearing external walls, to create facades with unbroken bands of window. For Perret, the opportunity presented by concrete was the ability to use a single material for the structure, the exterior facing of the building, and the internal finish. This approach was employed in many buildings of the post-1945 era, such as Louis Kahn's Salk Institute in La Jolla, California. For other architects, the particular virtue of concrete was allowing apparently unsupported overhanging masses to be cantilevered out, as in Frank Lloyd Wright's Fallingwater house in Pennsylvania. And perhaps most consequential of all, concrete enabled whole sections of buildings to



Frank Lloyd Wright's Fallingwater house in Pennsylvania, also a World Heritage Site, built 1936–39. Photo: Carol M. Highsmith; from the Highsmith (Carol M.) Archive collection at the Library of Congress.

be prefabricated in factories and then assembled on-site, speeding up construction time and eliminating the artisanal, craft aspect of making buildings—a principle applied to the greatest effect in the Soviet Union and its satellite countries.

Yet for all its associations with modernity, concrete was in some ways an unlikely choice as the symbol of the modern. A messy and mud-like material, concrete was difficult to handle, and to achieve the kind of precision that was expected of modern products required a great outlay of skilled workmanship. Reliance on traditional craft skills—which by no means precluded a degree of unpredictability in the results—made it an awkward fit within the paradigm of "the modern." And its widespread utilization in poorer regions of the world by self-builders who were able to create dry, salubrious, earthquake-proof dwellings and other structures with it gave it associations that did not fit the image of an "advanced" material. The paradox of concrete is that it has always been as much "unmodern" as it is "modern."



A drawing of the Dom-ino system, developed by Le Corbusier in the early 20th century for concrete construction. Courtesy of the Fondation Le Corbusier, © FLC / ADAGP, 2019.

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ADVANCING CONCRETE CONSERVATION

The GCI Project

BY ANA PAULA ARATO GONÇALVES

SIGNIFICANT TWENTIETH-CENTURY CONCRETE BUILDINGS and structures are at last receiving recognition as a result of many years of dedicated preservation advocacy. However, once these places are protected from demolition and neglect, undertaking their conservation according to recognized conservation principles becomes a significant and urgent challenge. In response, the Getty Conservation Institute (GCI) recently initiated the Concrete Conservation project as part of its larger effort to advance conservation of twentieth-century heritage under the auspices of its Conserving Modern Architecture Initiative (CMAI).

The foundation for the project was laid in 2014 when the GCI hosted a meeting of experts in the conservation of concrete heritage, to identify the gaps in knowledge and in resources in the field and to pinpoint potential actions to advance concrete conservation practice. The meeting's objective was to recommend specific short-, medium-, and long-term actions that could be undertaken by the GCI and others to move beyond the status quo. The proposed list of priorities was intended to prompt collaboration and stimulate action. The outcome of the meeting, which drew on preliminary research by the GCI on the status of concrete conservation, was a series of recommendations organized around three activities: research (historical, methodological, and scientific); creation and dissemination of literature; and education and training.[1] Examples of the issues identified included:

- lack of information on the durability and efficacy of available repair and treatment methods and materials;
- divergent views among professionals on the best practice for concrete repair;
- the destructive nature of analytical and diagnostic techniques;
- the complexity of undertaking durable concrete repairs that are aesthetically compatible with the original surface.

It was recognized that addressing these issues required targeted scientific research. The experts also concluded that creation and dissemination of specific literature in concrete conservation would have a significant impact, considering that current information on the subject is meager, disparate, and difficult to access. Moreover, the development of professional training opportunities in the many aspects of concrete conservation was considered a necessary step in overcoming the shortage of skilled professionals.

These three areas of work align well with the GCI's mission and therefore form the basis of the Concrete Conservation project, which commenced in 2017. The project also recognizes the need to help develop and support a community of practice in this emerging area of conservation.

FILLING GAPS IN KNOWLEDGE

An important goal of the GCI's work is the growth of the currently small community of practitioners involved in concrete conservation. Professionals skilled in both conservation and concrete repair are difficult to find in most parts of the world, which means that developing a community of practice is critical to the long-term preservation of our concrete built heritage.

The Getty Foundation's companion program to CMAI, Keeping It Modern, supports and leverages the GCI's work in modern heritage by funding important projects that have a rigorous methodological approach to conservation. More than seventy projects have been funded—a large number of them involving concrete buildings. And a few involve innovative and project-based research to assist in developing concrete repair strategies, including the Villa E-1027

Miami Marine Stadium, designed by Cuban-born architect Hilario Candela. The iconic cast-in-place concrete building—which opened in 1963 and closed in 1992 after being damaged by Hurricane Andrew—received a 2014 Keeping It Modern grant from the Getty Foundation to develop a conservation strategy for the concrete. Photo: Ken Hayden, ©KenHayden.com.

in France (designed by Eileen Gray and built 1926–29) and Miami Marine Stadium (designed by Hilario Candela and built in 1963).[2]

Creating and Disseminating Information

Targeted technical research is needed to develop more detailed guidance for conservation practitioners beyond what is currently available. This goal will take time to achieve, but meanwhile there is much that can be done to improve the current level of access to information. The GCI is working to publish guidelines, glossaries, bibliographies, and case studies to provide needed information on concrete conservation.

The GCI's first activity was to develop an annotated bibliography, published in 2015. The bibliography was created to assist researchers and practitioners in identifying available resources in concrete conservation, and to pinpoint areas that required further investigation. This publication will be updated in the next few years to include the latest literature.[3]

The first book in the Getty's new series Conserving Modern Architecture, *Concrete: Case Studies in Conservation Practice*, was published in 2019. The case studies demonstrate best practice in concrete conservation through fourteen projects from around the world, representing different building typologies, construction dates, scales, and methods of repair. Most importantly, these projects show how professionals have dealt with local constraints while striving for high conservation and performance standards.

Currently, three other publications are under development, two of which are translations of manuals by the Laboratoire de Recherche des Monuments Historiques (LRMH) and the Cercle des Partenaires du Patrimoine in France. LRMH has one of the few dedicated groups focused on historic concrete. The first translated publication consists of an illustrated glossary of concrete deterioration. It identifies the most commonly observed deteriorations, their characteristics, and the possible causes. It also includes a diagnostic matrix and describes useful in situ and laboratory testing techniques.

The second translation is a guideline on cleaning techniques for exposed concrete surfaces, derived from research by LRMH. It aids professionals in selecting the most appropriate cleaning technique based on the characteristics and soiling type of a concrete surface. Detailed and illustrated technical sheets are provided for each cleaning technique (water based, abrasive, poultice, peel, laser, chemical, and biocide), describing the equipment, settings, and pros and cons, and making recommendations. Case studies demonstrate the different types of cleaning techniques, and a decision-making methodology is included.

Additionally, the GCI is developing key principles for concrete conservation, which will be published in late 2019. This document not only will establish key principles but also will define a methodology that recognizes the need to conserve the material significance of historic concrete in repair work. Drawn from current best practice approaches in both the concrete repair and the conservation fields, these principles will be presented as a sequence of steps in the development and implementation of a conservation project.

Education and Training Activities

In addition to increasing access to information, the GCI is developing training modules on concrete conservation. The Introduction to Conserving Modern Architecture course—a partnership with the US National Center for Preservation Technology and Training (NCPTT)—included sessions on concrete in 2018 and 2019. The Keeping It Modern training delivered by the GCI in partnership with the Getty Foundation and the Twentieth Century Society has twice included specific workshops on concrete. The GCI is currently developing a longer training course on modern heritage that will include a module on concrete conservation with accompanying didactic materials, which will be available to training providers.

IMPROVING PRACTICE THROUGH RESEARCH

A critical component of the GCI's Concrete Conservation project is to undertake targeted scientific research that can provide clear guidance on historic concrete conservation and improve current concrete repair and treatment methods so that they adhere to conservation principles. Two complementary research projects have commenced: (1) field-based evaluation of repair projects at historic concrete buildings, and (2) laboratory-based research on patch repair materials for conservation projects.

Evaluating Past Repairs

The first of the current research projects, Performance Evaluation of Patch Repairs on Historic Concrete Structures (PEPS), is a partnership with Historic England and LRMH, institutions with extensive experience in concrete conservation.[4] Patch repairs are defined here as non-load-bearing repairs using either mortar or concrete. Patch repairs reestablish surface integrity against material loss, such as a spall caused by corrosion of the underlying reinforcing bars.

Patching—the most frequent repair to reinforced concrete—has a relatively high rate of failure. Moreover, the complexity of achieving successful results is more pronounced in historic exposed concrete, as there is an added difficulty of matching color and texture, on top of the ordinary requirements for adhesion and behavior compatible to the concrete substrate. For that reason, the GCI prioritized research addressing these challenges. As there are different approaches currently employed to repair historic concrete, the goal of GCI research is to characterize these approaches and evaluate their efficacy, durability, and appropriateness. This will help in

Instructor Brad Shotwell (from Wiss, Janney, Elstner Associates) explains the application of petrographic analysis in concrete conservation projects in a session dedicated to concrete conservation at the Introduction to Conserving Modern Architecture course offered by the GCI and NCPTT. Photo: Ana Paula Arato Gonçalves, GCI.

understanding the factors for success and failure of current patch repair approaches and materials, and in supporting the development of technical guidelines.

The first phase of PEPS includes the preliminary evaluation of thirty case studies, with ten case studies each in England, France, and the United States. The case studies represent a wide range of building typologies, ages of the original concrete, climates, and repair approaches. The methodology for this phase includes: (1) collecting data from documentation to understand how the repairs were developed and executed, and (2) field assessments to document and evaluate the current state of the patch repairs using visual survey, photography, condition mapping, and in situ nondestructive evaluation techniques. The results from this phase will establish the range of concrete repair approaches currently used in historic structures. Additionally, it will inform the following phase, which will include the selection of fifteen case studies for in-depth analysis.

The second phase involves in situ and laboratory analysis of both patch repair and original concrete from the selected case studies to provide a better understanding of the behavior of the repair materials and their interaction with the substrate. Priority will be given to in situ testing, especially nondestructive techniques, complemented by laboratory testing to increase the reliability of the results. In situ techniques will include the rebound hammer to test surface strength and using a cover meter to locate reinforcement bars and estimate the depth of concrete cover. Some in situ destructive tests will assist in gauging the adhesion of the repair material to the substrate. Samples will be removed to measure depth of carbonation and to carry out characterization of the material through chemical and petrographic analysis.

