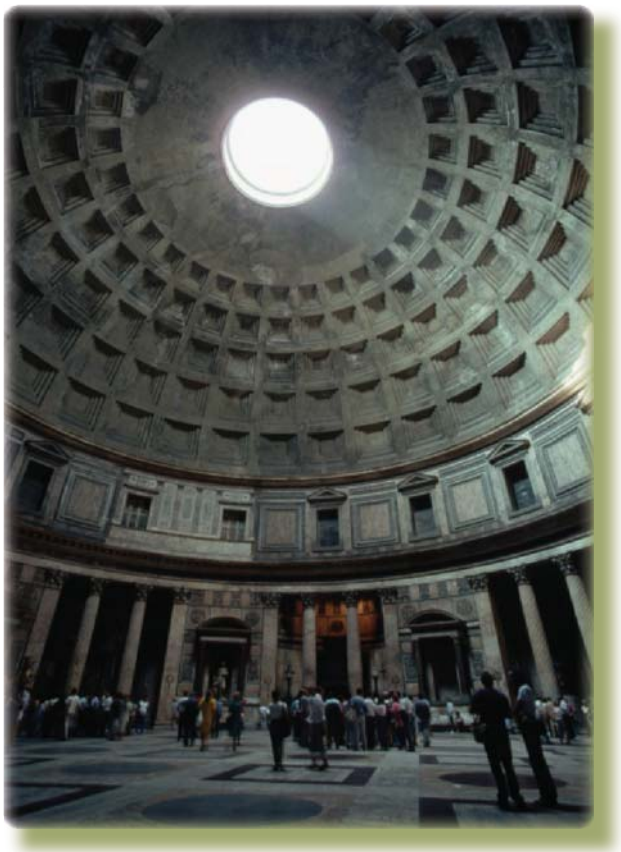
Concrete & Architectural Innovation

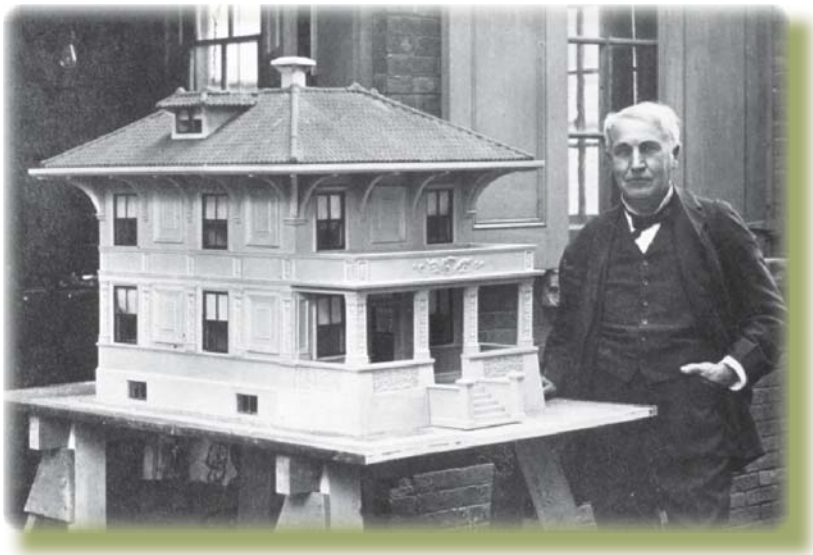
By Martin Moeller

Concrete is by far the most widely used building material worldwide, consumed at an estimated rate of over 5 billion cubic yards per year. It is easily taken for granted as the generic substance of roads, sidewalks, and other mundane elements of infrastructure, or even actively disparaged for its prevalence in countless banal buildings of the mid- to late 20th century. These common views of concrete, however, ignore the prominent role the material has long played in architectural innovation and experimentation. Thanks to its inherent strength, versatility, and almost limitless potential to assume different shapes and textures, concrete today is a vital medium for inventive designers exploring new forms of architectural expression.

The versatility of concrete is a key theme in the exhibition *Liquid Stone: New Architecture in Concrete*, organized by the National Building Museum in Washington, DC. Focusing on nearly 30 recent or current projects from all over the world, the exhibition presents a cross-section of striking buildings in which the use of concrete is an essential aspect of the design. It also examines the ways in which specific technological properties of concrete influence its architectural applications, and presents astonishing products, ranging from fabric-reinforced concrete to translucent concrete, that challenge fundamental assumptions about this ubiquitous building material.



