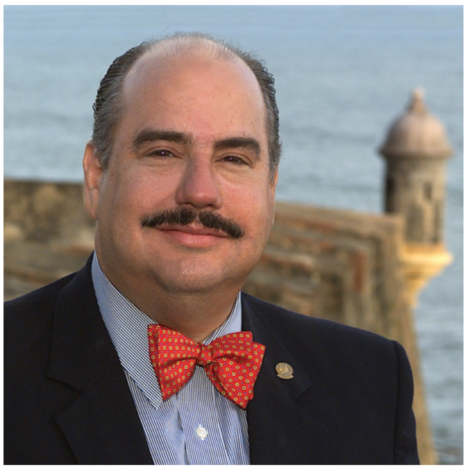
ACI A Century of Progress

Concrete — A Century of Innovation

Supplement to Concrete International



In our recognition of ACI's centennial, we also celebrate the development and growth of the concrete industry. In this first 100 years, ACI has achieved the maturity to feel proud about the progress attained and has the maturity to look forward with confidence to the goals for the next 100.

Globalization and electronic communications make the world smaller every day. It is important to recognize that a worldwide concrete community/industry exists. The mission for each of us is to build a reservoir of knowledge and cooperation to meet and solve the worldwide needs of that community. Concrete can easily be called the best construction material invented by man. For concrete to be recognized and succeed as the prime construction material, we must work together to develop and expand the excellence of our workforce. That workforce includes every single individual and organization involved in making concrete the extraordinary material that it is: students, professors, researchers, technicians, craftsmen, inspectors, materials and product producers, engineers, designers, architects, and even owners. We will need to follow all possible paths so that 100 years from now we will have transformed every goal into an achievement and every hope into history.

—José M. Izquierdo

ACI President 2003

ACI: A Century of Progress

This book is dedicated to the many thousands of American Concrete Institute members who, over the past century, have developed the standards, recommendations, and information that have made concrete the extraordinary material that it is.

ACI: A Century of Progress

BY ROBERT E. WILDE

"When the Institute shall have acquired the venerability that one hundred years of honorable achievement will confer, what a great privilege it will be for its members to review the marvelous progress of the industry in the light of the constructive work shown in the Institute records."

—Richard L. Humphrey
consulting engineer and ACI past president on the occasion of ACI's 20th anniversary, 1924

The history of an organization is a combination of events linking people, ideas, and activities. The American Concrete Institute, and its predecessor, the National Association of Cement Users, were born of ideas—the concept that better concrete for more durable, maintenance-free structures is possible. The American Concrete Institute reflects developments and knowledge within the concrete industry and the field of engineering, while at the same time influences those developments.

Space does not permit covering all aspects of ACI history and its technical efforts, or citing all the "great names" and the many officers, committee members, and innovators who have contributed time and effort so generously to ACI work and industry progress. The Institute owes its growth to many such people.

The Ward House in Port Chester, NY, was recognized by the American Concrete Institute and the American Society of Civil Engineers as a "National Historic Civil and Concrete Engineering Landmark." Built between 1873 and 1876, the house is recognized as the first and oldest extant reinforced concrete building in the U.S. The Ward House was constructed entirely of portland-cement concrete reinforced with I-beams and rods of iron. The structure demonstrated the practicability of reinforced concrete as a construction material for fireproof permanent buildings.

1904-1929: Formation and Growth

Early in the 20th century, a competitive market with a serious lack of standard practice in making concrete block had resulted in conditions unsatisfactory for building with concrete. In the summer of 1904 Charles C. Brown, editor of *Municipal Engineering,* Indianapolis, IN, at the suggestion of A. S. J. Gammon, Universal Concrete Machinery Co., Norfolk, VA, and John P. Given, Cement Machinery Co., Circleville, OH, undertook the formation of an organization to discuss the problem and attempt to bring some order to this expanding use of concrete. An editorial in the September 1904 issue of *Municipal Engineering* publicized the idea and requested suggestions of those interested as to the advisability of forming an association to promote this objective. In only a month, editor Brown declared that "not less than 100 persons expressed the desire to become members."

The hearty response resulted in an informal meeting in October 1904, during the Engineering Congress at the Louisiana Purchase Exposition in St. Louis, MO, held to commemorate the centennial of the U.S. land purchase from France. The original suggestion was to form an association of manufacturers of concrete block machines to educate the users of such machines in the proper methods of making good block, and to alert architects to the "necessity of paying attention to the material of which a building is to be constructed." After the informal meeting, the scope of the organization was extended to cover all the various uses of cement to bring about a better knowledge of the art.

OBJECTIVE ESTABLISHED

In the ensuing months, this trio of enthusiasts was instrumental in arousing interest in a convention dealing with concrete problems, which was held in Indianapolis January 17-19, 1905. A surprisingly large number of people—605—showed up. Of those 605 in attendance, 161 were enrolled as members at $5 annual dues. The society known as the National Association of Cement Users (NACU) was organized with the adoption of a constitution and bylaws.

An exposition at this first meeting of the NACU drew 47 firms, showcasing 21 block-making machines along with other construction equipment and materials. This was so successful that these exhibits were commonplace at NACU conventions in the early days of the association; by 1908, the convention/exhibition drew almost 130 exhibitors. Given was the presiding officer at the Indianapolis session but never held an elected NACU office. It was Given who nominated Richard L. Humphrey of Philadelphia to the president's post. Humphrey went on to hold the position for a decade. While widely known as a railway engineer, Humphrey was also recognized for his standardization activity. Only a few years before NACU came into being, he and others in the Philadelphia area were involved in the formation of the American Society for Testing Materials, now known as ASTM International.

The objective of the new society "to disseminate information and experience upon and to promote the best methods to be employed in the various uses of cement by means of conventions, the reading and discussion of papers upon materials of a cement nature and their uses, by social and friendly intercourse at such conventions, the exhibition and study of materials, machinery, and methods, and to circulate among its members, by means of publications, the information thus obtained," was not materially different from the present aims of the American Concrete Institute.

The varied interests of those present were reflected in the committees appointed to study: concrete block and cement products; streets, sidewalks and floors; reinforced concrete; art and architecture; testing of cement and cement products; machinery for cement users; fireproofing and insurance; and laws and ordinances. One of the

George Barrett detailed the 1853 construction of a concrete house in Spring Valley, OH, in his book entitled *The Poor Man's Home and the Rich Man's Palace or the Application of the Gravel Wall Cement to the Purposes of Building*. In the book's introduction, Barrett wrote: "The object of the writer of these few pages is, to add his own brief testimony to that of a few others (and but few there are) that this point had its consummation in a new discovery, which is scientifically based upon the cement, or concrete principles, of a material for the walls of buildings, composed of gravel, sand, and lime. And this I do under the full conviction, that it will be of essential service to all who may take this little volume in hand, and adopt the plan of building therein recommended."

Illustration courtesy of Ohio Ready Mixed Concrete Association.

The first reinforced concrete skyscraper in the world, the 16-story, 210 ft (64 m) high Ingalls Building in Cincinnati, OH, was built in 1902-03. Up until that time, no building more than two stories high had been constructed in reinforced concrete. Henry N. Hooper, the structural engineer, prepared the design using the Ransome system of reinforced concrete. (This photograph was taken in 1906.)

One of the pioneers in design and construction of concrete bridges, as well as most prolific, was Daniel B. Luten of Indianapolis, IN. From 1899 to the 1930s, his National Concrete Bridge Co. and related companies constructed thousands of bridges in the U.S. The 1902 tied-arch footbridge, with a Luten system of reinforcing, in Columbia Park, Lafayette, IN, was promoted as "the flattest concrete steel arch in the world."
Photo courtesy James L. Cooper

charter members stressed the need for such committees because of the "lack of reliable information as to the best methods of using cement in its relations to other structural materials and the lack of accurate data as to strength and durability of such products." Reinforced concrete was just beginning to be used to a considerable extent as a structural material. Railroads were pioneers in the use of concrete for structures (bridges) that carried excessively heavy loads and were exposed to all kinds of weather. They also pioneered factory-made (precast) components. C.H. Cartlidge, with the Chicago, Burlington & Quincy Ry., used factory-made concrete piles and slabs in trestles around 1906. However, the effort to introduce reinforced concrete was resisted by those who raised doubts as to the safety of such construction for buildings; the building codes were unfavorable. Concrete, on the other hand, was considered very satisfactory for sidewalks and massive foundations. Presentations at the first NACU convention indicated a predominant interest in sidewalks and concrete products. It was 1905 when a laboratory under the Structural Materials Division of the U.S. Geological Survey was established in St. Louis. The laboratory was to become involved with cement testing and was the precursor of the National Bureau of Standards, now known as the National Institute of Standards and Technology (NIST).

The 1906 convention attendees approved a resolution to be sent to the speaker of the House of Representatives that the NACU deemed "the investigations of cements, mortars, and other structural materials, now being conducted by the United States Geological Survey, of such far reaching importance to the people of this country" that Congress should make funds available for a more extensive scale of work during the next year. By mid-year, an appropriation of $100,000 was made available to the Structural Materials Testing Laboratories of the United States Geological Survey and the funds were expended mainly on investigations of cement mortars and concretes, including concrete blocks and aggregates.

At the second convention in Milwaukee in January 1906, the membership voted to apply for incorporation papers and to seek a charter from the District of Columbia—a document which was executed on December 14, 1906.

COMMITTEE WORK BEGINS

The sectional committees appointed at Indianapolis in 1905 wasted little time in getting organized, and several of them offered preliminary reports at the 1906 convention on: fireproofing and insurance, and art and architecture. E.S. Larned, chairman of the committee on testing of cement and cement products, noted that "the adoption of a standard specification for portland and natural cements during 1904, by the Joint Committee of the American Society of Civil Engineers and the American Society for Testing and Materials has proved a happy issue out of the maze of conflicting requirements." Before the adoption of the standard specification, much conflict of opinion existed on some of the principles governing the acceptance of cement. Each tester or engineer performing tests was, more or less, a law unto himself.

In 1907, the first definitive fruits of committee efforts were realized in the report of the committee on sidewalks, streets, and floors. This report, later adopted as a standard specification, emphasized the importance of a firm subbase, established thicknesses for top and bottom coats (two-course construction was the usual practice then), concrete materials and mixture proportions, and joint spacing. The necessity for clean aggregate and a low-slump mixture was recognized. Interesting are the detailed directions for hand-mixing and the absence of provisions for curing the finished concrete.

The committee on testing of cement and cement products pointed out the urgent necessity for standards for concrete block. Proposed specifications for these products included mixture proportions, mixing procedure, curing (steam curing was suggested), marking, testing, and the licensing of manufacturers.

The construction of buildings of reinforced concrete had made rapid progress by 1907 but was still considered a relatively new departure. The NACU committee on laws and ordinances noted that proper ordinances would do more than anything else to advance the use of this form of construction.

EARLY HEADQUARTERS

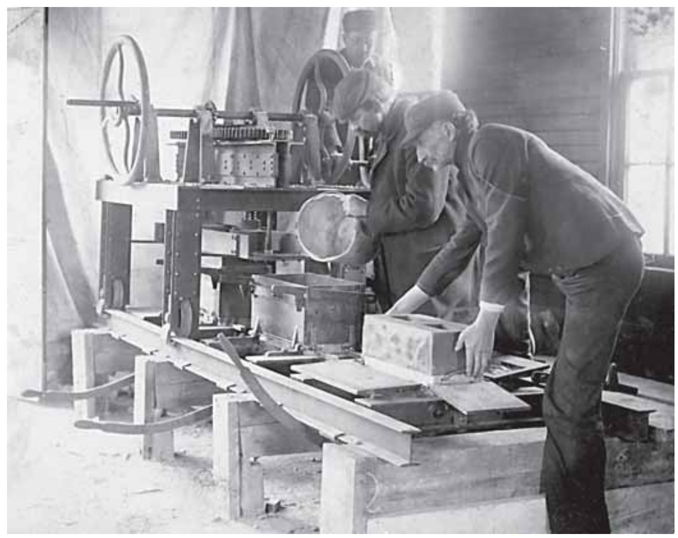
In those early years, the paperwork of the new association was more or less portable—in the briefcase or file of the president or volunteer secretary. Wherever their offices were located, that was the headquarters of the National Association of Cement Users. The executive committee of the board had the duty to attend to the business of the association and a vast amount of the detail work in connection with editing and publishing of the procedures and management of the convention and exhibition fell on the shoulders of Richard L. Humphrey, a consulting engineer in Philadelphia (president from 1905 to 1914) and the subsequent early presidents.

The establishment of a permanent headquarters in Philadelphia in 1908 more than fulfilled expectations. It really was just a legal formality because the headquarters were already located in Humphrey's office. An assistant to the president was secured and clerical force employed for carrying on the detailed work of the association. This made it possible to issue the convention proceedings in a more timely fashion, and greatly facilitated the handling of conventions and exhibitions. Up to that time, no salaries were paid to any officials except for certain expenses of the volunteer secretary or the exhibition manager.

EVOLUTION OF METHODS AND STANDARDS

Although primary interest in 1908 continued to be in sidewalks and concrete block, there was increasing discussion of reinforced concrete construction as well as precast concrete construction. Specifications were proposed for portland cement sidewalks and hollow building block. Informal reports were given on fireproofing and insurance and on laws and ordinances. The first report contained suggestions for fireproofing steel frames, additional thickness of structural concrete to increase fire resistance, hollow concrete block walls, concrete chimneys, and a brief reference to increased recognition of the value of concrete construction by fire insurance companies. The committee on laws and ordinances dealt with what today are considered code matters, such as design of members and factors of safety. The committee cited "Requirements for Reinforced Concrete or Concrete-Steel Constructed Buildings" developed by the National Board of Fire Underwriters in 1907 as the most recent ordinance available to municipalities when building with reinforced concrete.

A 1908 paper by William H. Mason, "Methods and Cost of Reinforced Concrete Construction with Separately Molded Members," described precast concrete work for an Edison Portland Cement Co. building in which many of the practices were similar to some of today's methods.



A circa 1900 concrete block manufacturing operation.

The era of modern stadium-building began early in the 20th century. Harvard University Stadium, built circa 1903, was believed to be the first massive reinforced concrete permanent arena for U.S. college athletics.
Photo courtesy Turner Construction Co.

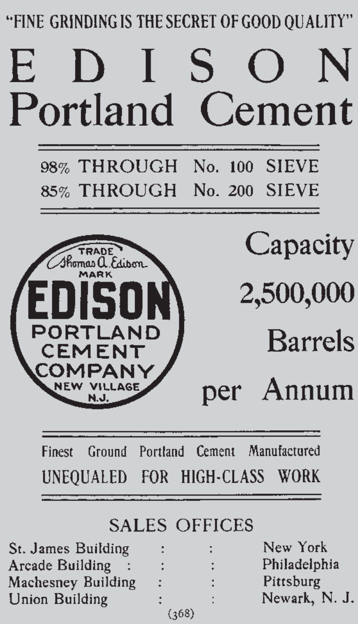
THOMAS A. EDISON AND CONCRETE

Thomas A. Edison, U.S. inventor best known for his development of the incandescent lamp and the phonograph, was a man with a wide range of interests—including cement and concrete. The Edison Portland Cement Co. began production in 1902. His newly designed 150 ft (46 m) long, 6 ft (2m) diameter kiln would eventually produce 3000 barrels of cement per day; there were ten kilns at the plant by the mid-1920s.

Among Edison's contributions to cement production were: the way raw materials were processed, including huge ball mills for pulverizing rocks to suitable size using steel balls and rods; research and development of production methods for grinding clinker to take advantage of cement particle size and distribution to increase hydration efficiency of cement; and an automatic oiling system to facilitate lubrication of bearings in the equipment used in cement manufacture.