Concrete spall due to corrosion in the steel reinforcement. Photo: Ana Paula Arato Gonçalves, GCI.

Results are expected to help provide better guidance to professionals on repair methods currently being used, but also to reveal issues that require further research. The methodology developed for this research will help guide other professionals in evaluating concrete repair on historic buildings.

Identifying Appropriate Materials

Since the field-based evaluation will not provide a complete comparison of repair materials because of the specificity of each site and the method of application, it was evident that this work should be complemented with scientific research comparing various repair materials. A laboratory-based GCI project is therefore underway to assess the performance of repair materials used in the conservation of historic concrete.

The goals of the GCI Science project include developing new evaluation techniques for built heritage materials, understanding the durability and deterioration of such materials, and evaluating novel conservation solutions. This effort includes research to compare the efficacy, compatibility, and durability of typical formulations used for the patch repair of historic reinforced concrete. The results are expected to contribute important data for professionals in the selection of appropriate repair materials.

Initial work will focus on the characteristics of mixes commonly in use and will assess their suitability for the repair of historic concrete. Such historic materials often have particular chemistry and mineralogy distinct from contemporary concrete, and they therefore require different repair materials. This laboratory work will complement on-site assessment of repairs and will provide principles for repair materials that can be used alongside recommendations of repair methods.

Historic concretes were commonly produced from local materials and thus can vary greatly. This is currently poorly understood, and GCI research will help in understanding the heritage of the concrete industry and the challenges in matching strength, flexibility, and appearance in creating good repairs.

FUTURE ACTIVITIES

To accomplish the goals of the Concrete Conservation project, the GCI plans additional activities that draw from and expand the current research. Research results will inform publications and training, and the GCI may also develop a field project that binds together the various strands of current work. Field projects ground the research, help focus the research questions, and ensure that solutions account for factors influencing outcomes on typical construction sites. Thus, the fieldwork helps translate the research into practice and provides opportunities for site-based training and dissemination. Additional research projects will be developed to meet the growing demands of the field.

It is hoped that the GCI's efforts will help catalyze the activities of others and strengthen the community of professionals working to conserve the concrete heritage of the twentieth century. With increasing recognition of the significance of this heritage and its ubiquitous presence in the world, the need for more professionals with adequate training and experience in repairing these structures will be even more pronounced.

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1. See Alice Custance-Baker and Susan Macdonald, *Conserving Concrete Heritage Experts Meeting: The Getty Center, Los Angeles, California, June 9–11, 2014* (Los Angeles: Getty Conservation Institute, 2015). http://hdl.handle.net/10020/gci_pubs/conserving_concrete_heritage
2. For information on the Keeping It Modern projects, see getty.edu/foundation/initiatives/current/keeping_it_modern/index.html.
3. See Alice Custance-Baker, Gina Crevello, Susan Macdonald, and Kyle Normandin, *Conserving Concrete Heritage: An Annotated Bibliography* (Los Angeles: Getty Conservation Institute, 2015). http://hdl.handle.net/10020/gci_pubs/concrete_biblio
4. The GCI's evaluations in the United States engage consultants Wiss, Janney, Elstner Associates, Inc.

THE ROLE OF CONCRETE IN THE CONSERVATION OF HERCULANEUM

Left: Excavations at the Palestra building in Herculaneum, 1932. Right: View of Herculaneum's House of the Bicentenary, 1939. The facade is undergoing restoration work with the reconstruction of the floor slab in reinforced concrete. Photos: courtesy of the Archive of the Parco Archeologico di Ercolano.

BY PAOLA PESARESI

IT TOOK A VAST CAMPAIGN OF EXCAVATION AND RESTORATION work over some four decades to recover the ruins of the Roman town of Herculaneum from over seventy feet of volcanic material that buried it in 79 CE. This campaign, singular in its scope and efficacy, unfolded at the heart of twentieth-century Italian history, starting with the rise of Fascism, through World War II, all the way to the economic boom of the 1950s and 1960s. The progress of the work—its accelerations, slowdowns, and interruptions—mirrored Italian political and economic events. Similarly, the methodologies used in restoration work were affected by the industrial developments and technological advances of the time.

A case in point is the structural consolidation work carried out across the site, which relied on steel and concrete for the delicate process of reinstating the collapsed Roman walls, floor plates, and roofs. The approaches employed at Herculaneum shaped and were shaped by the era's continuous international debate on the principles of conservation and restoration, embodied during that period in the charters of Athens (1931) and then Venice (1964). Here was born the internationally well-known image of the Herculaneum site that—along with Pompeii and Oplontis—earned inclusion in the UNESCO World Heritage List a few decades later.

The use of concrete and reinforced concrete in the twentieth-century restoration work at Herculaneum is an interesting lens through which to gain a broader understanding not only of conservation choices made in the past but also of deterioration issues in the present and conservation decisions to be made in the future.

THE TWENTIETH-CENTURY RESTORATION

The open-air excavation of the ancient city was largely carried out between 1927 and 1958 under archaeologist Amedeo Maiuri, although additional work continued intermittently for another twenty years. This massive excavation campaign was initiated by the rising Fascist regime, which supported numerous archaeological works, both in Italy and in occupied territories, because of their role in building the Fascist identity through the ideals of the Roman myth.[1] The speed typical of the first ten years of excavation and restoration in Herculaneum parallels the rise of Italian Fascism.

Excavations, conservation, restoration, and presentation to the public were all handled simultaneously. Maiuri viewed Herculaneum as a museum city, where objects and furnishings could be displayed among the restored ruins and next to the precious decorated surfaces, and he managed and organized the operations on a self-sufficient urban scale, with in situ suppliers, carpentry and metalworking workshops, and even an internal railroad. Although pace was a priority, Maiuri introduced a strict protocol for reconstruction matters, paying particular attention to the international debate on restoration methods, at that time specifying a clear articulation between original and new work.[2] Therefore, only visible building techniques were employed for the reconstruction. As a result, in addition to a harmonious approach to the scale of the site, visitors were able to clearly distinguish original areas from restored ones.

Left: A collapsed concrete slab at the House of the Bicentenary, from the 1939 period. This is how it appeared in March 2018. Photo: Paola Pesaresi/Herculaneum Conservation Project. **Right: The same spot after the concrete slab was replaced with a new wooden structure**, with work completed in late spring 2019. Photo: Di Lauro/Herculaneum Conservation Project.

USE OF CONCRETE

In Maiuri's early excavation and conservation work, concrete and reinforced concrete were rarely utilized for structural integrations, their use being limited to particularly complex situations (e.g., the support beams of the atria's large roofing). At the time, the use of concrete required great design skills and complex procedures, not compatible with the fast pace of the excavation and limited financial resources. For the wall reconstructions, the use of lime mortar was preferred, as it was made on site and cheap. Steel profiles, shaped as required on site, were used to replace the original timber lintels, as the now carbonized wood could not support the overlying structures.

Other factors affected use of concrete in Herculaneum in the early decades of excavation. Italy, unlike other European countries and the United States, had delayed modernization, which was realized only in the 1950s, during the so-called "economic miracle," induced by demands for postwar reconstruction. Despite the early introduction of reinforced concrete in Italy, its use was initially limited, owing to the lack of an economic impetus to facilitate its distribution and the exploitation of its technological potential.[3] Moreover, especially in central and southern Italy, the traditional *pozzolana* and composite concretes were favored over industrially produced concrete. By the mid-1930s, concrete finally became the most commonly used material for construction, thanks to its ease of manufacture and lower cost. Thus it also began to be regularly used for restoration work in Herculaneum. Moreover, through the Athens Charter its use was sanctioned, even recommended, to achieve a clear distinction between ancient and modern construction.

Thanks to the use of reinforced concrete, Maiuri could tackle technical challenges in ways unimaginable until then. Combining reinforced concrete with traditional techniques, he created axonometric vertical sections of certain houses, enabling visitors to glimpse their upper levels from the street or further away. Nevertheless, technical know-how on concrete construction was still limited. The reinforcement bars were smooth and oversized, the thickness of the concrete cover was excessive, and the mixes were not efficient. But this interlude was brief. In 1937 Fascist Italy embraced autarky and issued norms to reduce the use of steel, directly affecting use of reinforced concrete. Initially, the research for alternative types of reinforced concrete (with less steel) was encouraged, but in 1939 the technique was banned.

During these two years, Maiuri was working on restoration of the House of the Bicentenary to celebrate two hundred years since the ancient city's discovery. The reconstruction of this domus perfectly highlights contemporary trends. The plan was ambitious, with elevated structures up to three levels, an axonometric vertical section at street level, and portions of cantilevered slabs that allowed visitors to glimpse from below the frescoes on the upper levels. The reinforced concrete beams of the atrium roof were built during the first phase, while the lintels on the facade were constructed in the last period, presenting huge structural differences. Over the course of the project, the reinforcements got thinner and thinner, almost disappearing completely. Barely any cement was used in the concrete—the sand was replaced with volcanic ash from the excavation trenches. This was impure, rich in sulfates and chlorides, subsequently affecting the durability of the concrete and the reinforcements.

After the war, concrete use at the site grew again, eventually becoming the primary material used in structural interventions. From the 1950s, beams and lintels were regularly built in reinforced concrete; at the same time, the quality of reinforcements and of on-site concrete production improved. During the 1960s, additional shifts in practice and conservation methodology occurred. Conservation theory was changing, in response to large-scale postwar building reconstruction and its negative impact on the historic environment, as well as the influence of the Venice Charter and of authors such as Cesare Brandi, who emphasized the importance of preserving the authenticity of the site, including original materials, and the need to pay attention to the aesthetic impact of interventions. At Herculaneum, advances in building and material technology were exploited to enable the emerging interest in preserving the authenticity and integrity of the site as archaeological ruins to be realized. For instance, lintels or wooden doorposts were rebuilt using reinforced concrete to provide the necessary structural stability, while also incorporating the original carbonized wood, either placed alongside the concrete elements or sealed into them, taking advantage of the plasticity of cement.

DETERIORATION OF CONCRETE AT HERCULANEUM

Herculaneum today is, in many ways, an open-air laboratory allowing structural interventions and other restoration techniques used in the past to be observed and their durability and effectiveness evaluated. The premature aging of such interventions, together with a persistent lack of maintenance, meant that by the end of the 1990s the site was on the verge of a form of conservation "bankruptcy"—collapse at a site-wide scale rarely seen in heritage places not afflicted by wars and other conflict.