The Pantheon (c.126 C.E.), Rome, Italy. The impressive concrete dome of the Pantheon was made in part with lightweight aggregate, such as pumice, to reduce its weight. With a diameter of 142 feet, it remained the largest dome in the world until the completion of Filippo Brunelleschi's cathedral in Florence 13 centuries later. © Kelly/Mooney Photography/ CORBIS



Thomas Edison with a model of his prototypical all-concrete house (c. 1910). Courtesy of the Portland Cement Association

The Origins of Modern Concrete

Widely regarded as a quintessentially modern material, concrete actually dates back to the ancient Romans, who used it to build the great dome of the Pantheon and other landmark structures. Despite such auspicious beginnings, however, concrete technology was largely forgotten after the fall of the Roman Empire. New developments were virtually nonexistent until the 18th and 19th centuries, when several European inventors secured patents for cement-based materials.

In the 1860s came a pair of apparently humble innovations that, in fact, lay the groundwork for much of modern architecture. A Frenchman, François Coignet, introduced the concept of strengthening concrete with metal mesh to compensate for the material's weakness in tension. Working under the direction of Baron von Haussmann, the famously powerful prefect of Paris, Coignet used this reinforced concrete in a number of infrastructure projects. At about the same time, Joseph Monier,

a French nurseryman, received several patents for concrete flowerpots strengthened by wire mesh.

Yet another Frenchman, engineer François Hennebique, and British-American engineer Ernest L. Ransome, separately patented various techniques and systems that facilitated large-scale concrete construction. Ransome's methods were put to the test in 1902, when the New Jersey plant he designed for the Pacific Coast Borax Company caught fire. Metal machinery in the building melted from the intense heat, but the concrete structure remained intact. This event garnered significant press attention, and helped to make reinforced concrete the preferred material for industrial construction.

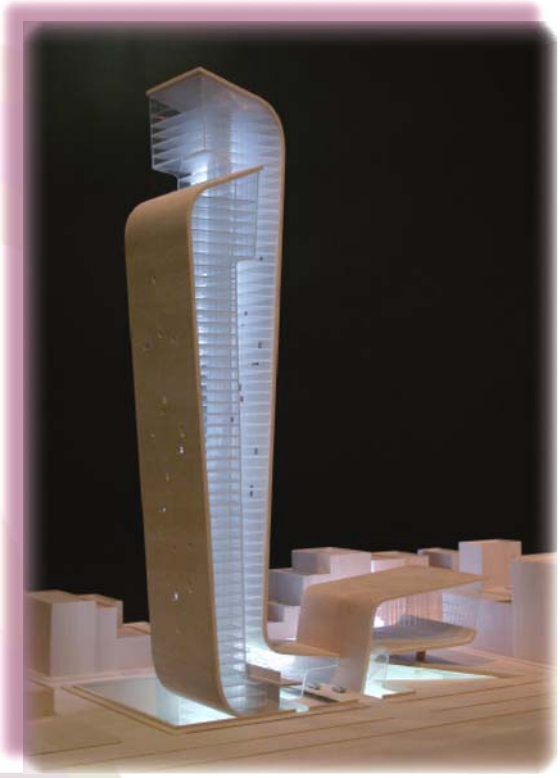
Concrete and the Early Modernists

Inventive architects soon began to exploit the new hybrid material—sometimes called "ferroconcrete"—for non-industrial buildings. Auguste Perret's apartment block on the rue Franklin in Paris (1903), for example, took advantage of the great flexibility afforded by the concrete structural frame to allow large expanses of windows and open interior spaces. Perret's apartment house came as a revelation in an era in which most urban buildings had heavy façades and dense interior structures.

Meanwhile, concrete grain elevators and factories began to dot the American landscape. With their simple forms and "honest" expression of structure, such buildings attracted the attention of early modernist architects eager to overturn historical design and construction methods. Soon, in the hands of architects like Le Corbusier, reinforced concrete became virtually synonymous with modernism. Le Corbusier's prototypical Maison Dom-ino (1915) was a diagrammatic design for a mass-produced housing structure, reduced to the most basic structural elements of concrete columns and floor slabs. This basic scheme resurfaced in some of the architect's later works, such as the Villa Savoye (1930), which is perched on "pilotis," slender concrete columns that lift the main structure off the ground.

The early modernists did not limit their experimentation in concrete to structural systems. Frank Lloyd Wright was among the first architects to appreciate the possibilities of concrete as a surface material. The plain concrete walls of his Unity Temple in Oak Park, Illinois (1908) were shocking at the time, but the building's sculpted concrete columns prefigured some of the architect's later, more overtly decorative work. For instance, Wright developed concrete "textile block," used in such works as the Ennis-Brown House in Los Angeles (1924), which carried finely honed sculptural motifs.