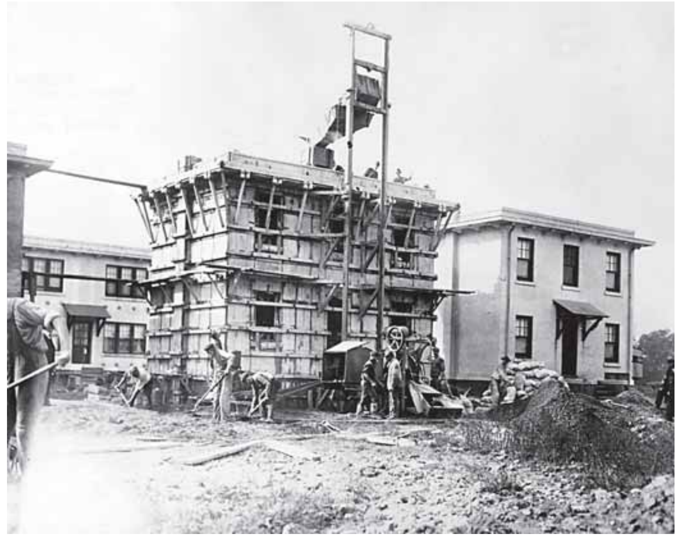
Edison contributed materials and talent for the first experimental concrete pavement in New Jersey. He invented a foamed concrete using aluminum powder that reacted with the alkalies from cement to form hydrogen gas, creating fine bubbles and foam. He developed a "free-flowing" concrete for use in building residential all-concrete homes that he designed and built using metal molds that could be assembled and disassembled.

Edison made so many contributions to so many fields that his contributions in the cement and concrete field are often forgotten.



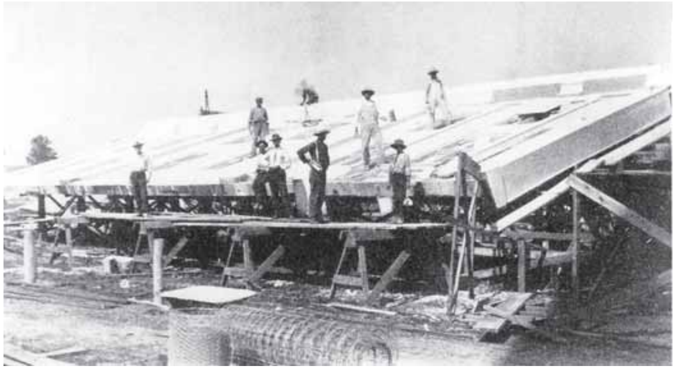
An advertisement for Edison Portland Cement Co. in the 1907 *Proceedings* of the National Association of Cement Users promoted fine grinding of cement.

Columns, girders, and roof slabs were cast on concrete beds and transported a short distance to the building site. Prefabricated reinforcing cages simplified the placing of reinforcement. Roof slabs were cast one on top of another to economize on space and forms. Another author extolled the virtues of "factory-made" structural concrete components. Thomas A. Edison and the Edison Portland Cement Co. were early NACU members. Edison went on to develop and implement a


Thomas A. Edison did not confine his studies to electricity, but was also involved in cement manufacturing and home building. He developed a metal forming system to cast complete houses out of concrete (1907-1909). About 500 different sectional molds were assembled into a single giant form. Walls, floors, stairways, roof, bathtubs, and conduits for electric and water service were cast in one operation. During a 6-hour single placement, concrete was elevated to a distribution tank at roof level, then flowed by gravity to fill the form. A cluster of 11 homes was erected in the Township of Union, NJ, in about 1908. By 1912, the American Sheet and Tinplate Co. had adapted and improved on Edison's house forming system. The company used sheet steel forms to build 74 concrete homes in Gary, IN.
ACI archives. Photo courtesy of Raymond C. Heun.

system of mass-produced reinforced concrete housing units. The houses were cast in place in iron molds. Edison wrote: "I think the age of concrete has started and I believe I can prove that the most beautiful houses that our architects can conceive can be cast in one operation in iron forms for a cost which will be surprisingly low." It is interesting to note that at the December 1910 convention in New York City, Edison personally staffed a booth that displayed a model of his system.

Interest increased in 1909 in methods of construction and costs of monolithic buildings, walls, bridges, subways, and railroad work. Architectural requirements and construction techniques in the housing field were also given attention. Revision of the specification for sidewalks recognized one-course construction and added a provision for keeping the completed work moist for three days; the previously required low-slump concrete was replaced by a consistency not requiring tamping. A proposed specification for roads set forth the requirements for aggregates, form construction, preparation of subbase, mixing, and one-and-two-course placing of the concrete. In two-course work, a 6 in. (150 mm) concrete base was to be overlaid with a 4 in. (100 mm) wearing surface of 1:3:6 concrete wet enough so as not to require tamping. It might be said that the need for better concrete was driven by the development of motorized transportation—the automobile. America was ready to expand at a rate beyond belief. In 1909, after a preliminary experiment, Wayne County, MI, laid a piece of concrete road 1 mile



One of the earliest site-cast, tilt-up wall panel construction projects was undertaken circa 1907 by Robert Aiken at Camp Perry, OH. The wall was cast upon a large tipping table (left). After 48 h, when the concrete was solid, jacks tipped the wall into position, the wall was braced, and the platform moved to the next position.

(1.6 km) long. This was the first stretch of rural highway in North America to be paved with concrete.

The lengthy report of the committee on laws and ordinances contained the results of a survey of owners of approximately 700 concrete buildings and a study of standard regulations for reinforced concrete construction. The first part of the report compared insurance rates for various classes of construction and pointed out the disparity in rates in various parts of the country and the need for re-rating concrete structures with due allowance for their superior fire-resistive nature. The second part of the report, relating to suggested building regulations, summarized current building regulations in Europe and principal cities of the United States. The regulations themselves encompassed materials, joints, general design assumptions, bending moments, working stresses, and construction techniques. The recommendations of the report conformed in general to the more complete report of the Joint Committee on Concrete and Reinforced Concrete. The NACU committee on reinforced concrete offered a report that accompanied the proposed regulations, explaining and commenting on various sections—somewhat similar to the commentary sections of the current ACI 318 building code requirements for structural concrete.

At the 1909 convention, the NACU assured that proper steps were taken in the development of standards by adding a new section to the association bylaws. Proposed Standard Specifications developed by a committee were to be mailed to members at least 30 days prior to the annual convention, and as amended and approved at a convention, passed to letter ballot to be canvassed within 60 days. A specification would be considered adopted unless 10% or more of the total membership voted in the negative.

NEW IDEAS, NEW ANSWERS

Robert Aiken's 1909 "Monolithic Concrete Wall Buildings, Methods, Construction and Cost" contained the elements of modern tilt-up construction. He described the erection of reinforced concrete retaining walls that were cast flat on the ground like a sidewalk, raised on one edge, and tipped into position (by a derrick) on a prepared foundation where they were anchored by steel rods to buried blocks of concrete. It was believed to be the first concrete wall erected without forms. The method proved so satisfactory that it was then used to build a factory, military barracks, and a mess hall. The latter building utilized a platform for casting the wall units, which were then tilted into final position.

The trend toward searching out answers to the unknowns in the design of concrete structures continued in 1910 with reinforced concrete columns and flat plates ("girderless" floors) receiving attention. In February 1910, the "Standard Building Regulations for the Use of Reinforced Concrete" were adopted.

The use of concrete for roads and highways was still in its infancy with trials being made of its use as a base for other materials, even including precast concrete brick. Concrete wearing surfaces were rare. There was disagreement about the merits of smooth or broomed surfaces, location and function of joints, and how to meet the differing requirements of horse-drawn and automotive traffic. To better suggest what practice to follow, a standard specification for concrete roads and street pavements, and another for portland cement curbs and gutters were issued.

At its sixth convention, the NACU took a strong stand in favor of continuing education and extension short courses conducted by state colleges. The short courses on agriculture at many state educational institutions had proven their usefulness to farmers. The NACU, recognizing the value of such courses, encouraged members to contact state institutions about introducing similar

"With the development of the portland cement industry and the rapid extension of the use of concrete, it is not strange that reinforced concrete has come into favor and that its use in buildings, arches, and foundations has grown rapidly. The advantages offered by reinforced concrete for many lines of construction are quite apparent...."

—Arthur N. Talbot
Bulletin No. 1, Sept. 1904
University of Illinois Engineering Experiment Station

Rapid progress in reinforced concrete between 1880 and 1910 was due in large measure to the efforts of François Hennebique. Among the early bridges built by Hennebique was this one across the Ourthe River, Belgium, built in 1904.
ACI archives. Photo courtesy of G. Magnel.

courses of instruction on cement and concrete so that attendees could gain a general knowledge of concrete ingredients along with the correct method of proportioning, mixing, and using concrete. These efforts may have aided indirectly the growth of state university extension programs for engineers. The University of Wisconsin had started a Summer School for Artisans and Apprentices in 1900. Various university non-resident education programs included correspondence studies in vocational-type training as well as advanced engineering. Many engineers learned about reinforced concrete design via self-study programs. The University of Wisconsin, for example, in 1910 offered 19 correspondence courses in structural engineering, including four courses in reinforced concrete construction.

BUILDING PERFORMANCE

Because of disastrous fires, particularly the 1908 Collingwood, OH, school in which 165 children lost their lives and the 1906 San Francisco earthquake and fire, there was a great deal of interest in 1910 in reinforced concrete structures to resist both of these forces. John B. Leonard, in "Use of Reinforced Concrete in San Francisco and Vicinity," said that due to the building laws in San Francisco denying the construction of reinforced concrete buildings in the city limits, there was no completed building of this type in San Francisco at the time of the earthquake and fire. There was one building just being constructed for which the owner had never received an official permit but "being confident of the merits of reinforced concrete intended to abide by the issue in the courts." This building was not subjected to any intense fire but it was in a section of the city that suffered severely from the earthquake. An examination of the building a few days after the disaster showed that the brick curtain walls had suffered considerably but that the reinforced concrete portion of the structure was entirely sound. John T. Simpson, in his 1911 *Proceedings* paper "Reinforced Concrete Schools," extolled the virtues of fireproof schools of reinforced concrete and showed that in many instances a reinforced concrete building could be built for the same price as a building of brick and wood.

Another paper entitled "The Spouting of Concrete" reported on a gravity system of conveying and distributing concrete that originated in California. Basically, the system involved a revolving mast or boom supporting a trough or pipe with a swivel and movable trough at the end of the boom. The combination gave a horizontal motion in any desired plane at the delivery end of the pipe or trough.

By 1910, the NACU sectional committee structure had been expanded with committees on building blocks and cement products; fireproofing; insurance; measuring concrete; nomenclature; reinforced concrete and building laws; roadways, sidewalks and floors; specifications and methods of tests for concrete materials; treatment of concrete surfaces; and education. The standards being developed were receiving increasing recognition in both the United States and Europe. The desirability of preparing recommendations for standard practice, in addition to rules governing the quality of the product and test requirements, had become evident and committee efforts were expanded accordingly.

The progress report of the committee on treatment of concrete surfaces, which could be considered a forerunner of the ACI series of recommended practices, offered guidance "which would enable anyone fairly experienced in the art to do good work." The committee also proposed specifications for portland cement stucco and scrubbed concrete surfaces; the latter was advanced to a standard. Patents were issued in 1911 to Carl Akeley on the cement gun and what was to become the gunite (shotcrete) method for applying mortar using compressed air.

In 1911, the committee on reinforced concrete and building laws proposed a series of tests of existing structures to secure data on the actual carrying capacity or stresses in reinforced concrete structures designed according to current practice, and to throw light on important questions relating to the design of structural members. Because such observations required specialized equipment and trained observers, the committee offered its assistance in arranging for the necessary apparatus and proper personnel to conduct the tests.

Closely related to the committee work, since it was the basis of its tests, was "A Test of a Flat Slab Floor in a Reinforced Concrete Building," by Arthur R. Lord. He described his technique for panel loading tests in the Deere and Webber Co. building in Minneapolis, MN, intended to provide data on flat-slab design and performance.

The following year, the committee reported on four such tests: two in which the reinforced slabs were supported on beam-and-girder framing, one on flat slab construction, and the other on a combination tile and concrete floor reinforced in two directions. Buildings tested were the ten-story Wenalden Building in Chicago; the eight-story Turner-Carter Building, Brooklyn; the

> “ I would ask the younger men in the profession to remember that real knowledge and everlasting care are necessary, so that the reinforced concrete industry in the future may proceed without setbacks from accidents caused by neglect or greed.”
>
> —*Ernest L. Ransome*
> Personal reminiscences, 1912

three-story Powers Building, Minneapolis; and a test panel for the Barr Building, St. Louis. Discussion included the addition of a report by W. K. Hatt on similar tests of the ten-story Franks Building, Chicago. Instrumentation and test procedures for those conducted under the supervision of the committee were described in detail by W.A. Slater. In support of these tests, the NACU established its first research fund, with money raised through voluntary contributions.

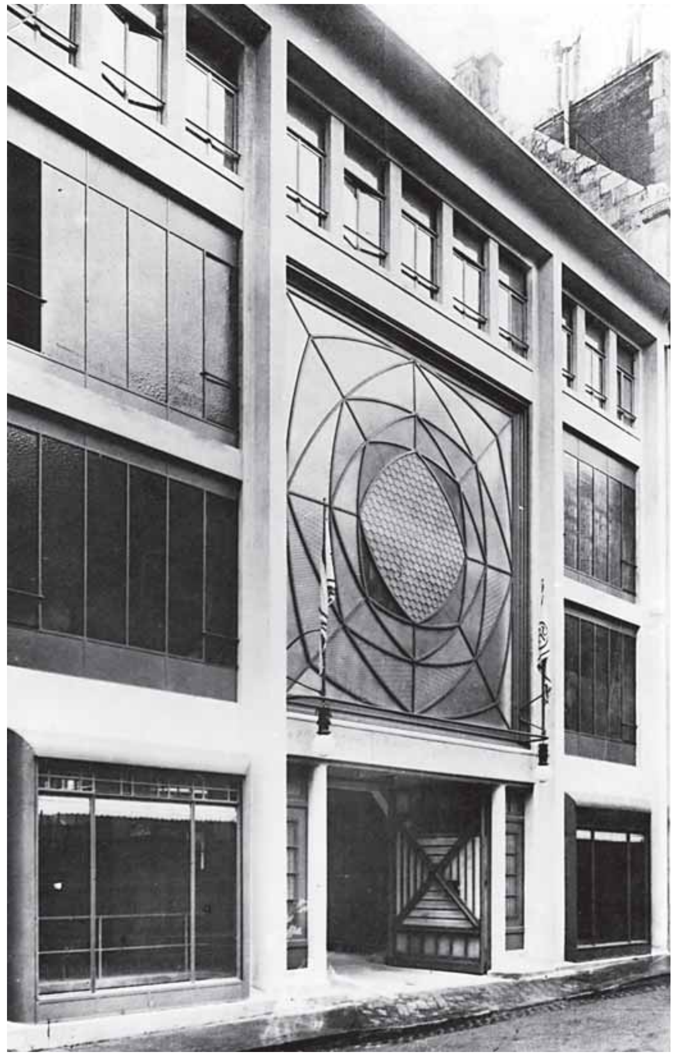
INDUSTRY CONCERNED; NACU RESPONDS

Indicative of the problems of the industry were the remarks of John Harrington, who addressed the 1912 convention in Kansas City. He stated that failure to recognize the need for careful inspection of materials and supervision of workmanship was perhaps responsible for the larger portion of failures of concrete structures. Too early removal of the forms, careless and unwise placing of reinforcement, inadequate provision for expansion and contraction due to changes in temperature, weak and leaky forms, inadequate tamping, loose methods of depositing concrete both in air and under water, and excessive dependence on designing with empirical methods and fallacious load tests were difficulties he felt should be guarded against and overcome.

As of 1912, the NACU had issued 14 standards. These included specifications for:

- cement, with an appendix on standard methods of testing and chemical analysis (It was the practice at that time, where pertinent, to adopt ASTM specifications, so NACU Standard No. 1 was the same as the ASTM standard.)
- portland cement sidewalks
- cement hollow building block
- concrete road and street paving
- portland cement curb and gutter
- scrubbed concrete surfaces
- concrete architectural stone, building block, and brick
- plain concrete floors
- reinforced concrete floors

Also, there were NACU building regulations for use of reinforced concrete and another for use of concrete architectural stone, building block, and brick. The recommended practices included one for reinforced concrete; one on concrete drain tile; and one for concrete architectural stone, building block, and brick. There were also special reports on insurance, treatment of concrete surfaces, and tests on reinforced concrete buildings. The standards were becoming more recognized and NACU regulations were being incorporated in the building regulations of many of the largest cities in the country. The printed proceedings had become valuable references, especially those reports relating to the design of flat slabs.