This trend was fortunately interrupted, thanks to the combined action of the public authority, today known as the Archaeological Park of Herculaneum,[4] along with the Packard Humanities Institute and other stakeholders in a long-lasting public-private partnership, the Herculaneum Conservation Project (HCP), now completing its second decade of activities. The conservation activities of the HCP address the whole fabric of the site, both the archaeological elements and the substantial interventions of the twentieth-century restoration campaigns, the latter often being the most in need of care. The reinforced concrete structures are among the most problematic in terms of deterioration and potential harmful effects on the preexisting archaeological structures. Work began in the late twentieth century to replace these interventions, but this effort was put on hold during the first years of the HCP. Careful study and experimentation were required to achieve lasting alternatives to the existing concrete interventions and, moreover, to comprehend what these elements had come to represent in today's image of the identity of this ancient city, and as Maiuri's legacy.

Study and experimentation began in 2005 and in recent years was extended to include a more thorough risk assessment, particularly the seismic risks associated with the compatibility of the reinforced concrete elements with the ancient and modern structures. Research on the deterioration patterns showed a close correlation between construction defects and the date of their execution, confirming, and sometimes consolidating, knowledge about the methods used during different intervention periods throughout the twentieth century. The deterioration issues were also related to the environmental conditions around the various concrete elements. At the same time, trial work was carried out utilizing contemporary construction materials and methods, particularly those developed for more demanding conditions such as maritime environments (with docks, piers, and tanks).

As a result, while the analysis of modern interventions was enriched with increasingly more detail, the trials allowed the evaluation of necessary resources and the effectiveness of the conservation methods. These data were considered sufficient to launch the process of decision-making about preserving or replacing the concrete elements. As a general rule, if the level of deterioration has reached a critical threshold and the concrete is directly exposed to the environment, replacement is recommended. If the concrete elements still function in supporting the original features, such as carbonized artifacts or frescoes, the recommendation is to preserve them.

A HERITAGE TO BE PRESERVED?

At Herculaneum, approximately 635 reinforced concrete elements have been identified. Of these, 508 are elements supporting shelters and 127 are lintels, either directly or indirectly exposed to the weather. Within the last category there are about 25 that support carbonized wood elements or wall paintings. Except for a few built during the autarky or during World War II (employing reused or low-quality materials, which limit their conservation), most lintels can be treated every ten years with techniques tested by HCP, with seasonal maintenance in the interim. In fact, testing has demonstrated that treatments with migratory corrosion inhibitors were effective after nine years in 80 percent of these cases. This ongoing maintenance increases the functional life span of these elements, reducing the disturbance that would occur to the archaeological fabric if they were replaced.

With respect to the elements that support carbonized wood and wall paintings, the potential impact of the anticorrosion inhibitors on the delicate surfaces has yet to be tested. In some critical cases, the conservation of the surfaces has been achieved through detachment and repositioning, but a new experimental treatment could represent a conservation choice for the future, especially for more complex cases.

Finally, regarding the concrete elements that support shelters: Considering the high seismic risk in the area and the fragility of the wall structures on which they stand, these elements will undoubtedly require replacement with less rigid materials, to minimize the risk to the ruins. This substitution process must be done progressively and with consideration of the role of these modern elements in conveying the site's collective image, that image with which the public is familiar. Herculaneum is like many sites subject to heroic and rapid discovery processes—the modern fabric of these places has become the heritage conservation challenge of the day, with no straightforward one-size-fits-all solution.

Paola Pesaresi is the conservation architect with the Herculaneum Conservation Project.

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1. Italian expansion in the Mediterranean began in the early 1920s. Italy occupied Corfu in 1923, Ethiopia in 1935, Albania in 1939, and additional territory in Greece, Slovenia, Croatia, Kosovo, and Montenegro after the start of the war.
2. While Maiuri did not personally participate in the 1931 Athens Conference, he submitted a summary report on the restoration approach employed at Pompeii and Herculaneum, and also sent a spokesman.
3. Industrial manufacture of concrete began after the unification of Italy in the mid–nineteenth century.
4. Parco Archeologico di Ercolano.

A lintel and post in reinforced concrete covered with Roman carbonized wood. The site is one of the shops on the Decumanus Maximus (Bottega del Plumbarius). Photo: Herculaneum Conservation Project.

THE DARING AND THE BOLD

A Conversation about the Conservation of Concrete Built Heritage

ELISABETH MARIE-VICTOIRE is a conservation scientist and research engineer with the Laboratoire de Recherche des Monuments Historiques in France.

ARUN MENON is an associate professor in the Structural Engineering Laboratory, Department of Civil Engineering, at the Indian Institute of Technology in Madras.

RUTH VERDE ZEIN is a professor of modern and contemporary design and architecture at the Mackenzie Presbyterian University in São Paulo.

They spoke with **SUSAN MACDONALD**, head of GCI Buildings and Sites, and **JEFFREY LEVIN**, editor of *Conservation Perspectives, The GCI Newsletter*.

SUSAN MACDONALD We thought we'd start by hearing from each of you about your favorite concrete building.

ARUN MENON My favorite building is the Golconde, constructed between 1937 and 1942 in Pondicherry, which was a French colony in south India. Intended and still used as a dormitory, it was designed by Antonin Raymond and George Nakashima. It's a beautiful example of climate-conscious design using reinforced concrete. It's probably the first example of a modern climate-conscious building using new materials, and it is in fantastic shape eighty years later.

RUTH VERDE ZEIN The Santa Paula Iate Clube in São Paulo is my favorite building. It was designed by João Batista Vilanova Artigas and his then-partner Carlos Cascaldi, and it was constructed between 1961 and 1965 as a beach club on this huge artificial lake. It is a very beautiful place with a view of the lake and with large slabs of concrete on eight supports. I first saw this building when I was ten years old, and it was something amazing to me because I could not understand how they put it all in place. For the first time in my life I wanted to be an architect!

ELISABETH MARIE-VICTOIRE My favorite is probably the Palais d'Iéna in Paris, built by Auguste Perret between 1937 and 1943. It's colored concrete with lots of details in the finishing, and it has great volumes inside of it, with a great grand stair. Everything was very well realized. It was listed as a historical monument with the first level of protection in 1965 and with the highest in 1993, and it was restored between 2014 and 2016. So it's also a great example of repair that is almost invisible.

JEFFREY LEVIN Are concrete buildings appreciated as part of the national heritage in each of your countries—and, if so, are they protected in any way through national or local regulations?

MARIE-VICTOIRE In France we have two levels of protection—inscription and listing, which are slightly different. At the moment, we have more than 840 concrete buildings protected by the government as historical monuments. Most of them are at the lowest level of protection, but there's a strong governmental policy of conservation of twentieth-century cultural heritage, so that number is increasing exponentially. The buildings are very varied in types and include a lot of churches and industrial buildings, among others.

MACDONALD What about public opinion? Does the public like this concrete heritage, or is there a feeling of bewilderment about it being protected?

MARIE-VICTOIRE I think you either love it or hate it. In France, there are some people who very much enjoy this type of architecture and think it's great that this architecture is protected. On the other hand, there are a lot of citizens who consider concrete grayish, massive, and ugly, and don't think it is cultural heritage.

MENON In India we have about 3,600 monuments, which are protected by the national inscription of the Archaeological Survey of India. Typically, these are monuments inscribed in the early 1900s, so none of the modern heritage would come under that. Most of the important cities—such as Mumbai, Delhi, and Pondicherry—have heritage acts in place and categorize buildings as grade one, grade two, grade three, and so on. But despite these lists, protection and conservation of these structures are not at the same level in different places. We have several cases where listed buildings were pulled down because of a powerful push for development. An important recent example is the famous Hall of Nations in Delhi, a landmark of structural engineering, which was demolished despite

Photo: courtesy of Elisabeth Marie-Victoire.

... This innovation has enhanced creativity in architecture—it's raised new types of buildings and some architecture that is very different. The main challenge is to change the image that citizens have in their head of a concrete building... We have to show them beautiful examples of concrete buildings...

ELISABETH MARIE-VICTOIRE

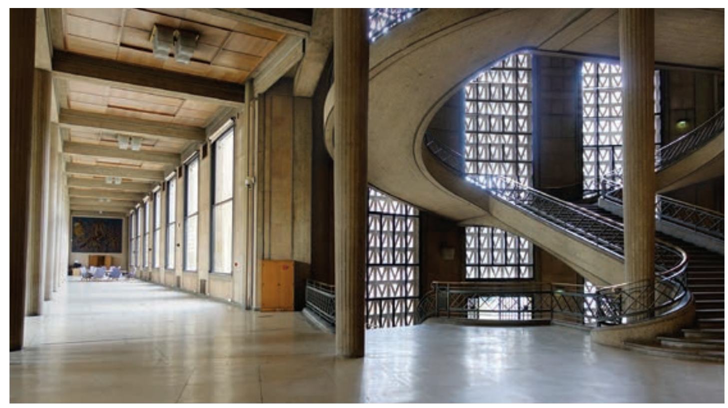
a lot of opposition. The legal aspects involve a complex scenario, but the big battle we need to fight is the perception battle. There's the conservation fraternity wanting to retain these buildings versus the negative connotation of concrete—the "concrete jungle"—when you look at the public perception. In India we don't have a very uniform approach to protecting modern heritage.

VERDE ZEIN In Brazil our federal heritage service began in the 1930s, and we have a peculiarity in that architect Lúcio Costa, who was the leader of modern architects, was the person in charge of heritage. As Costa was in charge of selecting the buildings to be considered as national heritage, as early as the 1940s we had modern buildings being protected. Many of the newer buildings designed by Niemeyer and others—all classical modern architecture in Brazil—are protected. But after the 1970s and 1980s, federal listings for heritage decreased in quantity. Instead, the states and the cities now have their own heritage departments, and every one of them has listings. Modern buildings are very important because we are a new country and modern architecture is considered very connected to Brazilian identity. The concrete buildings of the 1950s and 1960s began to be considered as heritage in the 1990s, and mostly by local governments, not the federal government. People don't hate them the way I've seen in Europe and the United States. Sometimes people don't care if you maintain a building, because it has no purpose anymore, it's abandoned. Then the idea of demolishing it in favor of development sometimes is stronger than the idea of conservation and heritage. But if the question is "are concrete buildings appreciated"—yes, they are. Besides, Docomomo Brasil is very strong. We have several chapters all over the country, and we also help to promote modern architecture.