Yerba Buena Lofts (2002); San Francisco, CA: Stanley Saitowitz Office/Natoma Architects, Inc. Photo © Tim Griffith

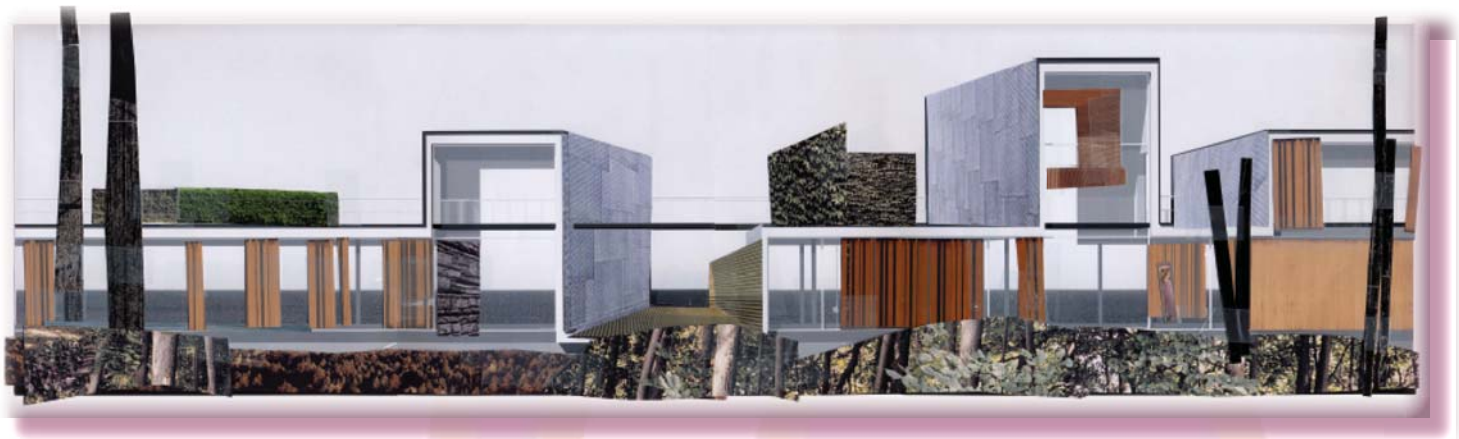


Model of Museum of the 21st Century (proposed), New York, NY; by Hariri & Hariri — Architecture. © Hariri & Hariri — Architecture. Image courtesy National Building Museum

Explorations in Sculptural Form

As early as the 1910s, architects were exploring the potential of concrete as a truly sculptural medium. In 1913, the ancient Pantheon was finally outdone by Max Berg's huge, domed Centenary Hall in Breslau, Germany (now Wroclaw, Poland), whose great concrete ribs allowed for clerestory windows that flooded the space with natural light. By the 1930s, significant developments in the concrete aesthetic were evident. Wright's Fallingwater (1937), for example, considered by many to be the greatest achievement of the architect's long career, relied on concrete for the famous cantilevered balconies that float so elegantly above the landscape.

The Library at the Eberswalde Technical School (1999), in Eberswalde, Germany, by Herzog & de Meuron, uses photoengraved concrete. Image © Margherita Spiluttini



Rendering of the Longitudinal House(s) (proposed), by VJAA, showing the folded concrete band that defines the various spaces of the conjoined houses, and the view to Lake Michigan beyond. Courtesy of VJAA

As the construction industry recovered from the tumult of World War II, designers once again turned to concrete as a vehicle for experimental form. Le Corbusier was influential again, but now in a more expressionistic mode, designing his highly evocative chapel at Ronchamp, France (1955). Expressionism reached new heights in the work of Eero Saarinen, whose two airport terminals—Dulles International (1962) and the TWA Terminal at Kennedy International (1962)—both masterfully exploited concrete forms to suggest the idea of flight.

By the mid-20th century, however, concrete was also becoming closely associated with less spectacular applications. As cities became filled with mundane skyscrapers lining what some called "concrete canyons" (even though many of the towers were primarily made of steel), and poorly maintained housing blocks were degrading the quality of life in urban neighborhoods, the public became disheartened with concrete's role in the "modern" city.

The living area of the Visting Artists House (2002), by Jim Jennings Architecture, showing the inscribed concrete walls by artist David Rabinowitch. Photo by Tim Griffith, courtesty of Jim Jennings Architecture

The Contemporary Era

More recently, sophisticated manufacturing technologies and lessons learned from past experimentation have enabled architects to employ concrete with an unprecedented degree of finesse and skill. Combined with new chemical additives, casting techniques, and construction methods, such advances have solidified concrete's role as the single most versatile building material. In the hands of talented architects and engineers, concrete is once again becoming synonymous with beauty and innovation.