Prototype of all large modern garages was the reinforced concrete garage on the Rue de Ponthieu, Paris, built in 1905. Architect and builder: Auguste and Gustave Perret.
ACI archives. Photo courtesy of Chambre Synidicate des Constructeurs en Ciment Arme de France.

It is interesting to note that as a harbinger of things to come, the December 1912 convention approved a resolution “that the proceedings of.....the National Association of Cement Users shall be published in a monthly journal to be known as the Journal of the National Association of Cement Users, provided arrangements can be made with a publishing company whereby the cost shall not exceed $2.00 per member per year for the entire proceedings.” (At that time 1500 to 2000 copies of an annual proceedings volume were published for around $3000).

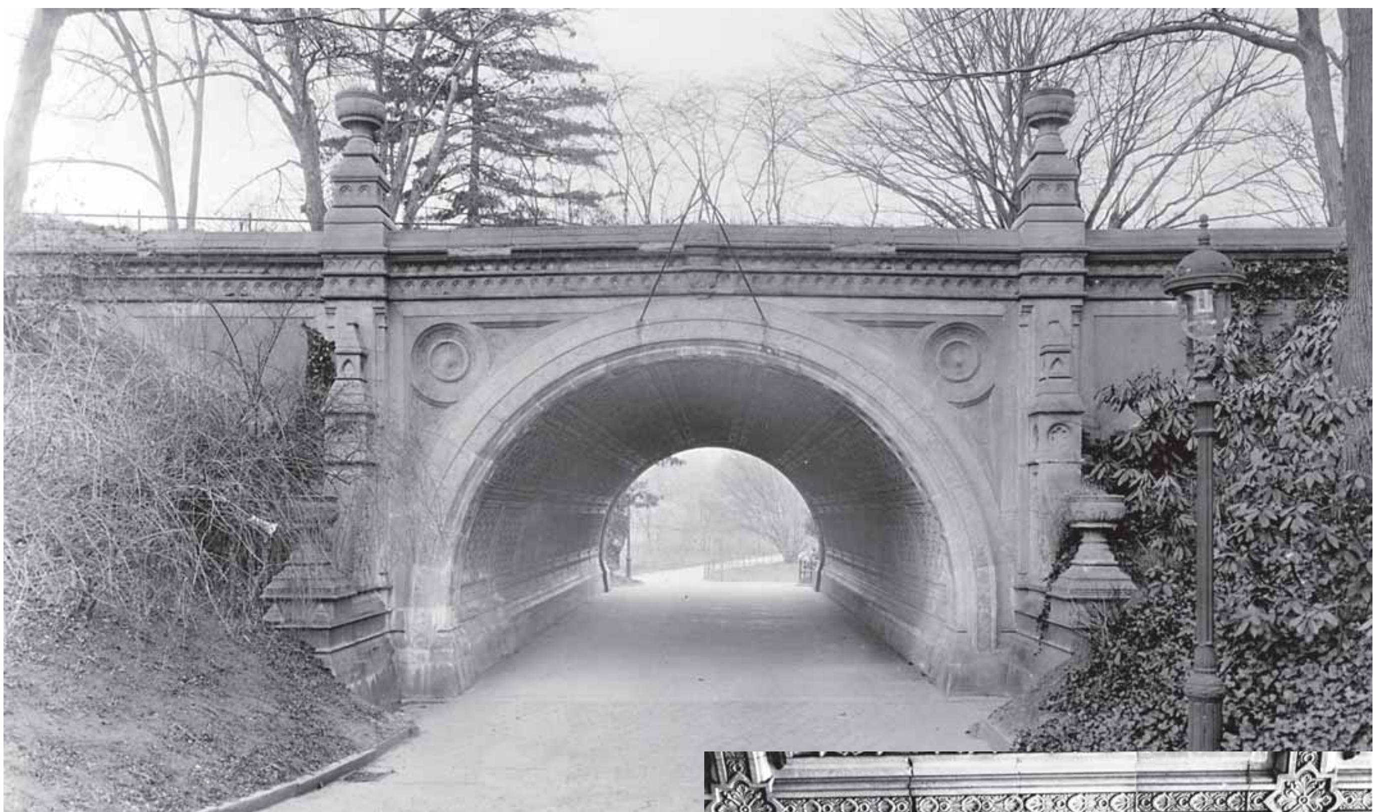
Engineers and contractors designing and building reinforced concrete structures had expressed a need for some standard method of measuring quantities in contracts for concrete work. A committee of the National Association of Cement Users subsequently proposed standard methods for the measurement of concrete work, which later that year were advanced to a standard.

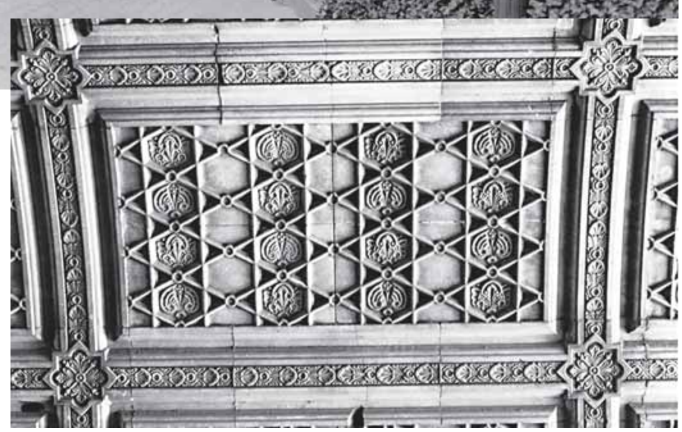
Reporting on pioneer work with concrete highways, Edward N. Hines said "With four years experience as a guide it has been demonstrated in Wayne County (Michigan) that a well-built concrete road is a practical form of construction which merits and will receive a more extensive adoption. Every test to which this work has been subjected only emphasizes its strong characteristics. The points considered and which might properly be termed a specification, are initial costs, ultimate costs (which include maintenance), sanitation and freedom from dust, good traction for all types of vehicles, smoothness, and ease of construction."

An investigation of reinforced concrete columns of large size was undertaken in 1913 by the committee on reinforced concrete and building laws in cooperation with the Bureau of Standards and the Engineering Experiment Station of the University of Illinois. Plain concrete and spirally and vertically reinforced columns 12 ft (4 m) long and 20 in. (508 mm) in diameter were studied. This was reported to be the largest series of columns of this size tested up until that time and results of great practical value in the formulation of building regulations were expected.

ACI EMERGES

At the eighth convention in Kansas City, MO, in 1912, the subject of changing the name of the National Association of Cement Users to one more indicative of its work was discussed at length. Such a possibility was given consideration for more than a year and on July 2, 1913, as a result of action of the Board of Direction of the National Association of Cement Users, the name of the society was changed to the American Concrete Institute. The objectives of the organization were unchanged, the new name being considered more descriptive of the breadth of its aims and interests.





The Cleft Ridge span in Prospect Park, NY, built in 1871-1872, is believed to be the first concrete bridge built in the U.S. The bridge was constructed of precast artificial stone known as beton agglomere (compacted concrete) or beton Coignet (named after its inventor, French engineer François Coignet). The precast units were cast on site and erected by traditional stone masonry methods. Elaborate ornamentation was possible through precasting, especially in the vault panels (see inset). Color pigments were also added during casting. Designer: Calvert Vaux. Builder: John C. Goodridge, Jr., and Long Island Coignet Stone Co.

ACI archives. Photo courtesy of F. M. Fuller. Inset photo courtesy of Rosemarie Dawes, Stephen B. Jacobs & Associates.

The first issues of the new monthly journal, appearing late in 1913, reflected the name change.

Coinciding with the name change, one of the most momentous engineering feats of all time was nearing completion—the Panama Canal. Although the French began actual work on the Canal in 1881, American engineers and constructors eventually built the 50 mile (80 km) canal in 1904-1914. The canal became feasible largely through the use of concrete, which was reported in detail in the Institute proceedings. Perhaps the greatest structural triumphs were the huge locks. Each lock chamber was a large concrete basin 1000 ft (305 m) long and 110 ft (34 m) wide, closed at both ends by large steel gates. The concrete walls were 81 ft (25 m) high, taller than a six-story building. The flight of locks at Gatun required 2 million yd^3 (1.5 million m^3) of concrete; the locks at the other end of the canal were even larger, with a volume of 2.4 million yd^3 (1.8 million m^3). The project surpassed anything seen before with its large, movable steel forms and streamlined system of concrete delivery from mixing plant to construction site.

The value of concrete for pavements was being increasingly recognized with its use reported in 1914 in numerous parts of the country. Reflecting this interest, the committee on concrete roads and street pavements presented for adoption standard specifications for one-course highways, one-course street pavements, and two-course street pavements.

President Richard L. Humphrey in 1915 summarized the progress of the organization during the first ten years:

> "The past decade has probably been the most critical in the history of the cement industry and there is no member capable of fully realizing the vital importance of the part this Institute has played in its development. Its educational work, its conventions, its expositions, and particularly its committee work in preparing recommended practice and standard specifications have guided the use of cement along safe and practical lines and assured the permanency of the construction in which the material is used...
>
> "Although this organization has produced more than 18 standards and recommended practices, its work has only just begun. The existing standards must be revised, new ones developed, and there never was so much need of work of this character as at the present time."

The number of technical committees had expanded to include those on reinforced concrete highway bridges and culverts, reinforced concrete chimneys, concrete in revetment work, and reinforcing steel.

Because the 1914 fire at the plant of Thomas A. Edison, Inc., West Orange, NJ, involved so many buildings constructed of reinforced concrete and other materials, the American Concrete Institute felt it was its duty to appoint a special committee to investigate and report on the facts in the interest of building science. The committee concluded in 1915, that considering the extraordinary conditions surrounding the fire, the behavior of the

> "When the compressive strength is plotted against the water ratio... a smooth curve is obtained.... It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of water required to produce a workable mix... strength depends on only one factor... the ratio of water to cement."
>
> *—Duff A. Abrams,*
> ACI President, 1930-1931

GEORGE WASHINGTON AND CONCRETE

Through the years, many Institute conventions have convened in February and sometimes were in session on February 22—the birthday of George Washington, first president of the United States. The sixth convention (1910) of the NACU was one of those occasions and President Richard Humphrey took the opportunity to reflect on the life of Washington and point out his close connection to the concrete industry.

"Among the first books relating to limes and cements it was my pleasure to read, was that which I hold, once the property of George Washington and now in the possession of Dr. George S. Webster of Philadelphia, PA. This book was published in 1780 by Dr. Bryan Higgins, and on the title page, which bears Washington's signature, appears the following inscription: *Experiments and Observations made With the View of Improving the Art of Composing and Applying Calcareous Cements and of Preparing Quick-Lime: Theory of these Arts; and Specifications of the Author's cheap and durable Cement, for Building, Incrustation or Stuccoing, and Artificial Stone.*

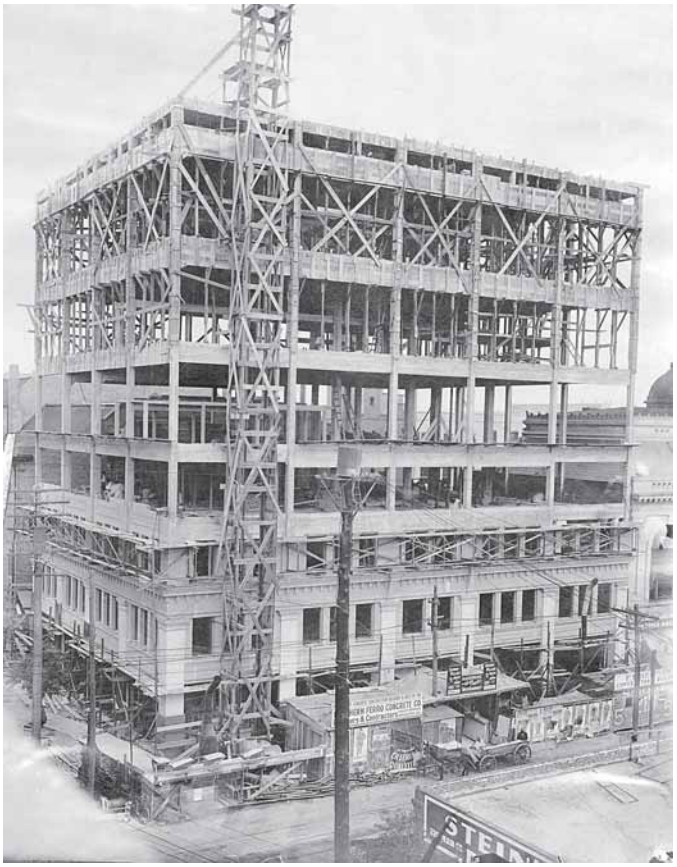
"It was this recollection of Washington's probable interest in cement that lead to some studies of his life which seem to indicate that he was one of the early users of cement in this country. It should be borne in mind, however, that the material which is today know as lime, was in those days called cement.

"It is probable that this material was made use of in the construction of the Potomac Canal with which Washington was early identified. You will recall that the use of cement in this country began in 1818, twenty-three years after Parker had obtained a patent for a material that he called Roman Cement. Canvas White at that time manufactured the natural cement which was used in the construction of the Erie Canal in which Washington was also interested, having made a reconnaissance for and examination of the proposed route and predicted its commercial success.

"Washington was identified with the promotion of our earliest canals, which mark the beginning of the cement industry in this country, and it is probable that the construction of the locks of the Potomac Canal, in which he was particularly interested, led him to acquire the book on limes and cement by Dr. Higgins."

concrete buildings was highly satisfactory and constituted an excellent demonstration of the merits of concrete as a fire-resistant building material. A particularly interesting point brought out by the committee was the rapidity with which reinforced concrete buildings could be restored to use.

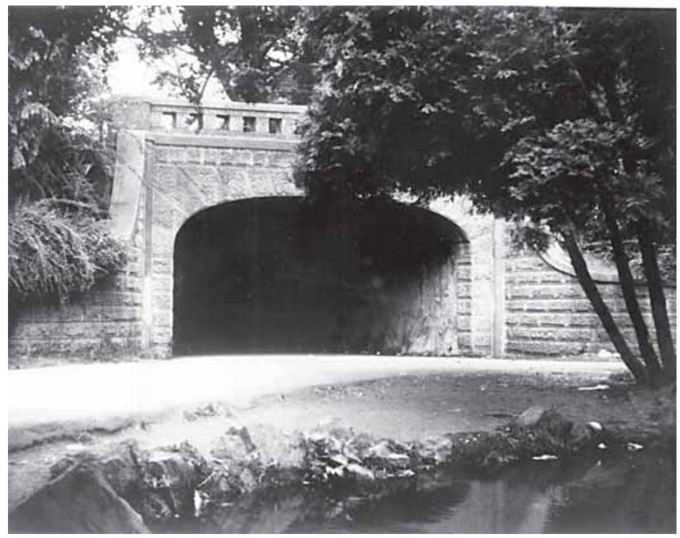
In 1916, the committee on reinforced concrete chimneys submitted a report in the form of a symposium covering foundations, types of chimneys, design, construction, a study of existing chimneys, and failures. Also, 1916 saw the "Final Report of the Joint Committee on Concrete and Reinforced Concrete." The joint committee was formed by the union of special committees appointed in 1903 and 1904 by the American Society of



The YMCA Building in Jacksonville, FL, built in 1908-09, was said to be Florida's first large reinforced concrete frame structure. It featured a running track suspended over the gymnasium by cantilevered concrete beams. Architect: H. J. Klutho. Builder: Southern Ferro Concrete Co.
Photo courtesy of Eugene Boeke/Beers Skanska.

One of the major selling points for concrete buildings in the early 1900s was that concrete rated high as a fire-resistant material.

An early twentieth century project. A three-hinged concrete arch bridge in Brookside Park, Cleveland, OH, built by the Block Bridge & Culvert Co. of Indianapolis, IN.



Alvord Bridge in San Francisco's Golden Gate Park was built in 1889 by Ernest L. Ransome. The reinforced concrete bridge is believed to be the oldest—and first to be constructed—concrete bridge with steel reinforcing bars in the U.S. The cold-twisted steel square reinforcing bar system was an invention of Ransome.