MARIE-VICTOIRE I should add that in France the first protection occurred in 1920. André Malraux, as postwar French minister of culture, also promoted protection of twentieth-century cultural heritage. But the real beginning was in 1920.

LEVIN Is there a group of practitioners in each of your countries that has some of the knowledge and expertise necessary for concrete conservation? Is this a developing area?

A FAVORITE CONCRETE BUILDING OF ELISABETH MARIE-VICTOIRE



Interior view of the Palais d'Iéna in Paris, designed by Auguste Perret and built in 1937. The rotunda was completed in 1943. Photo: Ana Paula Arato Gonçalves, GCI.

MARIE-VICTOIRE A few years ago, I would have said that it's really just the beginning. Now I think we've got some companies expert in conserving concrete and doing restoration with much less visible patch repairs. As our monuments are listed in France, we have the same rules for any heritage—we have to work to preserve the maximum amount of the original material. We have more and more companies that are involved in developing some expertise in that field, and there's a union, Groupement des entreprises de restauration des monuments historiques [GMH], that gathers companies that are in charge of conservation of historical monuments. This association has been involved in historical conservation since 1960, and now they are working on new guidelines to promote the quality of concrete repair. We've also got another entity in France, whose name is QUALIBAT, which means quality in building, and they award a level of quality to some companies and warrant the quality of the repair. This year they are introducing a new label for concrete repair.

MACDONALD What about architects and engineers? Where are they in terms of their expertise?

MARIE-VICTOIRE In France, it's very specialized work. In fact, the people who are in charge of restoration are architects who specialize in cultural heritage. We have a school, Centre des hautes études de Chaillot, for people who are already architects to get specialized training in cultural heritage and restoration.

Photo: Elena Macchioni, GCI.

We need so much research in the area of corrosion of steel reinforcement in concrete. Corrosion in reinforced concrete is one of the biggest challenges… We're going to be faced with a situation where some of these structures are beyond their structural safety levels and yet still need to be preserved.

ARUN MENON

MACDONALD France has probably one of the most regulated systems anywhere for ensuring quality control in heritage buildings. You've had buildings listed since the 1920s, but it sounds like in recent years there's been a shift to a better-defined community of practice working in this sphere.

MARIE-VICTOIRE It came from the need for repair. We had listed a lot of new cultural heritage, but then these buildings started decaying. With our strong policy of protection of the cultural heritage—and with so many buildings listed—the government in the 1990s decided to engage in research efforts to find solutions. Depending on the level of protection that a building has, the government pays for up to 50 percent of the repair. So the government pushed a bit for the research to find some solutions.

MENON In India we still don't have a full-fledged mechanism to handle modern concrete heritage. We do have a large rehabilitation market, so rehabilitation of concrete buildings and even prestressed concrete bridges and that sort of infrastructure is huge. We have a large number of concrete experts, with researchers and faculty members working in this area. Given that, the engineering approach to rehabilitation—field and laboratory testing, assessment, and repair technologies—is in a rather advanced state. However, when we come to modern concrete heritage, there is a certain disconnect. Many of these approaches and methods cannot be directly applied to rehabilitating buildings of exposed concrete. Conservation architects say, "No, this is not an acceptable approach." Within the ICOMOS scientific community there's a lot of talk today on how to actually rehabilitate these heritage buildings, because many need structural rehabilitation. But most architecture and conservation architecture curricula do not address aspects of material deterioration in concrete, corrosion of steel, and rehabilitation of modern buildings. While it is addressed in the civil engineering and structural engineering curricula, you still need to have specific guidelines for buildings classified as modern heritage. So as of now, the rehabilitation industry is huge, and there's a significant amount of research happening on this subject. But that needs to trickle down and find appropriate approaches for twentieth-century heritage.

A FAVORITE CONCRETE BUILDING OF ARUN MENON

The Golconde, constructed between 1937 and 1942 in Pondicherry, India, and designed by Antonin Raymond and George Nakashima. Photo: Aleksandr Zykov, licensed under the Creative Commons Attribution-ShareAlike 2.0 Generic license.

LEVIN Is any portion of that research being directed toward existing concrete structures?

MENON It is on concrete as a modern material, additives, and corrosion aspects of steel. The research is on how to make concrete more durable, but there is very little research on the preservation of existing concrete structures.

VERDE ZEIN It's quite the same in Brazil. Most of our constructions are in concrete, so we do know how to construct in concrete and how to rehabilitate concrete structures—but not historic or modern concrete. You want to maintain the same historic appearance of a building. This is an important new field, because the structures are getting old. We did not have this problem twenty or thirty years ago, when the buildings were not pristine but you could tolerate their appearance. Nowadays, most of the exposed concrete buildings have fifty, sixty, or eighty years, and they are showing the effects of time. There are some efforts, but they are just beginning. It's really a challenge, because we do have very important historic concrete buildings.

MACDONALD So where does the challenge lie? Education? Government legislation? Research?

VERDE ZEIN Research is very important, because it's a new field. If you want to rehabilitate an exposed concrete building, there will be lots of companies that say they have the expertise. But they really don't, because they don't know how to do concrete repair that doesn't make a patchwork of the appearance. So it is important to make people aware of this issue for research to get done. Another point is that rehabilitation of public buildings is very complicated, because you have to use the lowest price for the work. But you can't treat heritage buildings the way you would any building. Sometimes a building is not officially a heritage building, but it still should be treated as one with respect to its appearance. Sometimes the people who take care of these buildings do nothing, because they are constrained by the necessity of doing things legally. So there is the legal aspect, there is the research aspect, and there is making more public these problems that need to be addressed.

MACDONALD Would you say that professionals don't have a clear understanding of what good practice looks like?

VERDE ZEIN Yes, in Brazil at the moment we don't quite have the people who specialize and really have the expertise. And sometimes owners of a building don't do the rehabilitation, because it's more expensive to do better rehabilitation.

MARIE-VICTOIRE I think the first issue is probably public attitude. People much prefer to put money into the restoration of major cathedrals than into twentieth-century concrete heritage. And I agree that because concrete is a modern material, research is one of the main challenges. It's quite distinct from stone construction. At the moment, we really need research to improve the knowledge of concrete from the late nineteenth century to the late twentieth century. These are complicated materials, and we won't be able to repair them all using exactly the same material. In France there is also a big market for rehabilitation, while conservation and restoration are still a niche market. There has not been much developed at the moment, because it would be too expensive for so small a market. But there is a need for new research to improve the quality of repairs. And training is an issue. We need to train practitioners to improve the quality of the work. If we have the best material to use for repair but not the know-how, then the repair will fail.

MENON I would echo all those concerns. The four pillars that have to be addressed are legislation, training and education, research and development, and public outreach. I think it's the same across the world. We need so much research in the area of corrosion of steel reinforcement in concrete. Corrosion in reinforced concrete is one of the biggest challenges, even for modern infrastructure. The type and the quality of concrete that we largely use today are even more prone to corrosion. The quality of construction is another important parameter. So repair of reinforced concrete is a big challenge and requires economical and feasible techniques. Today there are techniques that can mitigate corrosion, but they're far too expensive and invasive. In another twenty to thirty years, modern concrete heritage is going to be that much older, and we will really have a problem on our hands, particularly when the steel reinforcement that's so important for structural performance loses significant tension capacity. We're going to be faced with a situation where some of these structures are beyond their structural safety levels and yet still need to be preserved. This is a big challenge for engineering research and development.

MACDONALD I think France still sustains a model where you have strong government leadership, and government funding and support for research and raising the level of the profession. But that's a model that's disappearing—and even in France, government is giving less support. What do we do when government is no longer leading by example?

MARIE-VICTOIRE In France there is a strong policy of protection, and the government twenty-six years ago did initiate research on the conservation of concrete. But clearly at this moment, as in many other countries, there is a lack of funding even though the government remains very interested in concrete. What we're finding with research is that we need to work together with other countries and share our experiences. Practice is different in different places, and we have to learn from each other. Research must be multidisciplinary and multicountry, and the funding should now be worldwide, rather than local. And we may be able to raise money through the rehabilitation market. People want rehabilitation to be as good as the restoration. They want it to be beautiful, not just functional. So the rehabilitation market may have some new solutions for the restoration market. I certainly hope so.

MENON We are also moving towards a model where the government funding is tapering off, and we have to live with that. But a lot of public-private partnerships are happening with the introduction in the last decade of corporate sector responsibility—CSR funding. For example, the Archaeological Survey of India is looking at companies "adopting monuments" and then working with them on appropriately investing in conservation and site management. That does not take away the importance of legislation and enforcement, mechanisms that lie solely with the government. Even in institutions like ours, the Indian Institutes of Technology [IIT], we are seeing research funding today coming more from industry than from government. And that actually helps achieve public outreach, while sustaining research at the same time.

MARIE-VICTOIRE When I mentioned the research that began twenty-six years ago, it was within a framework of an association named Cercle des partenaires du patrimoine, initiated by the French government, which gathers industrial funding and cement industry expertise as well as public scientific expertise to produce research on conservation of historic concrete. So the story began with that, and it probably will be the future, because research needs funding.

MACDONALD So working with industry not only helps us do the research but also has the benefit of working in a more integrated way, perhaps from the beginning.

MARIE-VICTOIRE We don't count only on industry's own development—they're also sponsors for further research. That's what we've done in France for many years now.

LEVIN Training has been noted as an area of need. What training initiatives or institutions currently exist in your country, if any at all?

MARIE-VICTOIRE As I mentioned, there is a graduate school for architects—Centre des hautes études de Chaillot, created in 1887—which is the highest level that you can reach for architects in charge of cultural heritage. But there is also the Institut National du Patrimoine, under the auspices of the French Ministry of Culture, which does training for conservators-restorers-historians, and we do some training for university master's degrees in heritage and environments, and for an engineering school. So there are several levels of training in France. At the moment, what we maybe need the most are conservators-restorers for ornaments. In concrete we not only have some walls to repair—we also have sculptures and windows to repair. In that field, we don't have enough experts. We are doing some training, but there are very few people who want to work on concrete.

MACDONALD What about training in this area for engineers and contractors?

MARIE-VICTOIRE We are doing some training at the university master's level and at a school for engineers, but the market is not big enough to train people. When we train students, we want them to have work at the end. At the moment, there aren't enough jobs. The market is still too small. In fact, when you talk about our schools for architects, those architects working on cultural heritage are working much more on stone architecture than concrete architecture.