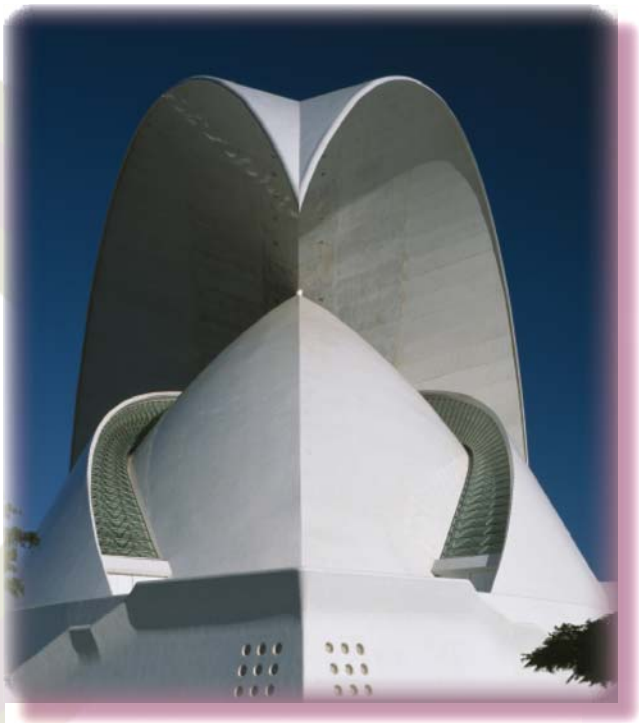
Prototype wall of LiTraCon, a translucent concrete product. Courtesy of LiTra Con, © GmbH

Simmons Hall, for example, a new dormitory at the Massachusetts Institute of Technology, takes advantage of the flexibility of the concrete structural frame to address two challenges. Concerned that the large building would become a barrier between the campus and the community, the architect, Steven Holl, sought to make it visually "porous." He was also eager to provide large, flexible common areas within the structure to encourage informal interaction among residents. Working with engineer Guy Nordenson, Holl devised a complex, three-dimensional concrete grid to carry structural loads at the perimeter, thereby making possible a variety of free-form openings and spaces throughout the building.

The architecture firm of Herzog & de Meuron employed a relatively new technology to lend visual depth to the façades of the Eberswalde Technical School Library in Germany. The building is lined with photoengraved concrete panels, which bear images that are integral to the material's surface. The technique involves placing a chemical in a fine dot pattern (replicating the tonal patterns in the original photograph) on a plastic sheet, which is then placed inside the concrete formwork. The concrete is poured in and allowed to set, and then the formwork and plastic are removed. As the panel is power-washed, the photographic image emerges.

The proposed Vail-Grant House, by Pugh + Scarpa Architects, derives its unusual form both from its steep site in the Hollywood Hills and from zoning restrictions intended to preserve views from a revered early modernist house by Richard Neutra next door. The design calls for a twisted, rectangular tube made of Structural Concrete Insulating Panels (SCIPs)—blocks of plastic insulation and wire mesh to which a concrete surface is applied. Despite the difficult site and the structural contortions dictated by the zoning regulations, the house is being built for a relatively modest budget.

A prototype of a canopy for the Shawnessy Light Rail Transit station in Calgary, Canada, made of an ultra-high-performance concrete called Ductal. Photo courtesy of Lafarge



The stunning, wave-like roof of the Auditorio de Tenerife (2003), in the Canary Islands, designed by Santiago Calatrava, exemplifies the sculptural possibilities of reinforced concrete. Photo by Alan Karchmer for Santiago Calatrava

Concrete and the Future

Since the advent of large-scale reinforced concrete construction roughly a century ago, most basic assumptions about the material's properties and limitations have remained largely unquestioned. Now in development, however, are various concrete products and technologies that challenge such preconceptions. Self-consolidating concrete, ultra-high-performance concrete (which is, in effect, self-reinforcing), and even translucent concrete are several of the most astonishing recent innovations that have the potential to stimulate radically new architecture in the future. By all indications, concrete, in its manifold guises, will continue to be a favorite medium for architectural experimentation and creativity.▪

Martin Moeller, curator of Liquid Stone: New Architecture in Concrete, is currently Senior Vice President for Special Projects at the National Building Museum. Before joining the National Building Museum in 1998, Moeller served as Executive Director of the Association of Collegiate Schools of Architecture, whose members include the faculty of all colleges and universities with accredited architecture programs in the United States and Canada.

Moeller is the author of the fourth edition of the AIA Guide to the Architecture of Washington, DC, scheduled for publication by the Washington Chapter of the American Institute of Architects and the Johns Hopkins University Press in 2006.

Moeller has served as a guest critic at six schools of architecture, and is an associate member of the American Institute of Architects. He is also a member of the Advisory Committee for Skyscraper: Achievement and Impact, a major new exhibition being developed by the Liberty Science Center in New Jersey.