C. A. P. Turner was one of the pioneers in reinforced concrete construction in the U.S. He is credited as one of the inventors of the flat slab system and built the first flat slab, the Bovey-Johnson Building in Minneapolis, MN, on a 14 x 17 ft (4 x 5 m) module in 1906. Turner's system was used in this garage erected in the early 1900s.

Civil Engineers, the American Society for Testing and Materials (now ASTM International), the American Railway Engineering and Maintenance of Way Association (now American Railway Engineering Association), and the Association of American Portland Cement Manufacturers (now the Portland Cement Association). A special committee from ACI, added in 1915, consisted of Edward Godfrey, structural engineer, Robert W. Hunt & Co., Pittsburgh, PA; Egbert J. Moore, chief engineer, Turner Construction Co., New York, NY; and Leonard C. Wason, president, Aberthaw Construction Co., Boston, MA. Most of the representatives from the other organizations were also ACI members.

The preliminary draft of the joint committee report appeared in 1908 with amendments in 1912. The 1912 joint committee recommendations had been widely adopted in practice in the U.S. A considerable amount of new material was added in the 1916 report; the committee's introduction went on to say:

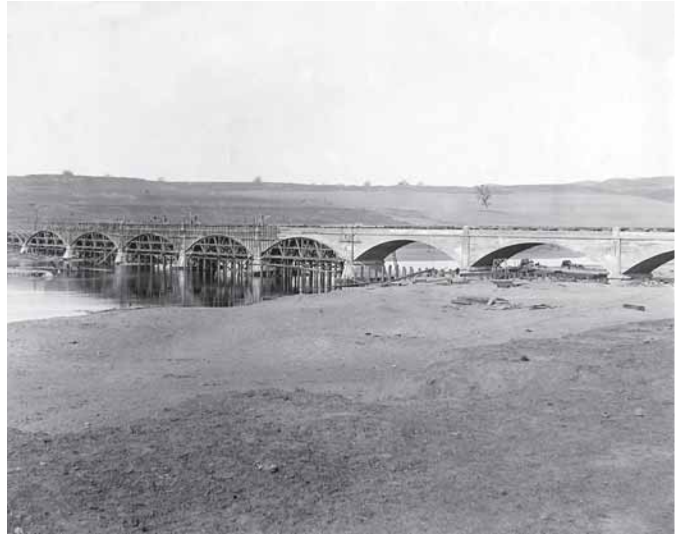
> "There are some subjects upon which experimentation is still in progress, and the art of concrete and reinforced concrete will be advancing for many years to come.
>
> "While this report deals with every kind of stress to which concrete is subjected and includes all ordinary conditions of proportioning and handling, it does not go into all types of construction nor all applications to which concrete and reinforced concrete may be put. The report is not a specification but may be used as a basis for specifications. In their use, concrete and reinforced concrete involve the exercise of good judgement to a greater degree than any other building material. Rules cannot produce or supersede judgement; on the contrary, judgement should control the interpretation and application of rules."

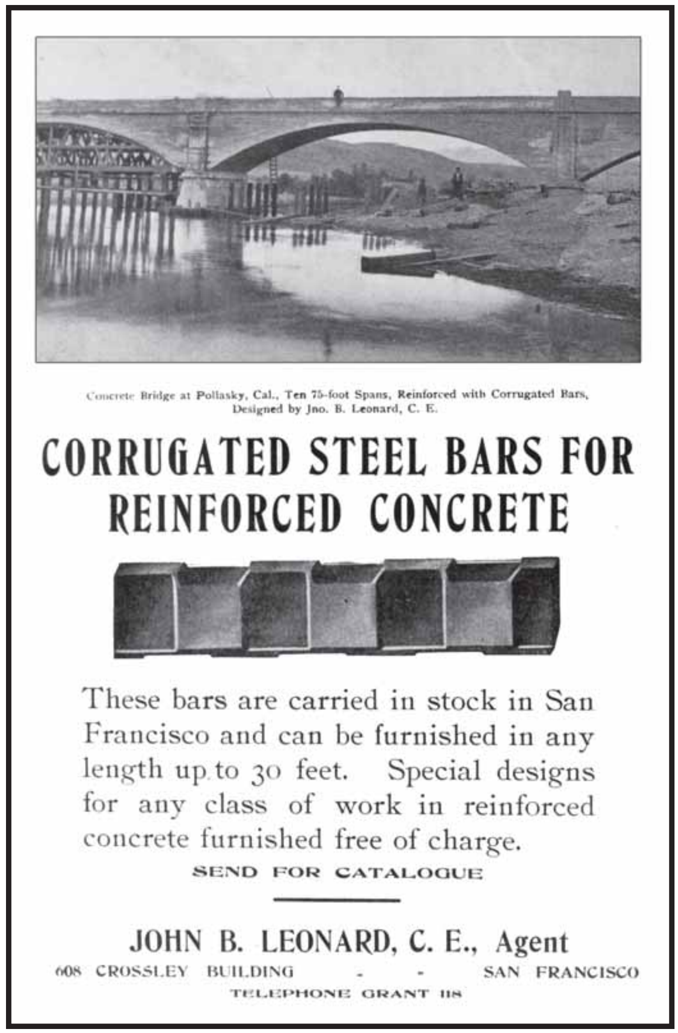
ACI/NACU had weathered financial ups and downs, but the 1915-1916 period was a difficult one. Due to a number of circumstances, association income was reduced and publication of the monthly *ACI Journal* was discontinued. A few committee reports were published at irregular intervals and the annual proceedings were finally published after a delay. The office in Philadelphia was closed but the activities of the Institute and the work of committees were only slightly handicapped since President Leonard C. Wason furnished the Institute, free of charge, the use of his offices in Boston.

WORLD WAR I ERA

Attention was called to plastic flow in 1917 by Earl Smith in the paper, "The Flow of Concrete Under Sustained Loads":

> "The one property of concrete recently brought to light which seems to be both necessary and sufficient to explain apparently abnormal stress and deformation phenomena is that of the flow under sustained loads. Flow is not used here in the sense of fluidity but in the sense of molecular displacement or rearrangement under the influence of an external force. It is the gradual but persistent deformation which takes place in the material while in the condition of sustained stress.
>
> "Flow should not be confounded with shrinkage; both





John B. Leonard was one of the early proponents of reinforced concrete bridges. One of his designs was the Pollasky Bridge in California (top). Built in 1905, the bridge incorporated ten 75-ft (23 m) spans. Corrugated steel bars manufactured by the Corrugated Bar Co. of St. Louis were the reinforcing (see the 1906 advertisement). The bridge's composite length made it the longest reinforced concrete bridge in the U.S. at the time.

Harvey Whipple was the first "executive vice president" of ACI, although at the time the position was called secretary, and later secretary-treasurer. He began his association with ACI when it was the National Association of Cement Users, and served as chief staff officer from 1919 to 1952.

factors exist in all concrete and they are easily distinguished. Shrinkage exists as a natural consequence regardless of the size, position, or stress, and is influenced mostly by age and moisture. Flow, however, exists by virtue of sustained stress. It is a time-stress effect."

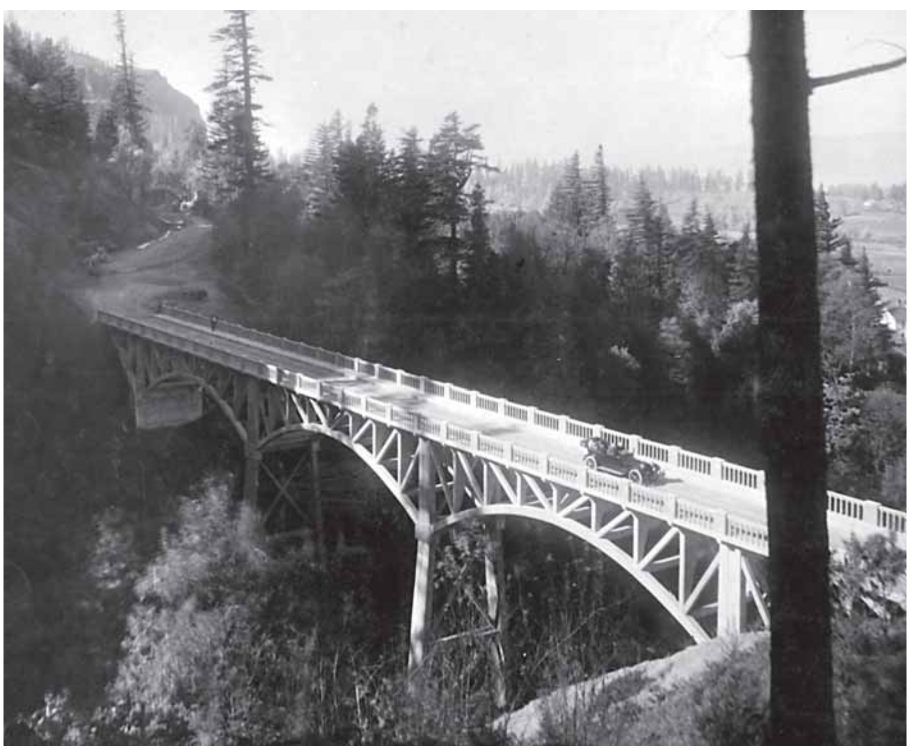
ACI was very active in developing recommendations for concrete roads and pavements. There were standard specifications for one-course concrete street pavement, two-course concrete street pavement, one-course concrete alley pavement, and concrete pavement between streetcar tracks.

ACI also recognized the standards being developed by the American Society for Testing and Materials. By 1917, ACI had adopted verbatim two ASTM standards as ACI standards, one on portland cement and the other on drain tile. A committee continued to investigate the possibility of a permanent office location and permanent secretary in either Chicago or New York.

Interest continued in determining the characteristics of concrete structures with tests of concrete columns with cast-iron cores, extensometer readings of a reinforced concrete building and a flat concrete-tile dome, and the influence of total width on the effective width of slabs. The first finishing machines for pavements were appearing and brought with them problems of control of consistency, finishing at joints, and curing. Curing by ponding or flooding was becoming popular.

Machine mixing had replaced hand mixing of concrete on work requiring large quantities of material. Duff Abrams was investigating the effect of duration of mixing time on the strength and wear resistance of concrete. One of the great landmarks in the development of concreting practices and concrete control was Abrams' water-cement ratio law of 1918.* It was in the 1916-1918 era that John J. Earley started to promote architectural treatments such as exposed aggregate surfaces used in the retaining walls at Meridian Hill Park in Washington, D.C., which served as a laboratory for experimenting with concrete aggregates. Although some work on lightweight aggregate (expanded shale, clay, and slate) was undertaken around 1908, Stephen J. Hayde is generally recognized as the founder of the expanded shale industry; he was granted a patent in 1918 on a process called Haydite. The product was to see fairly large use in the World War I concrete shipbuilding program.

The construction of buildings and related problems continued to



Laturelle Falls Bridge on the Columbia River Highway, built for the Oregon State Highway Commission in 1914, was one of the first concrete bridges in that state. The bridge was considered one of the lightest concrete structures for the load it carried until the advent of prestressing. Engineer-Architect: K. P. Billner. Builder: Harris Construction Co.
ACI archives. Photo courtesy of K. P. Billner.

* "Design of Concrete Mixtures," *Bulletin* No. 1, 1918, Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill.

preoccupy engineering interest in 1918. Flat slab buildings were tested and moment coefficients for such construction were analyzed. Contributions to concrete technology dealt with the effect of mixing time and blast-furnace slag as aggregate. Housing needs of this war period were reflected in the appointment of a new committee on concrete industrial houses, with reports on architectural details and construction techniques for concrete houses.

CONCRETE SHIPS

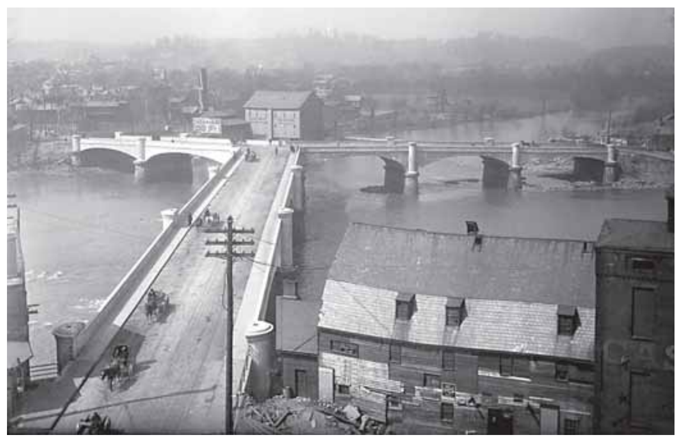
A number of ACI members were called "to duty" during World War I in the Department of Concrete Ship Construction, U.S. Shipping Board Emergency Fleet Corp., and numerous reports regarding their work appeared in the *ACI Proceedings* through 1917-1919.To deal with problems arising from the development of concrete ships during World War I, a committee on concrete barges and ships was appointed as a joint committee of ACI and PCA. Its work resulted in reports of design and construction of reinforced concrete ships and barges, layout of shipyards, and construction techniques.

Loss of ships due to submarine sinkings led to the development of concrete ships. The scarcity of steel, wood, and labor, and the length of time necessary to construct ships of steel or wood directed attention to the substitution of reinforced concrete. European countries had been building concrete barges and lighters, some for sea-going service. The first reinforced concrete cargo motor ship was launched in 1917 in Norway; the firm also built the first reinforced concrete floating dry dock, which could accommodate a vessel 75 x 25 ft (23 x 8 m).

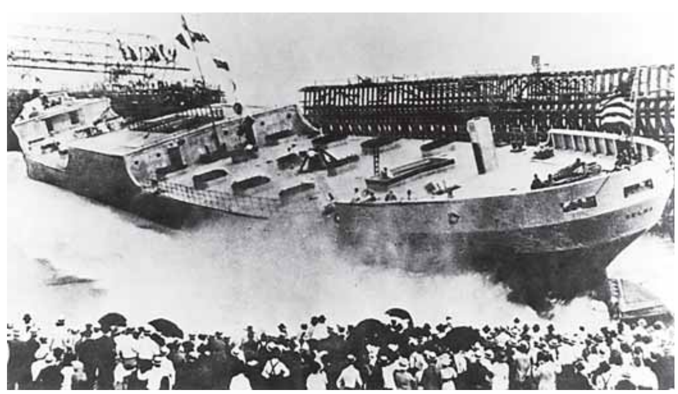
The pioneer of large reinforced concrete ships, however, was the "Faith," launched in the U.S. in 1918. In 1919, a special medal was awarded by ACI to Lesley Comyn of San Francisco in recognition of his work in building and promoting the first ocean-going U.S.-built concrete ship, the 5000-ton concrete cargo steamship the "Faith." In presenting the medal, President W. K. Hatt remarked: "In the development of reinforced concrete, it was the men of faith who pushed ahead the early construction in advance of theory or codes or formulations......While others were thinking of the difficulties of building and launching a concrete ship (Lesley Comyn) constructed a concrete ship, the 'Faith.' What others only dreamed, he dared to do."

Another technological breakthrough came about during construction of one of the concrete ships—the lightweight aggregate concrete ship the "Selma." The ship's reinforced expanded shale lightweight concrete hull had a thickness of 5 in. (127 mm) on the bottom and 4 in. (102 mm) on the side. During construction of the Selma, the initial step was taken in the development of the slump cone test (now ASTM C 143). To obtain good placement of concrete in the thin hull sections in and around the heavy mats of reinforcing steel, it was necessary to use an extremely fluid, easily-placed concrete. One of the engineers developed an apparatus that successfully overcame the difficulties of controlling

An outstanding early bridge: the Grafton Bridge, Auckland, New Zealand. Opened to traffic in 1910, the bridge was made up of one 42 ft (13 m) span, two spans 78.5 and 80.5 ft (24 and 25 m), a main arch span of 320 ft (98 m), four spans 75.5 ft (23 m) each, and two spans 35 and 37.5 ft (11 and 11.5 m). Design and construction by Ferro-Concrete Co. of Australia.
ACI archives. Photo courtesy of Auckland City Engineer's Office.



The concrete Y Bridge in Zanesville, OH, was completed in 1902 when use of concrete was still relatively novel in the midwest. The bridge's peculiar shape stemmed from the nearly right-angle convergence of the Muskingum and Licking Rivers near the city center. The bridge, with a combined length in its three branches of 970 ft (295 m), featured extremely flat arch spans.
Photo courtesy of Ohio Historical Society.