VERDE ZEIN In Brazil there are some postgraduate courses, but they include all areas—from brick to stone to concrete. The most traditional courses that we have for architects on the conservation of cultural heritage do not necessarily cover concrete—or it's just one of the subjects. As Elisabeth said, if the market is not asking for this kind of specialist, it's pointless to do the training. That's why I believe it's important to make people more aware of concrete heritage so that there is greater interest in it.

MENON In India in the last five years, we have almost a dozen master's-level programs in architectural conservation that have come up. Within those programs, people are talking about twentieth-century heritage and concrete as a material to preserve, but not so much about processes for structural repair and rehabilitation. On the other hand, within the engineering programs, there are very few master's-level programs on building rehabilitation itself, because jobs are not something you can easily get if you are superspecialized in building rehabilitation. Though the market is growing, it's not a big sector yet. We don't see master's-level programs in building rehabilitation coming up. Even our institution junked the idea of starting a program on structural conservation for the time being, because it's not something that will get our students jobs. Having said that, clearly there are gaps in academic programs that need to be addressed, but we'll have to see how the market, academia, and R & D all work together to take this forward in a sustainable manner. Embedding specific courses on the subject within mainstream architecture and civil engineering curricula could be one path. Again, we have skill development programs for construction labor—civil, electrical, and mechanical—but very few for artisans and masons working on conservation of heritage structures, and none for the twentieth-century concrete heritage.

MACDONALD Another thing all of you mentioned was research. Arun, it sounds like in India there isn't really any research happening in this area—that you know of as yet.

MENON I won't say there's widespread research, but at IIT Madras in the last few years we've had an increase in the number of students and researchers interested in the subject. One example of research is our work on the massive Presidential Palace—Rashtrapati Bhavan—in Delhi, designed by Lutyens. It has this long series of sunshades, the largest of which is a two-meter cantilever, which run for about five hundred meters around the building. These were meant to be constructed in sandstone according to Lutyens's original design, but possibly because of the difficulty of getting so much stone to make the cantilevers, and the paucity of time, they ended up making them in reinforced lime concrete. Now, after over eighty years, with all the lime carbonated, you have massive corrosion in the steel reinforcement of the sunshades in a very important building. You've got spalling and concrete cover falling off from a height of fifty feet. So we went through a couple of years of serious research on the subject of steel sitting in lime concrete, and we just completed a pilot project on ten meters of the sunshade. We put in place a protection system and now have six months of monitoring data. We're comparing four different techniques against each other, and a couple of them are very promising. So this is interesting research on corrosion protection in lime concrete.

VERDE ZEIN I know some architects and engineers researching modern concrete structures, but it's mostly historical research—how these buildings were constructed and the condition they are in today. But it's mostly academic, and not about what to do with them.

MARIE-VICTOIRE We have three main aspects of research in France. First is identification. We are just beginning a new project researching the cement industry in the nineteenth century in the north of France, as we already did in the Grenoble and Marseille areas, which were the cradles of the cement industry in France. The second aspect has to do with diagnosis and the main pathology—corrosion of the rebars. We're working on new nondestructive testing but also

Photo: courtesy of Ruth Verde Zein.

> These buildings are very interesting because they are very experimental. And that's their problem. People tried things that had never been tried before, and that's why the problems arose… The buildings deserve to be preserved as a reflection of that daring moment.
>
> RUTH VERDE ZEIN

on monitoring, including new sensors that could be put inside the concrete to monitor for warning signs. And the last aspect is repair. We've worked a lot on migrating corrosion inhibitors and realkalisation treatments, and at the moment we're focusing on hydrophobic treatments and cathodic protection. Some of the research is nationally instituted, but some we need to share with other countries. We can't work on such an advanced field alone. We need to open our doors and see what's happening in other countries. There is some specific research in concrete happening in the United States, England, Spain, and Italy. So research is going on in several places.

LEVIN A final question. We started at a micro level with each of you talking about a concrete building that meant a lot to you. Now I'd like to go macro and have each of you characterize what you see as the value of our modern concrete built heritage. If you were trying to explain to the public why we should care about this heritage, what would you say?

VERDE ZEIN These buildings are very interesting because they are very experimental. And that's their problem. People tried things that had never been tried before, and that's why the problems arose in recent decades. I like the boldness of these structures, but we can't do some of those things any longer because we are too aware of the consequences. At the time these buildings were designed and built, those who built them were not aware of the consequences. They were trying to do good things and go beyond what had been done previously. It was a very important moment, and the buildings deserve to be preserved as a reflection of that daring moment—even if it is to learn about the mistakes. And the mistakes were huge. But people love these buildings. The example I give is the Museum of Art in São Paulo, which is the most iconic building in my city at the moment. It's the place where all the political stuff and cultural things happen. You have to preserve this building because it's beautiful, it's daring, it's important, and last, but not least, it was designed by a woman—Lina Bo Bardi.

MENON Many of these buildings mark important evolutions in the use of reinforced concrete and the use of prestressing in concrete, and so on. I think the public will buy that these are important landmarks in the evolution of a country and in the engineering and the architectural character of a country. After 1947 when the British left, India was an impoverished country. During the postindependence era, India really didn't have resources, but nevertheless you see a kind of infrastructure growth that reflected national pride, as Indians handled these massive projects. There were a large number of these marvelous examples of human spirit that translated into infrastructure and mushroomed all over the country—and for those reasons they have to be preserved. Concrete really helped in achieving these aspirations—the evolution of engineering, architecture, and materials, and this postindependence spurt of infrastructure construction.

A FAVORITE CONCRETE BUILDING OF RUTH VERDE ZEIN

The Santa Paula Iate Clube in São Paulo, designed by João Batista Vilanova Artigas and Carlos Cascaldi, and constructed between 1961 and 1965. Photo: courtesy of the FAUUSP Library Collection.

MARIE-VICTOIRE I agree with Ruth and Arun. I think the innovation in the industry is an important justification for their preservation, but there are cities that won't see that as a fair reason. The other reason is that this innovation has enhanced creativity in architecture—it's raised new types of buildings and some architecture that is very different. The main challenge is to change the image that citizens have in their head of a concrete building, which is that of a car park where they park their car every week when they go to the marketplace. We have to show them beautiful examples of concrete buildings, of which we have a lot, including some with very beautiful sculptures and windows. We have beautiful concrete to show, and with those we could change people's points of view.

RESOURCES **CONSERVATION OF CONCRETE**

RESOURCES & ORGANIZATIONS

American Concrete Institute.
http://bit.ly/31MUIfx

American Concrete Institute Committee ACI 563-18: *Specifications for Repair of Concrete in Buildings, Reported by ACI Committee 563* (2018), Farmington Hills, MI: American Concrete Institute.

The Association for Preservation Technology International: *Practice Points 13: Data Interpretation and Early Corrosion Test Program for Historic Concrete Buildings* by Gina Crevello (2015), Springfield, IL: APTI. (PDF) http://bit.ly/2ZeP4B4

The Association for Preservation Technology International: *Practice Points 16: Assessment of Historic Concrete Structures* by Ann Harrer and Paul Gaudette (2017), Springfield, IL: APTI. (PDF) http://bit.ly/2Zg3vF8

British Standard Institution BS EN 1504-10: *Products and Systems for the Protection and Repair of Concrete Structures: Definitions. Requirements. Quality Control and Evaluation of Conformity*. Parts 1 to 10 (2017), London: British Standard Institution.

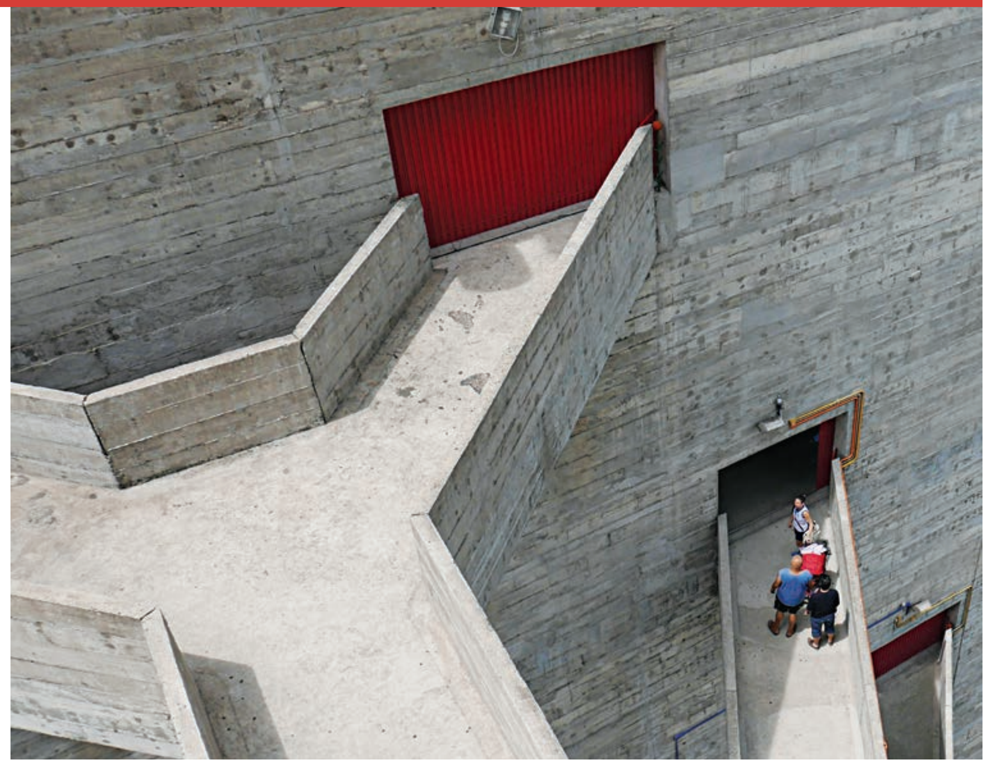
Getty Conservation Institute: *Concrete Conservation*. http://bit.ly/2ZmZ9jS

Getty Conservation Institute: *Conserving Modern Architecture Initiative*.
http://bit.ly/conserving-modern-architecture

ICOMOS International Committee on Twentieth Century Heritage: *Approaches to the Conservation of Twentieth-Century Cultural Heritage: Madrid-New Delhi Document* (2017). (PDF) http://bit.ly/2MonWhl

International Concrete Repair Institute: *Concrete Repair Terminology* (2015), Saint Paul, MN: ICRI. (PDF) http://bit.ly/33Mc6Tl

National Park Service, US Department of the Interior: *Preservation Briefs 15: Preservation of Historic Concrete* by Paul Gaudette and Deborah Slaton (2007).
(PDF) http://bit.ly/30f8zeo



Detailed view of walkways at the SESC Pompéia in São Paulo, which first opened in 1982 and was designed by Lina Bo Bardi. Photo: Chandler McCoy, GCI.