The concrete ship U.S.S. Selma was launched in June 1919. It was the first large vessel to be launched sideways. The tanker had a length of 434 ft (132 m), a beam of 43 ft (13 m), and a draft with full cargo of 26 ft (8 m). The ship's reinforced expanded shale lightweight concrete hull had a thickness of 5 in. (130 mm) on the bottom and 4 in. (100 mm) on the side.
Photo courtesy of Expanded Shale, Clay, and Slate Institute.

the consistency of the concrete and producing it uniformly batch after batch. The apparatus consisted of a 6 x 12 in. (150 x 300 mm) cylinder mold and an arrangement of fixed vertical tracks by which the mold could be raised. The cylinder was filled with concrete, then raised, and the drop of the mass was measured, with the result reported as the "consistency drop" in inches. As far as is known, this was the first successful effort to control the consistency of concrete in the field.

The construction of concrete ships was still a prime consideration at the June 1919 convention, even though the end of World War I was in sight. In fact, the summary of the proceedings of the June 28 session noted: "At this point the proceedings were interrupted long enough to read the announcement of the signing of the treaty of peace at Versailles. The members rose and joined in singing the national anthem."

CHANGES IN EDUCATION

Courses of instruction for civil engineers were changing. Because of the development of reinforced concrete construction, the standard instruction in masonry construction common at the turn of the century had been modified. Such topics as stone cutting, tools for surface finish, and the oblique voussoir arch were no longer of much practical interest to the engineering student. It was recognized that the concrete constructor had been working in advance of the analyst and experimentor. For the student, the design of reinforced concrete structures demanded more intricate analysis and increased application of applied mechanics. The monolithic nature of the construction demanded consideration of continuity and indeterminate action. The study of reinforced concrete also required a course in testing of materials.

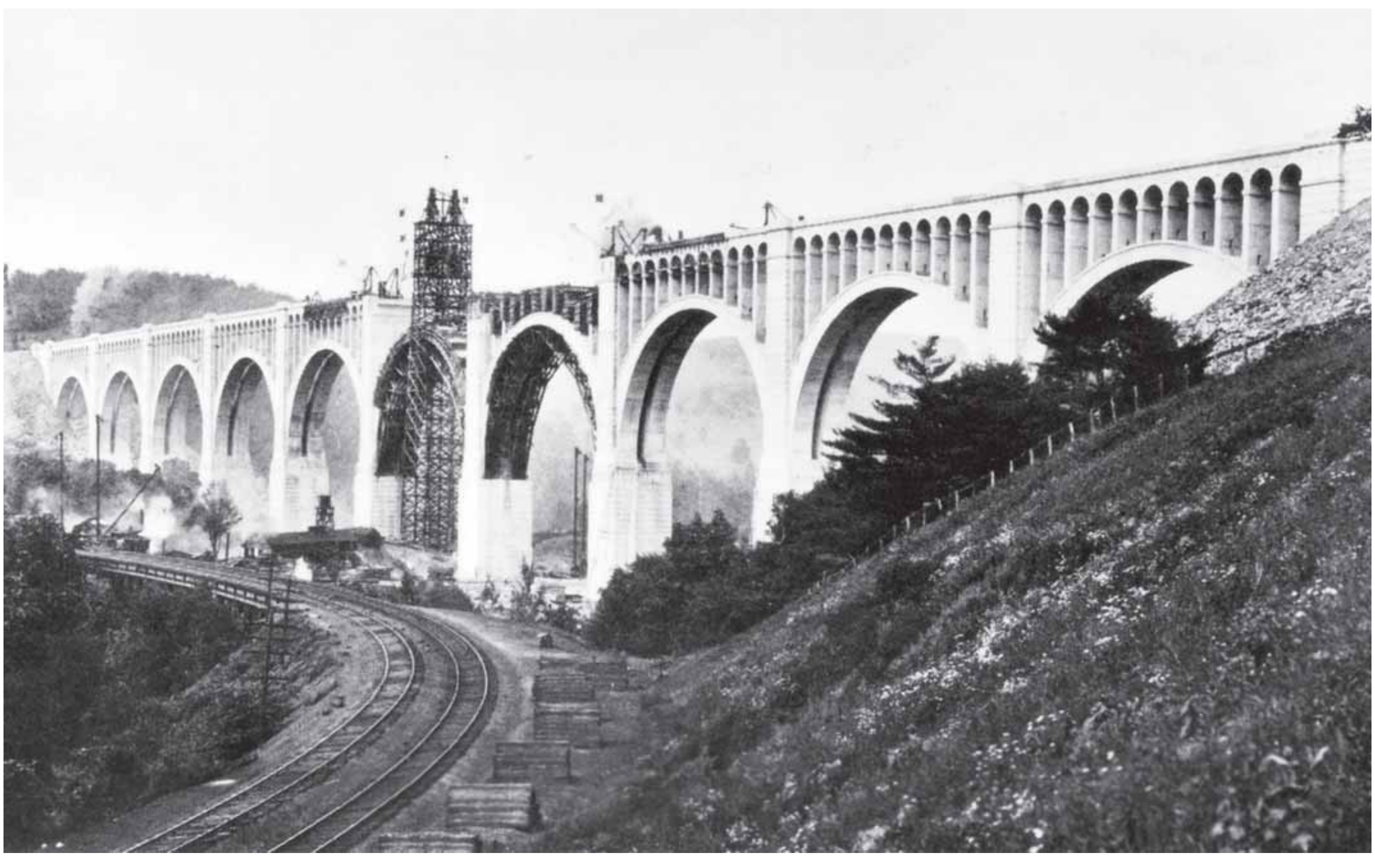
AWARDS REINSTATED

The 1919 convention marked the awarding of the first three Wason Medals "for the most meritorious paper," which had not been awarded during 1916, 1917, and 1918 because of the war. Leonard C. Wason had donated funds for the award in 1914, but production of the medals was postponed until 1919.

Prof. Duff A. Abrams, in accepting the award for his 1918 paper, "Effect of Time of Mixing on the Strength of Concrete," said "....the American Concrete Institute is doing a very wonderful work in promoting the use and extensive knowledge of this material. I believe we are at the beginning of a new era in concrete work."

MOVE TO DETROIT

What later proved to be a significant action for ACI's future took place at a meeting of the Board of Direction on November 5, 1919, at which Harvey Whipple was appointed Secretary with headquarters in Detroit, MI. At that time, Whipple was editor of the magazine, *Concrete-Cement Age*,



The Tunkhannock Viaduct, Nicholson, PA, completed in 1915, was the largest of its kind ever built of reinforced concrete. The double track viaduct consisted of ten 180 ft (55 m) and two 100 ft (30 m) arches with a total length of 2375 ft (724 m). The structure was 242 ft (74 m) high.

and accepted the position of secretary in addition to his duties on the magazine. One of Whipple's first chores was to inaugurate a series of newsletters, published at irregular intervals at first but later on a bimonthly basis.

The ACI Board indicated that there was an urgent need for special committees to investigate standardization of specifications for concrete reinforcement bars, standardization of units of design, proper values for vertical shear, relative merits of different types of concrete floor finish, and the most economical design for contractors' plants for working with reinforced concrete. There was also consideration of the desirability of publishing the Institute's standards in a single volume (an indication of things to come).

THE TWENTIES

The technical committee structure now included a committee on contractors' plants, i.e., the design and arrangement of the site mixing plant and machinery, handling and delivery of materials, all aspects of placing concrete and reinforcement, formwork, and the costs involved. Other new committees were those on plain and reinforced concrete sewers, research, standardization of units of design, storage tanks, and treatment of concrete surfaces. The number of ACI standards had grown to 25. The standard recommended practice for portland cement stucco was one of the first ACI documents to offer recommendations and commentary on facing pages.

The Institute's literature reported on fire tests of columns, form pressures, and application of the water-cement ratio to concrete proportioning. J. C. Pearson and J. J. Earley reported new developments in surface-treated concrete and stucco. Earley made precast members from specially graded aggregates in such a manner that a large percentage of the area of the treated surface (first wire brushed and then washed) was aggregate. Concrete of this type was used in a number of structures in Washington, D.C.

A. W. Stephens analyzed the economic possibilities of lightweight aggregate—a burned clay or shale developed for the shipbuilding program—for use in building construction. Stephens set up cost comparisons for beam-and-girder construction, columns, and flat slabs, and established limits at which lightweight aggregate would be economically feasible for various costs per cubic yard.

STANDARDIZATION

Recognizing the standardization of sizes and shapes already taking place in the steel industry, a special committee on units of design recommended that designers of concrete structures make greater efforts to: 1) use a minimum number of types of footings; 2) maintain the same cross section of columns through several stories; 3) use beam and girder depths that would minimize cost for reinforcing steel and concrete; 4) provide for use of the same forms for floors and roof; 5) maintain the same height within a structure; and 6) reduce the number of lengths and sizes of steel reinforcement. In connection with this last point, the committee on standardizing the specifications for steel bars for concrete reinforcement recommended the adoption of 11 standard bars ranging from 3/8 in. (10 mm) round to 1-1/4 in. (32 mm) square.

After several years of work, "Standard Building Regulations for the Use of Reinforced Concrete" was adopted as a tentative standard of the Institute. A recommended practice for portland-cement stucco covered preparation of surfaces (tile, brick, concrete, concrete block, and frame walls), application of wood and metal lath, preparation of mortar, number and types of stucco coats, and various types of finishes.

"Moments and Stresses in Slabs," by H.M. Westergaard and W.A. Slater (published 1921)—which became a classic in engineering literature—correlated the results of tests for a fairly large number of slab structures with the results of analysis. The report was an aid in the formulation of building regulations for slabs. The three parts of the report consisted of analysis of moments and stresses in slabs; a study of the relation between the observed and computed steel stresses and reinforced concrete beams made for the purpose of assisting in the interpretation of slab tests; and a study of the test results for flat slabs with a view to comparing the moments of the observed steel stresses with the bending moments indicated by the analysis and of estimating the factor of safety.

ACI continued to offer the means for the thorough and intelligent study of every phase of the industry, from concrete products to concrete buildings. Committee work and papers ranged from theoretical engineering problems and research to practical construction methods. While fire resistance and tests of columns and flat slabs received attention, reports were also devoted to plant and equipment for road and building construction. Periodic newsletters reported on the work of committees between annual publication of the Proceedings volumes.

On the recommendation of a special committee on organization, the Board of Direction in 1922 revamped the technical committee structure into five general committees dealing with matters affecting all other committees; two joint committees* on reinforced concrete and concrete pipe; seven engineering design and inspection committees; six committees on special structures (chimneys, bridges and culverts, sewers and conduits, tanks, houses, and roads and pavements); six committees on contracting (plant, floor finish, treatment of concrete surfaces, metal forms, central mixing, and field methods); and seven committees on concrete products manufacture.

One day of the annual meeting was devoted to a discussion of the tentative specifications for concrete and

---

* The Joint Committee on Reinforced Concrete included representatives from the American Concrete Institute, the American Society of Civil Engineers, the American Society for Testing Materials, the Portland Cement Association, and the American Railway Engineering Association. The Joint Committee on Concrete Pipe included representatives from ACI, ASCE, ASTM, AREA, U.S. Bureau of Public Roads, and the American Association of Highway Officials.

KATE GLEASON—CONCRETE HOME BUILDER

Kate Gleason, business executive, industrialist, builder, and philanthropist, was the first (and for a while, the only) woman member of the American Concrete Institute. Her interest in concrete and ACI came about from her responsibilities in the early 1920s as the first woman to become president of a national bank (First National Bank of East Rochester, NY). The bank had lent money to a builder constructing a group of modest homes. When he failed to complete the work, Gleason took it over and did the job herself, introducing some novel uses and applications of concrete. She went on to build Rochester's model community, "Concrest," with more than 100 dwellings.

She promised to tell about her experiences with concrete at the Institute's 1922 convention in Cleveland, OH. Then she went to Europe and almost overstayed. The ship on which she returned to the U.S. was fogbound many hours. Ashore at last, she wired Institute secretary Harvey Whipple that she was taking the next train to Cleveland and was ready to appear "with Paris gown and hat for moral support in undertaking to tell an audience of men how to build homes."

Graduating from high school at 16, Gleason registered at Cornell University for an engineering course and went on to become the first woman member of the American Society of Mechanical Engineers and the first saleswoman of machine tools. She was also involved with building projects in California and South Carolina. She even notched another career first when she was among the first passengers on the Graf Zeppelin's maiden voyage in Germany.

reinforced concrete, submitted as a progress report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, on which ACI was represented. Principal objections to the report were that it was too inflexible and ought to be a performance-type document rather than a rigid specification telling in detail how work should be done, and that it increased costs unduly (mainly because of new methods of specifying and mixing concrete).

EARLY PRESTRESSING

W. S. Hewett's 1923 paper, "A New Method of Constructing Reinforced Concrete Water Tanks," reported use of the concept of prestressing in forming watertight reinforced concrete tanks. He reasoned that concrete in compression was dependable. However, inducing even low tensile stresses in concrete was risky, particularly in structures subject to water pressure where any minute cracks were likely to cause serious trouble. By the use of steel rods and turnbuckles, he placed the concrete in compression to overcome this difficulty. This early use of prestressed concrete differed from present-day practice in that, of necessity, low-strength concrete and steel were used.

STADIUMS

Concrete construction was becoming well established for buildings and roads and also for another type of structure—stadiums. Racing, baseball, and intercollegiate football all required a large seating capacity. While early racecourse and baseball grandstands were usually built with timber seating on structural steel supports, a number of grandstands of a more permanent nature were using concrete. The first permanent stadium for intercollegiate games in the United States was built at Harvard University in about 1903. The project lent impetus to a myriad of reinforced concrete college stadiums.

THE FIRST TWENTY YEARS

In connection with ACI's 20th anniversary in 1924, Richard L. Humphrey in "The Progress of Two Decades" said:

> *"When the Institute was organized the first Joint Committee on Concrete and Reinforced Concrete had just been organized (summer of 1904) and was beginning the important work of preparing its recommendation for these materials which were to serve as a basis for the specifications that had been prepared by the second Joint Committee....*
>
> *"Many will recall the building code fight, especially in New York where producers of competitive materials sensing the growth of a dangerous rival endeavored to have requirements written into building codes to handicap this material and practically prevent its rise. The restrictions were so great that concrete building construction was not possible in Manhattan and but few structures were erected in the territory outside of greater New York. The pioneer work done by Henry C. Turner, Leonard C. Wason, A. L. Johnson, Roos F. Tucker, and others in courageously and persistently working to secure contracts for reinforced concrete buildings and of securing better code provisions has borne fruit beyond belief."*

It is not surprising that the 1924 convention devoted a full day to celebrating the growth of the Institute and the tremendous strides the concrete industry had made in the 20-year period. Summary papers covered the history and growth of almost every segment of the industry: cement, roads, mass concrete, mechanical equipment for handling concrete, reinforced concrete buildings, bridges, foundations, waterfront works, concrete products, architectural concrete, engineering research, and a down-to-earth summary of how to make good concrete.

COLUMNS

In the introduction to " A Study of Bending Moments in Columns," F. E. Richart said:

> "Information on the behavior of reinforced concrete buildings necessary to the proper design of such structures has been accumulated largely in the past 12 or 15 years. The reinforced concrete building is a highly indeterminate structure at best subject only to approximate analysis, but due to the numerous laboratory tests and the investigations of full-size structures there is probably more information now

available on the action of the reinforced concrete structure as a whole and of its elementary parts than there is on other types of construction......Data on the amount and distribution of the bending stresses induced in building columns and on the resistance of columns to combined bending and direct stress are rather meager. Due to the lack of information or to other causes, bending stresses are usually neglected in the design of concrete columns and such stresses are assumed to be provided for together with numerous other effects in the over-all inclusive factor of safety. That buildings are built under these conditions and that they stand up under loads without serious damage does not prove that better methods of design should not be available."

He then showed the amount and distribution of moments in building columns under certain conditions as indicated by analysis and by the results of experiments. Data were also presented on the resistance of columns subjected to both bending and axial stresses.

MATERIALS RESEARCH

A new Joint Committee on Concrete and Reinforced Concrete had been organized in 1920 and issued its report as a "standard specification" in 1924.

Practical problems were again of predominant interest in 1925. President A. E. Lindau noted, "An immense fund of information has been accumulated regarding the properties of concrete, its resistance to the elements, its behavior under stress....We have discovered many fundamental laws governing the making of a satisfactory product....One of the tasks before us is to reduce our knowledge of making good concrete to its simplest terms and carry that message to the man in the office as well as the man on the job." Production of better concrete in the field and in block and products plants was studied. Proportioning and mixing of concrete for buildings, bridges, and highways received more attention as well as column and floor forms and shores. Central mixing plants were coming into use for the production of ready-mixed concrete (based on the successful operation of similar plants for concrete highway paving). Internal vibrators for the consolidation of concrete were introduced in the 1920s. One of the first units, called a vibratory spade, was used on mass concrete projects.

The year 1926 marked the beginning of what would become an annual compilation reporting research on plain and reinforced concrete by various educational institutions and other research agencies. Researchers were devoting attention to plain concrete and concrete materials. Portland cement and high-alumina cements were receiving attention as well as new methods for testing cements. There were numerous investigations on the effects of impurities and grading of aggregates on the properties of concrete. Studies underway on reinforced concrete included subjects such as arches, beams, columns, chimneys, and slabs.

After several years in which papers and reports had advocated the desirability of field control of concrete, the committee on field methods reported in 1927 on the economic advantages of field control—not only for the large or monumental project but for the everyday job. "Field control of concrete" was interpreted by the committee to include the supervision of all the processes of concrete manufacture: quality of constituent materials; design of the mixture; mixing, placing, and curing; and the field tests. Examples were cited whereby scientifically proportioned concrete mixtures reduced the cost and increased the quality of the placed concrete.

20TH ANNIVERSARY DAY—1924

"Cement is the magic of concrete. It was suggested by nature but developed by man. The earliest use of concrete was to simulate a rock. Great rocks could be hewn by nature and placed only by tremendous labor but as concrete huge masses of stone could be placed with water as a vehicle.

"Reinforced concrete is the great romance of concrete. With the introduction of steel, the nature of the material was changed. Instead of remaining a rock resting on the ground it became a tree lifting its bole and branches into the air. The limbs of concrete bear some of our greatest and most useful structures. The fibrous property of reinforced concrete which permitted it to lift its head like a tree in the air, also permitted it to send roots down into the earth, as witness, concrete piles. Not only great massive things such as dams, buildings and bridges, but little things for ordinary use —a block, a length of pipe or a pot can be made of concrete—convincing testimony of the flexibility and general usefulness of this twentieth century material.

"Although the concrete tree is strong, its beauty is not yet enthusiastically received by architects because its optical stimulation is feeble. The full fruition of the tree in all its direct and indirect uses will to a considerable measure depend on our knowledge of what to do with it, which knowledge is being developed by the research and speculative thought of the universities. The development in the past twenty years is but a promise of the future. When science holds full knowledge of the art, when disconnected truths are ordered in a general way, the usefulness of concrete will be limited only by our ability to properly apply it to its uses."

—Author unknown but probably Harvey Whipple,
ACI Secretary-Treasurer, 1921-1952

Continued awareness of the necessity for better field concrete gave rise in 1928 to a group of papers on workability of concrete—attempts to measure it and discussion of the factors affecting it. The Institute was still very much concerned with concrete products, and reports were issued on roofing tile, cast stone, and masonry.

BUILDING REGULATIONS

"Standard Building Regulations for Reinforced Concrete" was proposed—the result of the combined efforts of the ACI committee and the Committee on Engineering Practice of the Concrete Reinforcing Steel Institute. The result was a reconciliation of the differences in the two previously separate codes and their combination into a single code of practice prepared for use as part of a city building code. Concurrent with issuance of the regulations, Arthur R. Lord offered a complete set of designers' tables and diagrams, covering a much wider range of concrete strengths than was previously available to engineers. At that time, use of 2000 psi (14 MPa) concrete was almost universal, except in columns, for common types of structures. Lord pointed out that the use of higher-strength concrete, with only a slight increase in cost, would result in concrete that was more workable, less permeable, and more resistant to outdoor exposures.

F. R. McMillan's *Concrete Primer* developed, in simple terms, the principles governing concrete mixtures and showed how a knowledge of these principles and of the properties of cement could be applied to the production of permanent structures in concrete. Sales of this first edition and subsequent revisions exceeded 100,000 copies. The *Primer* has also been translated into seven languages.

The year 1928 marked the presentation of the first Henry C. Turner Medal for "notable achievement in or service to the concrete industry" to Arthur N. Talbot for outstanding contributions to the knowledge of reinforced concrete design and construction. Outgoing ACI president Maxwell M. Upson recalled that in the early years of the century, the major topics of discussion were: "machinery mixers, handling devices, forms, and the like. Today we use a vocabulary then unknown—workability, fineness modulus, water-cement ratio, etc. They all constitute milestones to mark advancement ..."

EXPANDING SERVICES

By 1929, it was evident that the annual Institute convention and annual volume of *Proceedings* were not adequate to present the vast amount of research data and field information becoming available. Thus, to increase its output of technical information, ACI began publication of the *Journal of the American Concrete Institute*. The first Wason Medal for Research was awarded to S. C. Hollister for "advancing the art of bridge construction in the design, construction and test of a concrete skew arch." A new technical committee structure included about 40 committees divided among nine departments of interest. Some of the committees were essentially the same as former committees, continuing the work that had been undertaken. Most of the new committees had but four members—an author-chairman who was charged with writing the report and three "critics" or reviewers. Most of these committees had limited and definite assignments; when work was completed, the committee was discharged.

It was a notable year in more ways than one. A study of reinforced concrete columns sponsored by ACI was the most comprehensive effort undertaken to that time and was expected to extend their application. Efforts to standardize the building codes of the nation had disclosed wide variation in the method of designing reinforced concrete columns. These differences were not just of formulas but also of resulting permissible loads. It was felt that the study would result in a rational method of design that would permit the most economical use of concrete and steel to meet any load requirements for a given cost basis. Such an investigation was also desirable in view of the trend toward higher concrete strengths. The tests were undertaken in the engineering laboratories of the University of Illinois Experiment Station and the Fritz Engineering Laboratories at Lehigh University.

The first of a new series of specifications, "Construction Specifications for Concrete Work on Ordinary Buildings," was published in 1929. "How-to-do-it" specifications continued to occupy the major attention of ACI technical committees. A report on permissible openings in construction was aimed at reducing abuses during building operations, and one on portland-cement stucco finishes summarized available information on best practices governing a type of construction then prevalent. The Institute released reports on winter concreting methods and specifications for supplying, fabricating, and setting reinforcing steel on ordinary buildings. An interesting and informative guide for workmen, "Steel Setters' Primer," was appended to the latter.

Within the preceding three years, the making and marketing of central plant concrete appeared to have fully established its economic soundness. Although not entirely new either in practice or in principle, the rapid increase in the number of plants and the growing use of ready-mixed concrete led to proposed specifications for ready-mixed concrete and a symposium on the design and operation of central mixing plants. The first formal specifications for

> "The achievement of today was the goal of yesterday. It cannot be the goal for tomorrow. Great as have been the achievements in the field of concrete today, they are only the dreams of yesterday come true."
>
> —*Solom0n C. Hollister*
> ACI President, 1932-1933

ready-mixed concrete are believed to be those proposed in 1930 by ACI Committee 504, Miles N. Clair, author-chairman. (Later, by mutual agreement, it was decided that such work was within the scope of ASTM.)

There were also changes in methods of floor construction as recommended in "Good Practices in Concrete Floor Finish." The old 1:2 specification (1 part cement to 2 parts sand by volume) for floor surfaces was replaced by the new one calling for a somewhat harsher mixture (1 part cement, 1 part coarse sand, 1.5 to 2 parts gravel or crushed stone, and not more than 5 gallons of water per sack of cement).

Volume changes in concrete were also receiving major attention. In the introduction to the paper, "Volumetric Changes in Portland Cement Mortars and Concretes," Raymond E. Davis and G. E. Troxell said, "Of late we are beginning to appreciate that the permanency of a concrete structure is dependent upon more than mere strength and rigidity and that certain other properties concerning which we have little quantitative data are frequently of even greater importance in problems of design. Of these properties, perhaps the one for which the need for adequate information is greatest, yet least is known, is that of portland cement mortars in concrete in changing their volume, not only during the early period of the hardening process but thereafter as variations in moisture conditions occur." An extensive 1930 committee report summarizing the results of investigations having to do with volumetric changes in cement, mortars, and concrete due to causes other than stress was concerned mainly with those changes influenced by moisture conditions and by variations in the temperature of the material.

Cement itself began to be the object of greater notice. Seldom were any of the characteristics of cement presented in earlier test reports, other than it was a standard portland cement and met current standards. The report on variations in standard portland cement was intended to dispel the erroneous idea that there was such a thing as a "standard" portland cement. It was 1930 when ASTM adopted a tentative specification for high early-strength cement.

The design phase of concrete engineering was expanding. There were committees on rigid frame design, design of two-way slabs on beams, design of spiral columns, structural loads and reductions in design, permissible openings in construction, deflections of reinforced concrete members, and fire resistance standards. Architectural design was covered by committees on portland-cement stucco finishes, concrete as a sculptural medium, monolithic concrete surfaces, composite concrete structures, and economics of tall building design.

The changing picture of design methods was perhaps best exemplified by the report of the committee on simplified rigid frame design. Hardy Cross, author-chairman, proposed the method of moment distribution, which became widely accepted by the engineering profession.

CONCRETE PRODUCTS

What changes had taken place in the concrete products field? Since 1925, production of block had more than doubled, with an increasing use of block for above-grade construction. A new recommended practice for the manufacture of concrete block and building tile was issued. Another committee reported on the design of concrete products plants for single or multiple shift operations. New developments in block plants included use of burned shale and cinder aggregates, utilization of high-frequency vibration to consolidate drier concrete mixtures, and increased mixing time.

The publication of abstracts of current periodical and bulletin literature significant in the field of cement and concrete began in the January 1930 *Journal* as a separately printed section. Although not planned as such, this could be called the forerunner of the Institute's *Concrete Abstracts* magazine that was to appear far in the future.

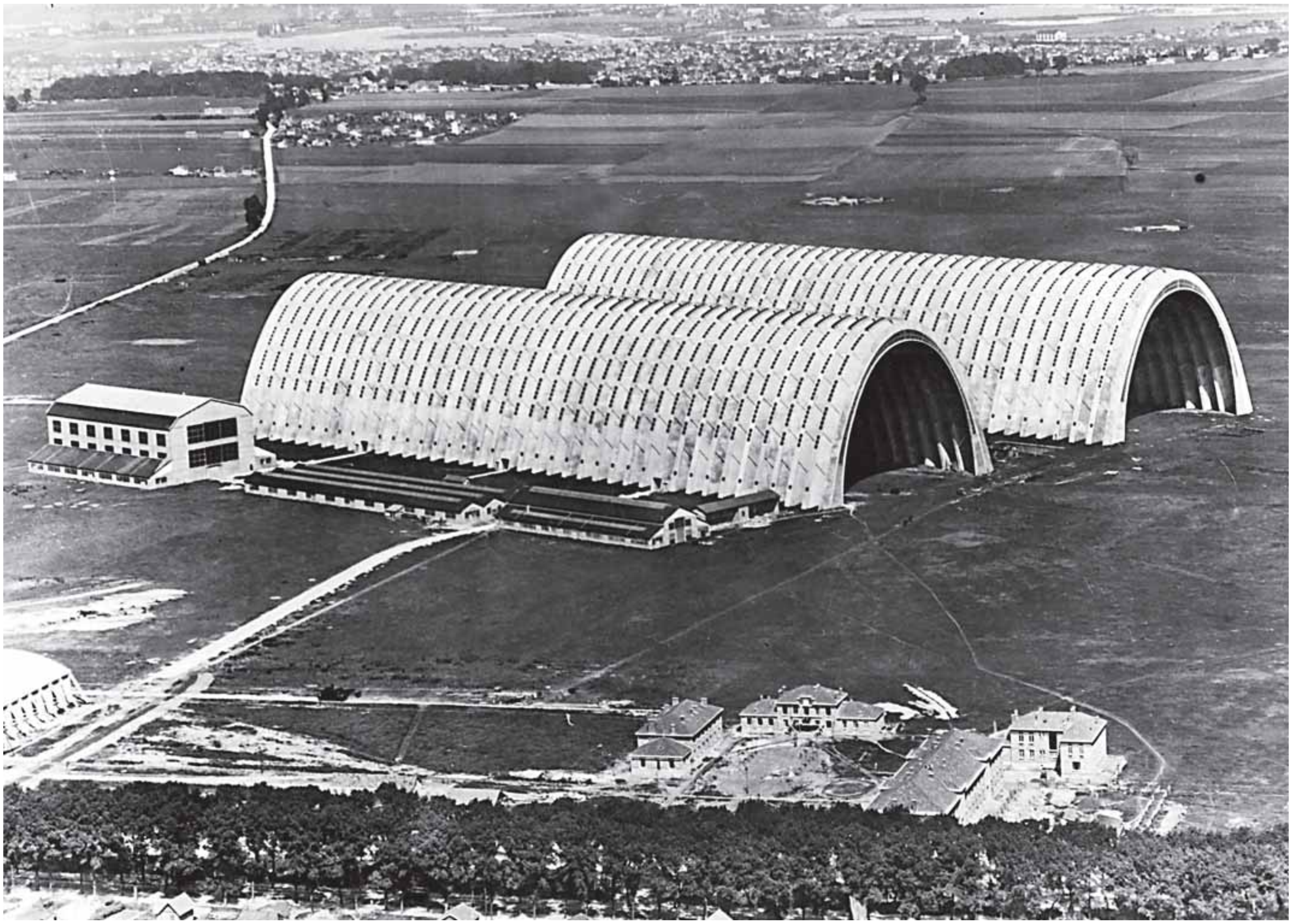
New construction techniques were emerging. Exceedingly dry concrete was now being economically placed on large jobs by use of vibration.

By May 1930, industry requests for information had resulted in the formation of several new committees on effect of vibration on properties of concrete, cinders as an aggregate, design for hurricane exposure, use of lightweight concrete in buildings, and painting on concrete surfaces. A new Joint Committee on Concrete and Reinforced Concrete had also been organized. Committee action resulted in specifications for the small job where full-time inspection was not maintained, and based on the assumption "that such work will be awarded......*to honest contractors only* who can be depended upon to do high grade work." Believing that poor concrete work on small jobs was due to lack of technical knowledge, the specifications were printed on right-hand pages with explanatory notes on left-hand pages.

MASS CONCRETE

Mass concrete studies were assuming particular importance with the impending contracts for construction of Hoover Dam. Along with numerous reports by government agencies and private investigators, ACI Committee 108, in "Properties of Mass Concrete," summarized then-existing data and suggested a program of investigation, much of which was to be fulfilled in the next few years.

A growing demand for information on colored concrete resulted in a proposed recommended practice for the use of pigment admixtures in troweled concrete surfaces. Other Institute committees were studying economics of lightweight concrete in buildings, deflection of reinforced concrete members (a study of beam-and-slab type of construction), and design for hurricane exposure. ACI Committee 105, Reinforced Concrete Column Investigation, published its first and second progress reports from both the University of Illinois and Lehigh University.



One of the earliest applications of mechanical vibration in placing concrete was that used in building the dirigible hangars at Orly, France, 1921-1924. Utilizing a system of corrugated arches—40 corrugations 10 to 18 ft (3 to 6 m) deep—the hangars had a span of about 295 ft (90 m), a rise of about 195 ft (59 m), and were approximately 984 ft (300 m) long. Engineer: E. Freyssinet. Contractor: Enterprises Limousin.
ACI archives. Photo courtesy of Chambre Syndicale des Constructeurs en Ciment Arme de France.

In the ready-mixed concrete business, steel bins had come into general use. The weighing method of controlling material proportions had supplanted the older methods of volumetric measurement, and the use of bulk cement was developing rapidly. It was an opportune time for Committee 603's outline of progress, "Design and Operation of Central Mixing Plants."

A Selection of Concrete and World Events: 1904-1929

This chronology lists some of the events that occurred during 1904 to 1929—a selection of various happenings from numerous resource materials. No claim is made for completeness. No relationship between events is to be inferred. The listings for each year are not necessarily the most important events that took place in those years—but are interesting and/or notable events.