BOOKS & JOURNALS

APT Bulletin: The Journal of Preservation Technology 48, no. 1: Special Issue on Concrete (2017).

Concrete and Culture: A Material History by Adrian Forty (2016), London: Reaktion Books Ltd.

Concrete: Building Pathology, edited by Susan Macdonald (2003), Oxford, UK: Blackwell Science.

Concrete: Case Studies in Conservation Practice, edited by Catherine Croft and Susan Macdonald with Gail Ostergren (2019), Los Angeles: Getty Publications.

Concrete Repair and Maintenance Illustrated by Peter H. Emmons (1993), Kingston, MA: RS Means.

Concrete Repair Manual, 4th ed., by American Concrete Institute and the International Concrete Repair Institute (2013), Farmington Hills, MI; St. Paul, MN: American Concrete Institute and International Concrete Repair Institute.

Conserving Concrete Heritage: An Annotated Bibliography, edited by Alice Custance-Baker, Gina Crevello, Susan Macdonald, and Kyle Normandin. (2015), Los Angeles: Getty Conservation Institute.
(PDF) http://bit.ly/2KJJsuV

Historic Concrete in Scotland, Parts 1–3 (Short Guide 5) by Dennis Urquhart (2013), Edinburgh: Historic Environment Scotland. (PDF) http://bit.ly/2ZaEvPt

Practical Building Conservation: Concrete (English Heritage), edited by David Odgers (2012), London: Ashgate Publishing, Ltd.

Raw Concrete: The Beauty of Brutalism by Barnabas Calder (2016), London: William Heinemann.

"Reinforced Concrete" by Amy E. Slaton, Paul E. Gaudette, William G. Hime, and James D. Connolly, in *Twentieth-Century Building Materials: History and Conservation*, edited by Thomas C. Jester (2014), Los Angeles: Getty Conservation Institute, 61–70.

For more information on issues related to conservation of concrete, search **AATA Online** at **aata.getty.edu/home/**

GCI News

Part of the June 19, 2019, ceremony rededicating the Church of Kuñotambo, seen in the background. Photo: Anna Flavin, GCI.

Project Updates

CONSERVATION OF THE CHURCH OF KUÑOTAMBO

In June 2019 the Getty Conservation Institute, in partnership with the Dirección Desconcentrada de Cultura de Cusco (DDC-C), announced the results of a ten-year collaboration to seismically retrofit and conserve the Church of Kuñotambo—a seventeenth-century earthen building in Peru—as part of the GCI's Seismic Retrofitting Project (SRP). The church was rededicated at a June 19 event celebrating the project's completion. It was attended by Peru's vice-minister of culture, the bishop of Cusco (the city nearest to Kuñotambo), the director of the DDC-C and other DDC-C officials, several local authorities, and James Cuno, president and CEO of the J. Paul Getty Trust, as well as staff of the GCI's Buildings and Sites department responsible for management of the project. The day included a special mass, a rededication ceremony, and presentation of a handmade Peruvian cape for the patron saint of the town, Santiago Apóstol, from the Getty.

Earthen architecture is among the oldest and most prevalent building types in the world. Buildings made with earthen materials can be extremely vulnerable to earthquakes and subject to sudden collapse during seismic events, especially if poorly maintained. The SRP began in 2009 as part of the GCI's Earthen Architecture Initiative and grew out of years of GCI research into the seismic strengthening of earthen buildings. The objective of the SRP is to adapt high-tech retrofitting techniques to better match the equipment, materials, and technical skills available in many countries with earthen structures. The work at the Church of Kuñotambo is not valuable only to its community; it also advances ways earthen buildings around the world can be protected from the destructive effects of earthquakes.

The first phases of the SRP included identification and assessment of four prototype buildings in Peru representative of typologies across Latin America, as well as laboratory testing, in situ testing, and numerical analyses of the four selected structures. The project, now in its final phase, includes the design and implementation of retrofitting and conservation measures at two of the prototypes—the Cathedral of Ica and the Church of Kuñotambo. The seismic retrofitting techniques developed for these historic buildings can be applied to similar structures in the region and elsewhere in order to make them more seismically safe.

Interior view of the Church of Kuñotambo, following seismic strengthening and wall paintings conservation. Photo: Anna Flavin, GCI.

The Church of Kuñotambo—the most prominent building in the Comunidad Campesina Kuñotambo, a remote Andean village southeast of Cusco—has been in continuous use since its original construction in 1681. It was built with thick mud brick walls and buttresses over a rubble stone masonry foundation and a wood-framed gable roof. The church interior features beautifully executed wall paintings depicting saints as well as other figurative and geometric motifs.

Despite its historic and artistic significance, the church was in a fragile state in 2009 when the GCI began collaborating with the DDC-C. The structural performance of the building was severely compromised by a leaking roof, inadequate or broken connections of the roof framing, the loss of several exterior buttresses, and settlement of the foundation, which caused walls to lean and separate from the main structure.

A program of engineering assessment and study began in 2011, conducted by the GCI and consultants from the Lima-based Pontificia

Universidad Católica del Perú (PUCP) and the Universidade do Minho in Portugal. These studies aimed to identify the properties of the building materials and construction systems to help create accurate models of the building's behavior during an earthquake.

Based on the modeling, a design for retrofitting was proposed, which used local materials and techniques to stabilize and strengthen the structure. In conjunction with this work, wall paintings conservators began an in-depth study and program of testing and stabilization to protect the site's wall paintings during construction.

Retrofitting included strengthening the church's foundation, reconstruction of supporting buttresses, and the installation of timber ring beams, corner keys, and roofing. The church's gilded eighteenth-century altar was also conserved, in addition to sculpture and other artworks. Final conservation of the wall paintings and finishing of the exterior was completed in spring 2019.

The Kuñotambo project received support from the GCI Council and Friends of Heritage Preservation.

The Eames House in Pacific Palisades, the day of an April 10, 2019, event celebrating the adoption of a conservation management plan by the Eames Foundation. Photo: Andrzej Liguz, for the GCI.

MANAGEMENT PLAN FOR EAMES HOUSE

In April 2019 the GCI and the board of the Eames Foundation held an event at the Eames House to celebrate the completion of a conservation management plan (CMP) for the house and its adoption by the board.

Lucia Dewey Atwood of the Eames Foundation, and Edgar Garcia, representing the Mayor's Office of Los Angeles, at the Eames House event. Photo: Andrzej Liguz, for the GCI.

A CMP is a document that evaluates and identifies the cultural significance of a specific place and presents policies that can ensure it is managed and conserved in a way that protects and enhances its significance. Earlier in the year, the GCI's Conserving Modern Architecture Initiative team finished work on the CMP for the Eames House, an iconic work of modern architecture located in Pacific Palisades, California, and completed in 1949. Designed by Charles and Ray Eames, it was their home for thirty years and is now operated by the Eames Foundation as a house museum. The GCI has worked with the Eames Foundation since 2012 to provide technical support for their efforts to conserve the house.

In addition to the management plan, the GCI has partnered with the Eames Foundation on a variety of conservation projects at the site, so the April event also marked a milestone in finalizing the initial phase of work. Members of the local and national press attended, as well as representatives of Los Angeles Mayor Eric Garcetti's office, who presented the GCI and the Eames Foundation with a Certificate of Congratulations to mark the completion of the CMP.

In July the Eames Conservation Management Plan was awarded a Preservation Design Award from the California Preservation Foundation.

MOSAIKON BYBLOS

In collaboration with the Directorate General of Antiquities (DGA) of Lebanon and the ICCROM-ATHAR Regional Conservation Centre in Sharjah, United Arab Emirates, the GCI conducted an international training course in Byblos in the conservation of in situ mosaics from March 26 to April 26, 2019. The course—which included six DGA employees and six government employees from Jordan, Libya, and Palestine—was developed primarily to provide supplemental training for practitioners who had received previous training in the conservation of lifted mosaics in museums as part of the MOSAIKON initiative.

The course, hosted by the Regional Center for the Restoration and Conservation of the Lebanese Heritage in Byblos, consisted of classroom lessons and supervised practical exercises on one of the few remaining in situ mosaics left at the site; it was delivered by an international team of conservators, including

Technician training at the site of Byblos, Lebanon, in spring 2019. Photo: Thomas Roby, GCI.

university teachers. The conservation technician trainees were instructed in a methodology developed by the GCI for documenting mosaics, and in techniques for conserving mosaics in situ using lime mortars to stabilize them. They were also taught how to carry out preventive conservation measures, such as reburial and drainage of mosaics.

Each trainee was provided GCI training handbooks in Arabic and in either English or French, as well as tool kits for mosaic documentation and conservation treatments. Plans are underway for a second training work site in Lebanon in 2020, focused on the conservation of mosaics in storage.

CONSERVATION OF NEA PAPHOS

In June 2019 GCI staff conducted a three-week field campaign to continue work on a master plan for the site of Nea Paphos in Cyprus. During this time, site mapping was conducted, which entailed the laser scanning of all underground areas of the main archaeological park and the Hellenistic necropolis of ancient Paphos. The necropolis, known as the Tombs of the Kings, consists of impressive rock-cut tombs with a peristyle atrium and burial chambers. Drone photography of the site was also completed, as was terrestrial photogrammetry of the sheltered mosaics. In addition to the mapping, progress was made on developing the site geographic information system; both are being carried out by the Carleton Immersive Media Studio of Carleton University, Ottawa.

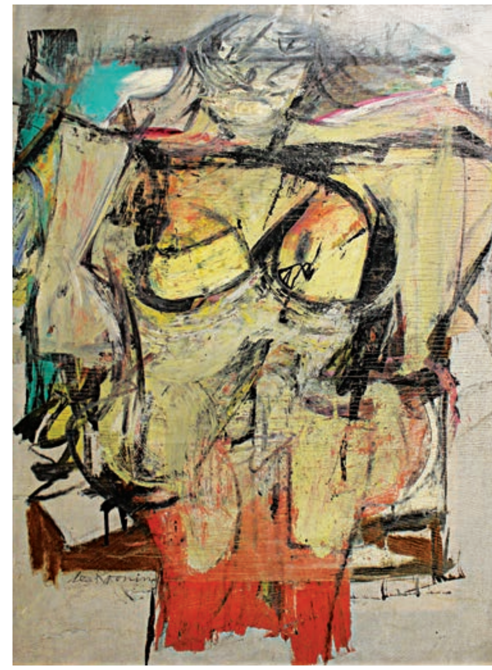
Moreover, an environmental monitoring system was installed by Tobit Curteis Associates for gathering data related to temperature, wind, and rainfall—data that will be used to help design a protective shelter for the site. This is the next step in the process to develop a prototype shelter that can protect the site's most significant mosaics. In early April an experts meeting was held in Paphos to define the shelter's design and performance criteria, and to identify areas where more information is required. The need for environmental monitoring was one of the areas identified.

CONSERVING DE KOONING'S *WOMAN–OCHRE*

A conservation project focused on a painting by Willem de Kooning that had been missing for over three decades was begun this spring at the Getty.

In 1950 de Kooning, a pioneer and leader of the abstract expressionist movement, began his best-known body of work, the Woman series. A painting in the series, *Woman-Ochre* (1954–55), was gifted to the University of Arizona Museum of Art (UAMA) in Tucson in 1958 by collector Edward Joseph Gallagher Jr. and was regularly exhibited at UAMA, as well as loaned to important exhibitions on de Kooning.

In 1985 *Woman-Ochre* was stolen from UAMA, and it remained missing until August 2017 when antiques dealer David Van Auker purchased a group of items including the painting at a posthumous estate sale of an Arizona couple. While the painting was displayed in his New Mexico store, several customers commented on its resemblance to de Kooning's work, prompting Van Auker to research the artist and connect the painting with the 1985 theft. Van Auker contacted UAMA staff, who retrieved the painting and brought it back to the museum. Despite the painting's discovery, the theft remains unsolved, and the FBI investigation into who stole the painting continues.



***Woman–Ochre* in August 2017**, shortly after it was recovered in New Mexico and returned to the University of Arizona Museum of Art. *Woman–Ochre*, 1954–55, Willem de Kooning. Oil on canvas, 30 x 40 in. © 2019 The Willem de Kooning Foundation / Artists Rights Society (ARS), New York.

Badly damaged during the theft and from its decades-long disappearance, *Woman-Ochre* now needs professional care. Through an agreement with the University of Arizona, conservators at the Getty Museum and scientists at the Getty Conservation Institute are working together to study, repair, clean, conserve, and document the painting. This work includes reuniting it with the original frame and repairing and restoring remnants of the canvas that were left behind after the theft. The Getty–University of Arizona project will also be a teaching opportunity, providing access and information to graduate-level conservation and science students at local universities, as well as those from the University of Arizona. The GCI's analytical work on *Woman-Ochre* is being carried out as part of GCI Science's research on modern paints, a project of its Modern and Contemporary Art Research Initiative.

View of the archaeological site of Paphos in Cyprus. Photo: Carleton Immersive Media Studio, for the GCI.

The Getty and the GCI are well versed in the work of de Kooning. In 2010 the GCI worked closely with Susan Lake, then head of Collection Management and chief conservator at the Hirshhorn Museum and Sculpture Garden in Washington, DC, on an in-depth study of de Kooning's paintings from the 1940s through the 1970s, published by the Getty as *Willem de Kooning: The Artist's Materials*.

The *Woman-Ochre* project began in April 2019 and is expected to take approximately a year and a half. In summer 2020 the painting will go on view temporarily at the Getty Museum before returning to its home at UAMA.

A session of the Introduction to Conserving Modern Architecture Short Course, held in May 2019 at the GCI. Photo: Ana Paula Arato Gonçalves, GCI.

Recent Events

INTRODUCTION TO CONSERVING MODERN ARCHITECTURE SHORT COURSE

In May 2019 the Conserving Modern Architecture Initiative (CMAI) of the GCI hosted a three-day introductory course for midcareer professionals on the topic of conserving modern built heritage. This was the second year this course was offered, and it is intended for architects, conservators, and others working in the field of historic preservation who are interested in learning about conserving works of modern architecture, which is a small but growing area of practice. This year, the class of twenty-five represented seven countries from around the world. GCI staff and outside instructors in private practice taught the course. The curriculum included lectures and labs, a site visit to the Eames House, and interactive exercises. The CMAI plans to offer this course again in the spring of 2020.

Upcoming Events

SCHOLAR APPLICATIONS NOW AVAILABLE

The Conservation Guest Scholar program provides an opportunity for conservation leaders to pursue research that advances conservation practice and contributes new ideas to the field. Successful candidates are in residence at the Getty Center for periods of three, six, or nine months and are chosen by a professional committee through a competitive process.

Instructions, application forms, and additional information are available online in the "How to Apply" section of the Getty Foundation website. The 2020–21 Conservation Guest Scholar program application deadline is November 1, 2019. For inquiries contact: gcischolars@getty.edu.

2019–20 GUEST SCHOLARS

Anica Draganíc
University of Novi Sad, Serbia
"Preserving the Industrial Past"
September 23–December 13, 2019

W. Brent Seales
University of Kentucky, Lexington
"Conservation as Data Science: Digital Restoration, Virtual Unwrapping, and the Quest to Read the Invisible Library"
September 23, 2019–March 27, 2020

David Gole
University of Queensland, Brisbane, Australia
"Heritage Manual for the Conservation of African Modernist Buildings and Structures"
January 6–March 27, 2020

Silvia Fernández Cacho
Andalusian Historical Heritage Institute, Seville, Spain
"Cultural Landscapes Recording and Documentation: Theories, Methods, and Techniques"
April 6–June 26, 2020

Susanna Caccia Gherardini
University of Florence, Italy
"Villa Savoye Restoration Works (1965–2020): A Case Study to Investigate Theories, Methodologies, and Techniques for the Preservation of Modern Architecture"
April 6–June 26, 2020

John Hughes
University of the West of Scotland, Paisley, United Kingdom
"Microscopy of Historic Building Materials: Theory, Practice, and Education"
April 6–June 26, 2020

Irma Passeri
Yale University Art Gallery, New Haven, Connecticut
"The Value of Losses in Works of Art"
April 6–June 26, 2020

GRADUATE INTERNSHIP PROGRAM

Applications are being accepted for the 2020–21 Getty Graduate Internship program. These internships are full-time positions for students who intend to pursue careers in fields related to the visual arts. Programs and departments throughout the Getty provide training and work experience in areas including curatorship, education, conservation, research, information management, public programs, and grant making.

The GCI pursues a range of activities dedicated to advancing conservation practice, to enhance the preservation, understanding, and interpretation of the visual arts. Twelve-month internships are available in the GCI's Collections, Buildings and Sites, and Science departments.

Instructions, application forms, and additional information are available online in the "How to Apply" section of the Getty Foundation website. For further information, contact the Getty Foundation at gradinterns@getty.edu. The application deadline is November 1, 2019.

2019–20 GRADUATE INTERNS

Xinying Hao
Wuhan University, China
Characterization of Asian and European Lacquers

Gayathri Hegde
Heritage Matters, India
Earthen Architecture Initiative / Seismic Retrofitting Project

Sophie Kirkpatrick
École Nationale Supérieure des Arts Visuels de La Cambre, Belgium
Cleaning of Wooden Gilded Surfaces

Janine Koppen
Hochschule für Technik und Wirtschaft, Berlin, Germany
Modern and Contemporary Art Research Initiative / Preservation of Plastics

Olivia Kuzio
Rochester Institute of Technology, United States
Collections Research Laboratory / Technical Studies Research

Luciana Murcia
Universidad del Museo Social Argentino, Buenos Aires, Argentina
Preservation of Plastics / Disney Animation Cels

Marie Pype
Katholieke Universiteit Leuven, Belgium
MOSAIKON

Wendy Rose
The Courtauld Institute of Art, United Kingdom
Conservation of Wall Paintings / Bagan and Nefertari

Valerio Sabbatini
Università degli studi Roma Tre, Italy
Bagan Documentation and Structural Monitoring

Caitlin Spangler-Bickell
Museo delle Culture, Italy, and Universiteit Maastricht, Netherlands
Managing Collection Environments Initiative

TERRA 2021 WORLD CONGRESS

The Getty Conservation Institute—in partnership with the National Park Service's Vanishing Treasures Program and the University of Pennsylvania Weitzman School of Design—is organizing the *Terra 2021 World Congress on Earthen Architecture: Looking Back, Moving Forward* in Santa Fe, New Mexico, to be held June 8–11, 2021.

This will be the thirteenth international conference on the study and conservation of earthen heritage under the auspices of the ICOMOS International Committee on Earthen Architectural Heritage; it will convene specialists in earthen architecture from a range of disciplines and countries.

From July 10 to July 12, 2019, the GCI hosted the first steering committee meeting of international specialists in earthen heritage conservation, to develop the focus, scope, and program of the Terra 2021 World Congress.

Staff Update

KARI JOHNSON RETIRES

After twenty-one years of service to the Getty Conservation Institute, Kari Johnson retired in early May 2019. For nearly her entire tenure at the GCI, Kari was the sole indexer for AATA Online.

Drawing on her wide-ranging proficiency in modern European languages and extensive knowledge of history, art history, and conservation, Kari applied her expertise and curiosity to bring added value and depth to AATA's abstracted sources. In addition to indexing close to three thousand records per year, she worked on many special projects to improve and enhance access and retrieval of new and legacy information, as well as to prepare for large-scale data migrations. Kari also contributed significantly to the conservation thesaurus project, which incorporated and harmonized AATA indexing terms with the Art & Architecture Thesaurus (AAT). Even after the completion of that project, Kari continued to submit hundreds of new candidate terms to the Getty Vocabulary Program's AAT, the Thesaurus of Geographic Names (TGN), and the Union List of Artist Names (ULAN).

Kari will be greatly missed, and her GCI colleagues wish her the very best in her retirement.

Tribute

SHARON CATHER (1947–2019)

Sharon Cather—who along with David Park established the Conservation of Wall Painting Department at the Courtauld Institute of Art in 1985 and who was the Shelby White and Leon Levy Professor of Conservation Studies at the Courtauld when she retired in 2018—sadly passed away in June 2019 after a long illness.