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1904		
Foundation laid for an association of cement users at Louisiana Purchase Exhibition, St. Louis, MO.	Grain elevator is first U.S. slipform project. First reinforced concrete bridge in midwestern U.S. First railroad tunnel under Hudson River between Manhattan and New Jersey.	Theodore Roosevelt was U.S. President. Third modern Olympic games held in St. Louis. U.S. acquired lease on Panama Canal. New York City opened its first subway.
1905		
National Association of Cement Users organized at first convention, Indianapolis, IN. First *Proceedings* volume appeared.	Power applied to wheels of concrete mixer to produce first concrete paver. Albert Kahn designs reinforced concrete factory building for Packard Motor Car Co.	Einstein described Theory of Relativity. There were 24,250 automobiles sold in the U.S., up from 4192 in 1900. Chicago reported more than $80 million spent in construction of buildings.
1906		
Second annual convention held in Milwaukee. Membership was 312. NACU filed incorporation papers in Washington, D.C. First report on laws and ordinances sets NACU/ACI on road to code and standards writing.	Walnut Lane Bridge, Philadelphia, PA, set pattern for concrete arches in U.S. Edison Portland Cement Co.'s new plant was ready to come on-line. French engineers grouted surface of railway tunnel with mortar applied by compressed air.	Wright brothers patented an improved airplane. (First successful flight was in 1903.) Radio telephone was invented. San Francisco devastated by earthquake.
1907		
First standards adopted (on side-walks and hollow building block). Membership was 427, income was $3600, expenses were $2500.	Ross Drive Bridge over Rock Creek Park, Washington, D.C., was first open-spandrel concrete arch design. American Concrete Pipe Association (originally Interstate Cement Tile Manufacturers Association) organized.	Electric vacuum cleaner and electric clothes washer invented. Financial panic hit U.S. R. Baden-Powell established the Boy Scouts.
1908		
Headquarters established in Philadelphia, small staff hired. Membership was more than 600. Nine committee reports: topics included sidewalk specifications, testing cement products, machinery, fire-proofing and insurance, art and architecture.	Thomas A. Edison mass produced 11 homes in concrete. E. S. Ransome introduced sidewalk slipform paving machine. The 47-story concrete Singer Building built in New York. Turneaure and Maurer published *Principles of Reinforced Concrete Construction*.	Postage between U.S. and Great Britain was set at two cents. Sulfanilamide theory described. Henry Ford introduced the Model T automobile.

1909-1912

1909

ACI EVENTS

Executive Board reported a need for larger convention facilities. Contributing Member grade was created to increase income. New voting procedure for standardization proposed.

CONCRETE EVENTS

Portable, horse-drawn concrete mixer used in Sheridan, WY. The first 1-mile (1.6 km) long, [18 ft (5.5 m) wide] rural concrete pavement was placed in Wayne County, MI. Concrete pumped for the first time. Royal Liver Building in Liverpool first concrete-framed British skyscraper.

WORLD EVENTS

First airplane flight over the English Channel. Income tax amendment offered to U.S. Constitution. First wireless message was sent between New York and Chicago. Commander Peary reached North Pole.

A historic marker along Woodward Avenue in Detroit, MI, marks the location of the first mile of rural concrete highway built in the U.S. in 1909. It could be said that the mile-long road was instrumental in "putting the nation on wheels."

1910

ACI EVENTS

Membership was 909. Members were encouraged to use and promote the use of NACU standards. Convention topics included concrete use in Europe and concrete in marine environments. Five standards or proposed standards were presented. First "building code" appeared.

CONCRETE EVENTS

Tilt-up concrete construction was used on a three-story hotel in Arizona. First known concrete shell structure built for railway station, Bercy, Paris, France. Buffalo Bill Dam (originally known as Shoshone Dam) in Wyoming was world's highest concrete arch dam.

WORLD EVENTS

U.S. census tallied 92 million people. The U.S. public debt was $12.41 per capita. Elmer Sperry invents gyrocompass. American Road Makers (founded 1902) changed name to American Road Builders Association.

1911

ACI EVENTS

Membership passed the 1000 mark. Advertising sales and book sales of the 1910 *Proceedings* exceed the cost of producing the volume. The authoritative nature of the information being produced was beginning to be recognized.

CONCRETE EVENTS

Roosevelt Dam on the Salt River, AZ, completed. A precast concrete railroad bridge was built in California. Patents issued to Carl Akeley on the cement gun and what became the gunite (shotcrete) method for applying mortar using compressed air.

WORLD EVENTS

Norwegian explorer Roald Amundsen reaches the South Pole. The first transcontinental U.S. airplane flight was recorded. Standard Oil was broken up into 33 separate companies under the Sherman Antitrust Act. Air conditioning was developed.

1912

ACI EVENTS

The Association's influence was increasing overseas and many standards were being used outside the U.S. Major U.S. cities were adopting NACU standards. A research fund was established to aid Building Laws Committee work.

CONCRETE EVENTS

Tilt-up concrete factory building erected in Chicago. Vast amounts of concrete were being mixed and placed in Panama Canal locks. Memorial Bridge over Tiber River, Rome, used reinforced concrete centering to withstand floods during construction.

WORLD EVENTS

Steamship Titanic sinks on maiden voyage. The 8-hour workday extended to U.S. federal workers by Congress. China, a monarchy since 2205 B.C., became a republic. Packard built first truck to cross the continent under its own power.

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1913		
Name changed to American Concrete Institute to reflect true scope of organization. Wason Medal established. *Proceedings* appeared in form of a journal (venture ends in 1915). Money was short and publication of 1912 *Proceedings* was postponed (published in 1915).	Keokuk Dam opened on Mississippi River between Keokuk, IA, and Hamilton, IL. Baltimore installed 9 ft (3 m) concrete pipe for water under pressure. Concrete was mixed in a central plant and hauled to the job by dump truck for Baltimore project.	Schick test for diphtheria developed. Henry Ford developed first moving assembly line. The Hetrodyne radio receiver developed.
1914		
The Institute had 18 standards available. A committee was appointed to investigate concrete performance during the fire at the New Jersey Edison plant.	First Concrete Road Conference held. Portland cement consumption reached 28 million barrels. One ACI convention paper reported construction without forms where concrete was plastered on ribbed, expanded metal. Construction of Panama Canal completed. ASTM established Committee C9 on Concrete and Concrete Aggregates.	Archduke Ferdinand and his wife were assassinated, touching off World War I. Henry Ford raises wage rates from $2.40 for 9-hour day to $5 for 8 hours. An ordinance proposed in Detroit would limit the height of buildings to ten stories.
1915		
Leonard C. Wason became second ACI president. Richard L. Humphrey had been re-elected to nine consecutive terms for a total of 10 years. Dues doubled to $10 and special drive raised $17,000 to relieve debt. Edison fire report was 110 pages. Short-lived *Journal* ceased publication.	U.S. Bureau of Reclamation slip-forms canal liners. Concrete received high marks in Edison fire report. ACI reported the results of tests on large reinforced concrete columns. Tunkhannock railroad viaduct was largest concrete bridge. Cinderblock was introduced.	First New York to San Francisco telephone call completed. The tungsten light bulb filament invented. The neon light invented. Long-distance radio-telephone developed. Albert Einstein postulated his General Theory of Relativity.
1916		
Institute offices moved to Boston with new president, paid employees discontinued. The First Joint Committee report completed. Membership campaign established with emphasis on contractors.	Portland Cement Association founded. A combination of a steel frame, precast concrete units, and cast-in-place concrete offered as the way to speedy, economical construction. Research on time-dependent deformations (“flow”) was reported. National Aggregates Association organized. A Federal standard formula for a concrete mix was published.	National Research Council of the U.S. National Academy of Sciences was established. Largest Army budget in U.S. history approved—$125,000,000. The military tank was developed. The x-ray tube was developed. U.S. purchased Virgin Islands from Denmark.
1917		
ACI offered its assistance to war effort. Committee appointed to study possibility of a numbering policy for committees. There were 14 committees active.	Finishing machines for pavements were reported. Slag was studied as an aggregate for concrete. Precast concrete unit construction was reported for a wide variety of structures. Structural lightweight concrete developed.	United States entered World War I. Russian Empire collapsed. Constitutional amendment passed by U.S. Senate forbidding manufacture and sale of alcoholic beverages (ratified 1919).
1918		
War curtailed activities. Convention delayed from January to June because of travel restrictions. First two Wason Medals awarded. Question of permanent headquarters raised again. Effect of mixing time on strength reported.	Expanded shale aggregate patented. Slump test developed in California. Abrams’ study on water-cement ratio published. Effect of mixing time on strength studied. Concrete Masonry Association, National Slag Association, and National Stone Association organized. Reinforced concrete ship “Faith” launched.	World War I ended. Czar Nicholas of Russia and his family assassinated. Influenza kills 20 million worldwide. Mass spectroscope developed. Automatic toaster invented.

1919-1924

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1919		
Following a study by a special Board committee, headquarters established in Detroit. Harvey Whipple appointed Secretary. Membership was 350.	The Selma, 7500-ton concrete tanker, commissioned. Mies van der Rohe proposed core-cantilevered floor construction for Berlin skyscraper. Biggest project of year was Brooklyn Army base, a complex of reinforced concrete warehouses.	Versailles Peace Treaty signed (U.S. Senate fails to ratify). Daily airmail service began between New York and Chicago. British dirigible crossed Atlantic from Scotland to New York in 4 days and returned in 3 days. Department of Agriculture's Office of Public Roads and Rural Engineering became Bureau of Public Roads.
1920		
Membership climbed to 573 under new Secretary and staff, beginning a steady climb until 1929. Publication Committee was formed. A newsletter was approved for regular distribution. First consideration given to publishing all standards in a single book.	Interest developed in exposed aggregate finishes and surface treatment of concrete. Longest span concrete arch in the world at 400 ft (122 m) was under construction over the Mississippi River at Minneapolis. First commercial plant dedicated to expanded shale aggregate began operating in Kansas City, MO.	Nineteenth Amendment to Constitution granted women suffrage. First airmail flight from New York to San Francisco. Autogyro developed. League of Nations, established by Versailles Treaty, began in Geneva.
1921		
Financial assistance ($1000) given to aid work of Westergaard and Slater and "Moments and Stresses in Slabs" published. Committee to establish uniform format for standards was established. Harvey Whipple named Treasurer and Secretary and proposed emphasis on field problems of contractors, development of design information, and consideration of problems in product manufacture.	Rigid frame concrete spans used in many grade separation bridges. ACI advocated adoption of ASTM specifications for portland cement. A concrete highway between New York and Atlantic City, NJ, completed.	U.S. peace treaty with Germany declared and signed. Limitation of Armaments Conference convenes in Washington, D.C. First radio broadcast of a baseball game from Polo Grounds in New York City. The "boom" of the Roaring Twenties began.
1922		
Membership reached 890, short of the 1000 goal. Number of active committees was 33. Committees were arranged by groups and numbered for first time. Committee work was coordinated through headquarters.	West Port High School gymnasium, the first lightweight aggregate concrete structure, completed in Kansas City, MO. Shotcreted house in Connecticut reported.	Radar invented. Leaded gasoline developed. Insulin discovered. Benito Mussolini came to power. Soviet states formally establish Soviet Union. About 80% of U.S. highways were inadequate for motor traffic; of 3.2 million miles (5 million km) of roads, only 150,000 miles (241,000 km) were paved.
1923		
Membership was 924, short of 1000. Rules governing standing committees adopted. *Proceedings* included 26 papers and 22 committee reports. Only papers presented at the convention would be considered for publication.	Frank Lloyd Wright's Imperial Hotel, Tokyo, survived earthquake. Water tank "prestressed" with adjustable bands reported. Studies on aggregates suspected of causing concrete deterioration reported. Lightweight expanded shale concrete block introduced.	First sound-on-film motion picture shown. First commercially sponsored radio program. Adolph Hitler lead Beer Hall Putsch in Munich and was sent to prison.
1924		
Institute commemorated 20th anniversary. Final report of the Second Joint Committee. Committees were urged to use ACI newsletter to report progress and reserve convention time for final reports and significant matters. ACI and steel companies adopted standard for 11 reinforcing bar sizes.	Structural performance in the 1923 Japan earthquake was reported in the literature. The economic value of admixtures was discussed. The Concrete Reinforcing Steel Institute was formed. Tests of impure water for use in concrete were reported.	Ford cars sold for as little as $290. Frosted incandescent lamp invented. Olympic games held in Paris. Manmade insecticides used for first time.

1925-1929

	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1925	President Alfred E. Lindau noted that the industry is producing and storing data at a faster pace than it is making use of it. Committees were challenged to recommend needed research to established research institutions. ACI referred subject of shotcrete for restoration of structures to committee for study.	Post-tensioning system for embedded reinforcing bars was patented. Hipped plate construction was used in Germany. Bronx River Parkway, the first public road with entrances and exits rather than intersections, opened in New York.	John T. Scopes arrested for teaching Darwin's Theory of Evolution. Col. "Billy" Mitchell court-martialed for advocating expanded role for airplane in the military. Germany agreed to demilitarize the Rhineland. Caterpillar Tractor Co. formed.
1926	To reduce duplication, proposed and tentative standards were offered as separate preprints, reserving *Proceedings* pages for final documents. Regional meetings considered but decided against. Richard L. Humphrey left Board after 21 years; Board recognition included Honorary Membership. (Formal revision of Bylaws creating this class of member was adopted in 1927.)	One grade of steel (formerly three) and 11 sizes of reinforcing bar (formerly 26) accepted as standards. Research on expansion and contraction reported and the value of wire mesh in controlling them. The effect of curing on strength was reported. Section of Wacker Drive, a double-deck reinforced concrete street, built in Chicago.	Admiral Richard Byrd and Lloyd Bennett flew over the North Pole. Robert H. Goddard demonstrated the practicality of rockets. Gene Tunney defeated Jack Dempsey for the heavyweight boxing championship.
1927	Henry C. Turner Medal for noteworthy achievement was established. Membership passed 2000. Dues were raised from $10.00 to $12.50 when study shows costs per member over $12.00. Eight ACI convention papers discussed time as a factor in making concrete.	End-loop form ties invented. A drop test for measuring workability was reported from Japan. First seismic provisions appeared in 1927 Uniform Building Code. Lone Star cement introduced high early-strength cement.	Charles A. Lindbergh flew solo nonstop New York to Paris. Brookings Institute established. Television invented. Warner Brothers produced the sound film "The Jazz Singer." Holland Tunnel, longest underwater automobile tunnel at the time, between New York and New Jersey opened.
1928	First edition of *Concrete Primer* by F. R. McMillan published. Committee formed to study the publication of a periodical Journal to replace annual *Proceedings* and to investigate the possibility of publishing a 100-page manual of practice on concrete and reinforced concrete.	A method of predicting strength based on water-cement ratio was offered. Concrete block made with lightweight aggregate showed promise. Ford Field, Dearborn, Mich., built a 7 in. (178 mm) thick reinforced concrete pavement 2653 ft (809 m) long runway for the new Ford Trimotor planes.	Television was successfully demonstrated. Iron lung invented. Kellogg-Briand Peace Pact (Pact of Paris) condemned war as an instrument of national policy. Teletype invented. Walt Disney introduced Mickey Mouse. First highway cloverleaf in the U.S. built in New Jersey.
1929	The *ACI Journal* was approved as a monthly periodical, appearing ten times per year. Institute supported column investigations at University of Illinois and Lehigh University. Membership reached 2736 just before The Great Depression, highest number until 1947. Publication Committee authorized to consider papers through an informal body of manuscript readers.	The Cement and Concrete Reference Laboratory was formed. Extensive column investigation underway. Admixtures described as "...one of the liveliest subjects of interest..." Hardy Cross presented his moment distribution method of design of continuous structures. Structural lightweight concrete used in frame and floor system of 28-story Park Plaza Hotel in St. Louis.	Rocket engine developed. Penicillin discovered. U.S. stock market crash triggered country's worst depression. Airship Graf Zeppelin flew around the world. The U.S. Army Engineer Waterways Experiment Station formed in Vicksburg, Miss.

ACI Past Presidents 1904-1929

This pictorial presentation features the past presidents who have guided the American Concrete Institute to leadership in the concrete industry from 1904 to 1929.