Sharon Cather. Photo: Juana Segura Escobar.

Sharon distinguished herself on multiple levels. From her commitment to teaching and research, to the formation of a talented generation of outstanding professionals, to furthering conservation both intellectually and organizationally, she made major contributions to the field, as well as to the Courtauld, where she was an integral part of creating an international center of excellence in education and research in wall paintings conservation. Sharon educated a generation of highly respected conservation professionals—some of whom went on to become GCI staff and consultants and to work on significant Institute projects. The quality of the Courtauld's graduates was the result of Sharon's engagement with—and commitment to—her students, which included leading the critical site-based field component of the Courtauld program; under her direction, Courtauld students from around the world worked on major conservation projects at sites in Bhutan, China, Cyprus, Egypt, Ethiopia, Georgia, India, Jordan, Malta, Spain, and the United Kingdom. Her contributions to research in conservation were equally respected and significant. Indeed, Sharon helped set the wall paintings research agenda for the conservation field.

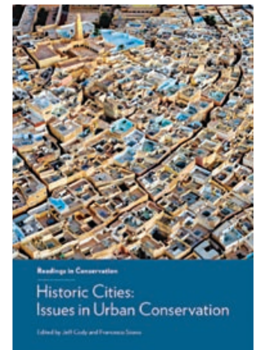
Throughout her career at the Courtauld, Sharon engaged with the GCI in a variety of ways. The establishment of the Courtauld program—in which Sharon played an essential role—was, in fact, the first collaborative training project of the GCI, which cosponsored the first six years of the program. In this period, the Institute's work with Sharon and the Courtauld also included co-organizing a 1987 symposium focused on wall paintings conservation. From September 2000 to February 2001, Sharon was a Conservation Guest Scholar at the GCI, where she conducted research for a book on wall paintings conservation. As an adjunct to the GCI's work at the Mogao Grottoes with the Dunhuang Academy, a degree program in wall paintings conservation was established at Lanzhou University, China—a collaboration with the Courtauld that Sharon directed; in addition, Courtauld students undertook fieldwork at the Mogao site.

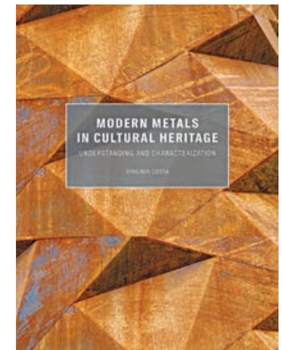
The GCI was one of many conservation organizations with which she was involved. During her career of extraordinary dedication to conservation advancement, Sharon worked closely with a variety of national and international conservation organizations and served for six years on the IIC Council, including a stint as vice president from 2010 to 2014 and as chair of the Technical Committee for both the 2010 IIC Istanbul Congress and the 2012 IIC Vienna Congress. For her work in China, Sharon received in 2014 the People's Republic of China Friendship Award, the country's highest award for foreign experts. For her broad contributions to the field, Sharon was awarded in 2017 the Plowden Medal from the Royal Warrant Holders Association, which cited "her commitment and leadership in research, innovation and education in wall painting conservation" towards "a more holistic, methodical and scientific approach to conserving wall painting across the world—whether in an English cathedral or an Indian palace."

What cannot be easily summed up is the enormous regard, admiration, and comradeship that Sharon engendered from those who were her students, and from those who worked so closely with her over the many decades during which she tirelessly advanced wall paintings conservation in countless ways. Those who learned from her and those who benefited from Sharon's lifetime of efforts on behalf of the field will profoundly miss her friendship. A singular voice in conservation has been stilled.

A conference to celebrate Sharon's life and achievements will be held in York in the United Kingdom, April 16–18, 2020. For further information, please contact David Park at david.park@courtauld.ac.uk.

Print & Online Publications





Historic Cities: Issues in Urban Conservation
Edited by Jeff Cody and Francesco Siravo

This book, the eighth in the Getty Conservation Institute's Readings in Conservation series, fills a significant gap in the published literature on urban conservation. The topic is distinct from both heritage conservation and urban planning. Despite the recent growth of urbanism worldwide, until now no single volume has presented a comprehensive selection of these important writings.

The anthology, profusely illustrated throughout, is organized into eight parts, covering such subjects as geographic diversity, reactions to the transformation of traditional cities, reading the historic city, the search for contextual continuities, the search for values, and the challenges of sustainability. With more than sixty-five texts, ranging from early polemics by Victor Hugo and John Ruskin to a generous selection of recent scholarship, this book thoroughly addresses regions around the globe. Each reading is introduced by short prefatory remarks explaining the rationale for its selection and the principal matters covered.

The book will serve as an easy reference for administrators, professionals, teachers, and students faced with the day-to-day challenges confronting the historic city under siege by rampant development.

Modern Metals in Cultural Heritage: Understanding and Characterization
Virginia Costa

The proliferation of new metals—such as stainless steels, aluminum alloys, and metallic coatings—in modern and contemporary art and architecture has increased the need for professionals who can address their conservation. This volume seeks to bridge the gap between the vast technical literature on metals and the pressing concerns of conservators, curators, and other heritage professionals without a metallurgy background. It offers practical information in a simple and direct way, enabling curators, conservators, and artists alike to understand and evaluate the objects under their care.

This invaluable reference reframes information formerly found only in specialized technical and industrial publications, for the context of cultural heritage conservation. As the first book to address the properties, testing, and maintenance issues of the hundreds of metals and alloys available since the beginning of the twentieth century, it is destined to become an essential resource for conservators, artists, fabricators, curators, collectors, and anyone working with modern metals.

Available for purchase at shop.getty.edu

ONLINE

Advancing Microfading Tester Practice
Vincent Laudato Beltran

In 2018 a select group of scientists and conservators experienced with the microfading tester (MFT) met at the Getty to discuss the current state of the technique and to propose how its practice might be expanded in the cultural heritage field. This publication summarizes the outcomes of their discussion.

Among the topics addressed during the meeting were the technical aspects of MFT, including the range of MFT iterations in use, the conservation field's reliance on the Blue Wool standards and potential issues arising from this reliance, strategies for collecting and interpreting MFT data, and the ways MFT results facilitate communication about lighting policy with museum staff.

The scientists and conservators gathered placed particular emphasis on development of an MFT community of users. This could be achieved through sharing and access to information via training workshops, guidelines, and online didactic material, in addition to regional networks of MFT expertise created through the identification of MFT users around the world.

ONLINE

Seismic Retrofitting Project: Modeling of Prototype Buildings

Paulo B. Lourenço, Federica Greco, Alberto Barontini, Maria Pia Ciocci, and Giorgos Karanikoloudis, in collaboration with Daniel Torrealva and Claudia Cancino

This research report summarizes the methodology and presents the conclusions of the modeling phase carried out by TecMinho, University of Minho, Portugal, as part of the GCI's Seismic Retrofitting Project (SRP).

Between 2015 and 2017, TecMinho studied four prototypes of historic earthen architecture in Peru in their current conditions and in retrofitted configurations. *Modeling of Prototype Buildings* presents the results of this effort, offering advanced numerical modeling approaches for historic adobe structures. The report includes 3-D numerical models of the structures, the characterization of the material properties, and the damage comparison, all of which are based on the visual inspection of the four SRP buildings and the testing program performed by SRP partner Facultad de Ciencias e Ingeniería of the Pontificia Universidad Católica del Perú.

This publication is one in a series from the SRP intended to provide professionals and researchers in the field of structural engineering a methodology for the assessment of historic earthen structures using advanced numerical modeling techniques. Additional reports in the modeling phase are *Recommendations for Advanced Modeling of Historic Earthen Sites* and the forthcoming *Simplified Calculations for the Structural Analysis of Earthen Historic Sites*.

Using four Peruvian buildings representative of typologies of historic earthen construction in Latin America, the SRP combines traditional construction techniques and materials with advanced methodologies to design and test easy-to-implement seismic retrofitting techniques and maintenance programs to improve the structural performance of earthen historic buildings in Peru and other countries in Latin America.

ONLINE

Cleaning of Wooden Gilded Surfaces: An Experts Meeting Organized by the Getty Conservation Institute, March 12–14, 2018

Stéphanie Auffret and Sydney Beall Nikolaus

Wooden gilded surfaces are complex, multilayered, and pervasive in museum collections, on artifacts of different nature and scale, and as architectural elements in buildings such as churches and palaces. In March 2018 the GCI convened an experts meeting to discuss the challenges related to the cleaning of these surfaces. Twelve participants from around the world were invited to share their insights and expertise. This publication is a comprehensive summary of the discussions that took place, covering the current state of the field; options for education on the topic in countries including Australia, Brazil, France, Italy, Spain, the United Kingdom, and the United States; types of cleaning systems; evaluation of these surfaces and the effectiveness of cleaning; and the next steps for advancing this area of the conservation field.

Online publications are available free at getty.edu/conservation.

For more information about the work of the GCI, see getty.edu/conservation and

YouTube

CONSERVATION PERSPECTIVES
THE GCI NEWSLETTER

VOLUME 34 • NUMBER 2 • FALL 2019

The J. Paul Getty Trust
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Tom Learner, *Head of Science*
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Conservation Perspectives, The GCI Newsletter
Jeffrey Levin, *Editor*
Angela Escobar, *Assistant Editor*
Carol Hahn, *Production Assistant*
Picnic Design, *Design*
Graphic Visions, *Lithography*

Conservation Perspectives, The GCI Newsletter is distributed free of charge twice a year to professionals in conservation and related fields and to members of the public concerned about conservation. Back issues of the newsletter, as well as additional information regarding the activities of the GCI, can be found in the Conservation section of the Getty's website, www.getty.edu/conservation.

The Getty Conservation Institute (GCI) works internationally to advance conservation practice in the visual arts—broadly interpreted to include objects, collections, architecture, and sites. The Institute serves the conservation community through scientific research, education and training, field projects, and the dissemination of information. In all its endeavors, the GCI creates and delivers knowledge that contributes to the conservation of the world's cultural heritage.

The GCI is a program of the J. Paul Getty Trust, a cultural and philanthropic institution dedicated to the presentation, conservation, and interpretation of the world's artistic legacy.

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AMERICAN FORESTS

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Geisel Library at the University of California, San Diego, designed by William L. Pereira & Associates. It opened in 1970. Photo: Sara Lardinois, GCI.