Richard L. Humphrey
1905-1914

Leonard C. Wason
1915-1916

William K. Hatt
1917-1919

Henry C. Turner
1920-1921

William P. Anderson
1922-1923

Alfred E. Lindau
1924-1925

Maxwell M. Upson
1926-1927

Edward D. Boyer
1928-1929

1930-1954: An Era of Expansion

In its first 25 years, the American Concrete Institute, including its predecessor, the National Association of Cement Users, had been identified directly or indirectly with most of the research work in the field of concrete. In that time, major subjects for investigation, as either laboratory or field research, or both, included (approximately in the order of their sequence):

1. Longitudinal stresses in reinforced concrete beams;
2. Web stresses in reinforced concrete beams;
3. Distribution of stresses in wide reinforced concrete beams;
4. Stresses in reinforced concrete pipes;
5. Strength of reinforced concrete footings;
6. Stresses and moments in flat slabs;
7. Stresses and moments in slabs supported on girders;
8. Strength of concrete columns;
9. Bond resistance between concrete and steel;
10. Proportioning of concrete to secure high strength, durability, impermeability, and low shrinkage; and
11. Stresses and load distribution in concrete dams.

At the beginning (1905-1911), most attention was given to product plants, construction, and specifications. There was a gradual change during the first quarter-century of the Institute's existence and by 1930-31, the publications reflected a predominant interest in research, with the remainder of the pages nearly equally divided among design, construction, and specifications.

The usefulness of committee contributions was possibly no more evident than in acceptance of the various ACI building codes. By the end of 1931, many municipalities and organizations had adopted in full or in part one of the Institute building codes (editions of 1925, 1927, or 1928), or permitted designs based on them.

Institute committees were not resting on their laurels. Proposed specifications for concrete pavement applied to average conditions in municipalities. ACI Committee 105 made its third and fourth progress reports on the reinforced concrete column investigation; test results were pointing to a new type of design formula for concrete columns. The use of vibration for consolidating concrete was now being recommended over hand tamping for some jobs; it also permitted use of concrete with a lower water-cement ratio.

Perhaps one of the most important reports of 1932 was that on plain and reinforced concrete arches. Considering only fundamental principles, it was the result of an attempt to establish a rational method of determining stresses in concrete arches due to live and permanent loads as affected by plastic flow, shrinkage, and temperature variations.

In 1933, the extensive reinforced concrete column investigation began to come to a close with a tentative final report and minority recommendations. The column tests had not only furnished a fund of new information, but also verified general relations previously established on a more restricted range of materials. In addition to reviewing the principal findings, by way of interpretation, the committee presented recommended design formulas for spirally reinforced concrete columns, tied columns, and splices in vertical bars. Although there was not complete agreement on the formulas, these test results and recommendations were to have a considerable influence on later building codes.

A by-product of Hoover Dam was the engineering knowledge made available for individually smaller but, in time, collectively greater undertakings. While numerous mass concrete structures had been built in spite of incomplete knowledge of all factors involved, an undertaking of this magnitude, involving more concrete than the U.S. Bureau of Reclamation had placed in all other structures since 1902, warranted an investigation to secure fundamental data required for solution of mass concrete problems. The problems involved were manifold, many without precedent. ACI members individually and collectively were connected with many of the investigations, and Institute publications were one means of disseminating the results to the engineering public.

In the architectural field, the unusual and daring use of concrete in the Bahi'a Temple in Illinois prompted the *ACI Journal* to carry a series of papers on the work, and a recommended practice on architectural monolithic concrete construction became available. The 1930s brought a revival of interest in the economic possibilities of concrete houses. In addition to the economy factor, technological advances influencing this new interest were the rapid development of lightweight aggregates, new information on coloring treatments, and commercial production of precast concrete floor joists.

Several important committee reports in 1934 were: proper methods of design and construction of concrete structures to prevent damage from volumetric changes of the concrete, design of two-way slabs on beams, and a proposed standard specification for the design and construction of reinforced concrete chimneys. A series of tests on reinforced concrete T-beams were conducted for the building code committee's use. The building code committee also proposed revisions of the 1928 code with respect to load tests, allowable unit stresses, protection for reinforcement, wind loads, flexural computations and moment coefficients, slabs supported on four sides, shear and diagonal tension, and in bond and anchorage. A proposed spiral column design was based on the results of Committee 105's investigation, and important changes were proposed in connection with the design of bearing walls.

COMMITTEE DIVERSIFICATION

By mid-1931, there were 71 technical committees in operation and the list of current ACI standards, tentative and proposed specifications, and recommended practices totaled 35—eight for masonry units, four for pipe and drain tile, five for reinforced concrete, five for roads and streets, four for sidewalks and floors, four on surfaces, and five on miscellaneous topics (sewer design, ready-mixed concrete, aggregates, measurement of concrete work, and burial vaults).

Changing interests and emphasis were reflected in the formation of new ACI committees on properties of job-cured concrete at early stages; mass concrete; plastic flow; admixtures; effect on concrete of repeated and reversed loads; resistance to impact; bond strength; and relations of cement content, strength, water-cement ratio, and durability. Materials receiving attention were burned clay or shale aggregates and welded-wire fabric as a reinforcing material. New design committees began to function on the topics of minimum permissible thickness of slabs and walls, effect of foundation settlement, moment of inertia of reinforced concrete members, and plain and reinforced concrete arches.

DEVELOPMENTS IN MATERIALS, EQUIPMENT, AND DESIGN

By the end of 1934, technologists were better understanding cement composition and its relation to concrete properties. In turn, greater attention was being given to choosing different cements to fit special conditions. The production and use of cements had advanced to the stage where engineers were recognizing not only standard portland cement, but also a number of special cements such as high early strength, low heat, and sulfate-resistant types.

In 1934, the U.S. Army Corps of Engineers used concrete pumps to build locks on the upper Mississippi River. Contractors were using large-line pumps on big concrete jobs like dams and powerhouses. However, it would be quite a while before concrete pumping was used on smaller projects. By 1935, vibrators had been used with good results in building dams, bridges, and tunnels. Flexible-shaft and motor-in-head vibrators had become available. Consolidation of concrete with vibrators was now widely accepted for both large and small projects.

Design of concrete bridges had been somewhat shackled by the persisting influence of stone and steel construction. The stone or masonry influence was felt in the production of arch designs while the steel influence manifested itself in elaborate precautions to keep concrete beam-and-girder bridges within statically determinate limitations. Continuity had been

The reinforced concrete thin shell American Airlines hangar at Chicago's Midway Airport, built in 1947-1948, was one of the largest commercial airline hangars at the time; eight DC3s could be serviced in each hangar at one time. Each hangar had a clear span of 257 ft (78 m) with a rise of 42 ft (13 m).
ACI archives. Photo courtesy of Ammann and Whitney.

more or less neglected with one exception—the flat slab. Maney's slope deflection method (1918) and Cross' moment distribution method (1929) did much to encourage statically indeterminate design in the U.S. Rigid frame bridges were bringing new economies in span lengths between 40 and 120 ft (12 and 37 m) and popularity of this type of bridge had increased to the point that in 1934 some 150 had been built or started—as many as had been built in the previous 10 years.

The year 1936 marked an important milestone in ACI specification activity. Prior to that time, Institute specifications had covered materials, concrete products, design, manufacturing, and construction practices. By arrangement with ASTM, ACI dropped its specifications for "over-the-counter" engineering materials. In return, ASTM discontinued standardization efforts in design and construction practice. Anticipating this arrangement, the Institute had already given up activities in writing standards for concrete aggregates and had long since relinquished the writing of specifications for portland cement.

One development underway was the stimulation of more committee reports of the "how-to-do-it" kind. A *Manual of Concrete Inspection* was in preparation and another, the *Manual on Standard Details and Methods of Detailing* was under study by ACI Committee 315.

JOINT COMMITTEE PROGRESS REPORT

The Joint Committee on Specifications for Concrete and Reinforced Concrete, as an institution, was almost a year older than the American Concrete Institute. The first Joint Committee was organized in 1904 and made its report 12 years later. The second Joint Committee, organized in 1920, submitted its report in 1924. The third Joint Committee was formed in 1930 under the chairmanship of W. A. Slater, director of the Fritz Engineering Laboratory, Lehigh University; on Slater's death in 1931, Alfred E. Lindau became chairman. The committee included an equal number of representatives from the American Society of Civil Engineers, American Society for Testing Materials, Portland Cement Association, American Concrete Institute, American Railway Engineering Association, and the American Institute of Architects.

In the 1936 progress report, the principal departures from the 1924 report were found in the provisions for design. These gave special consideration to the increasing use of the principle of continuity and the elastic frame analysis in the design of reinforced concrete structures. Because of the essentially monolithic character of reinforced concrete construction, these newer methods were not considered merely as refinements, but as attempts to produce a more rational and better balanced design.

The column provisions were based on the results of exhaustive tests sponsored by the American Concrete Institute, and mainly followed the recommendations of the committee reporting those tests. The safe loads on columns were expressed in terms of the gross area of the column, the ultimate strength of the concrete, and the yield strength of the steel. Spirals were given credit only when present in a sufficient amount to offset the loss of carrying capacity that might result from damage to the shell.

In flat slab construction, the very restrictive formula for slab thickness in the previous report had been abandoned, opening the way to broader use of higher-strength concrete. The provisions for shear and bond had been made somewhat more conservative.

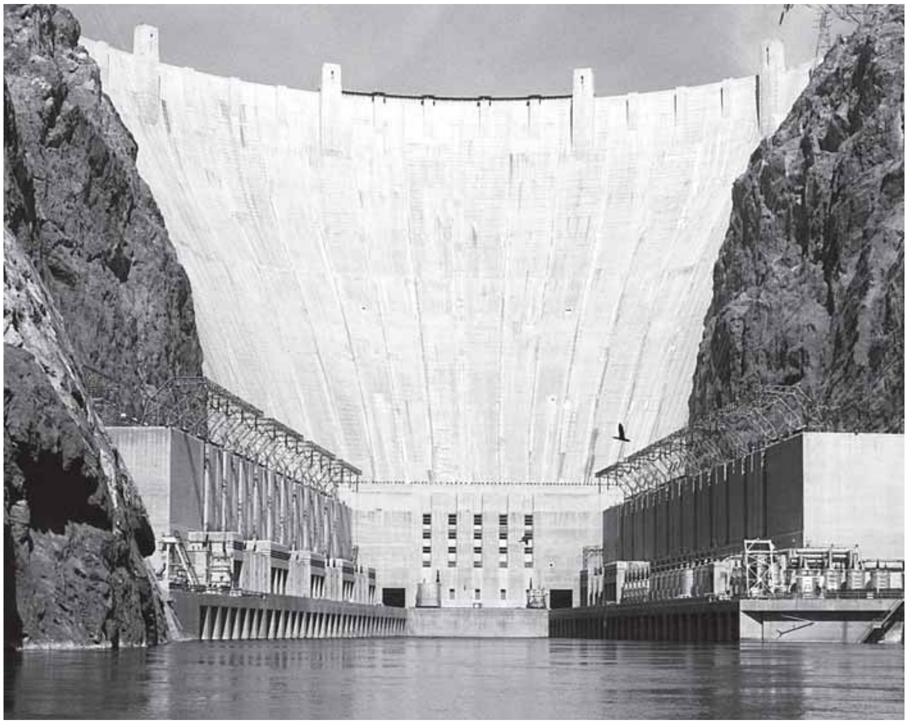
The Joint Committee provided alternate specifications for proportioning concrete. One of these was intended for use where the contractor was specially qualified and offered the services of a concrete technician. It gave the contractor rather wide latitude in the selection of mixtures. The other was for use where the engineer had facilities for making an economic study of available materials in advance of the work and could specify exact mixtures and quantities. In both specifications and recommended practice, emphasis was placed on designing concrete for durability. The strength factor was no longer a primary consideration.

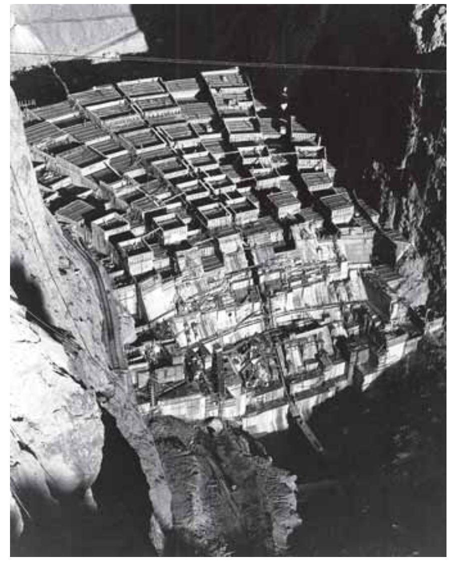
CONSTRUCTION THROUGH THE GREAT DEPRESSION

During the Great Depression, despite falling membership and dwindling income, the Institute persevered, and by 1936 had weathered the storm. However, even at its worst in 1935, Institute membership of 1160 was a long way from the low mark of 430 set in 1919.

Important 1936 reports were those on the economics of ready-mixed versus job-mixed concrete, and on recommendations for using vibration during concrete placement. Chiefly of economic interest to the concrete products field was the report on high early-strength cements in concrete masonry manufacture. Two outstanding committees—ACI Committee 102, Volume Changes in Concrete, under the direction of Raymond E. Davis, and ACI Committee 105, Reinforced Concrete Column Investigation, with W. A. Slater, F. E. Richart, and Inge Lyse in charge, had already made available a wealth of data and given a new insight into behavior of concrete and reinforced concrete under sustained stress. Many investigators had worked to determine the magnitude of volume changes due to elastic deformation, plastic flow, temperature changes, and shrinkage. The literature was voluminous, but little had been published on the utilization of these data in design.

> "Before we can expect the findings of research to be adopted and made a part of current engineering practice, it is necessary that they be understood, abstracted, and molded into a form usable by the practitioner."
>
> —*Frank T. Sheets*
>
> President, Portland Cement Association, during an address at the 34th ACI annual convention in 1938





Hoover Dam was the first modern mega project—the greatest dam constructed in its day. For nearly two years, every day, around the clock, a bucket of concrete was dumped into a form every 60 seconds. The dam was raised to 726 ft (221 m) by placing and cooling concrete in 230 massive blocks (December 1933 photo).
Photo courtesy of the U. S. Bureau of Reclamation.

ACI Committee 313's report on the effect of plastic flow and volume changes on design was the result.

The 33rd annual convention also marked the first annual open session of ACI Committee 115, Research, a feature continued for many ACI conventions. The session was a direct outgrowth of the annual survey of current research in concrete inaugurated around 1937 under the active sponsorship of Inge Lyse, formerly the committee's secretary.

Architectural considerations were receiving so much attention that a new committee combining science, craftsmanship, and architecture was organized to develop specifications and recommended practices for exposed aggregate architectural concrete. The method had already been used successfully in the Baha'i Temple, Edison Memorial Tower, and other structures by John J. Earley, in the preceding 20 years. Another committee was authorized to study specifications and recommended practices for construction of terrazzo floors.

Lightweight concrete pavement for bridge decks received a big boost with completion of the San Francisco-Oakland Bay Bridge in 1936. A $3 million savings in construction cost, and 4 miles (10 km) of six-lane reinforced concrete pavement with scarcely any cracks, resulted from adopting lightweight concrete for paving the upper deck of the bridge.

There had probably been greater advances in the previous decade in design of mass concrete structures, in construction practices, and in knowledge of the effect of various elements upon properties of mass concrete than ever before. Raymond E. Davis and F. R. McMillan, chairman and vice-chairman of ACI Committee 108, respectively, together with the full committee, then supplemented this information by extensive field surveys of more than 60 dams and other structures in service.

The Institute's building code tentatively adopted in 1936 was already the basis of an increasing body of municipal ordinances, in some cases adopted in large part by reference. The building code committee proposed further revision of the tentative 1936 code to bring it up to date. The subcommittee on flat slabs had made an extensive analytical study of the applications of the principles of continuity to design of flat slab structures, and revised this section of the code accordingly . Design problems were not static, however, and the literature included reports on rectangular sections under torsion, bond studies, shearing deformation in continuous beams and rigid frames, circular flat slabs with a central column for underground tanks and reservoirs, eccentrically loaded columns, rigid frame bridges, and shell design. A new committee took on the task of developing a recommended practice for concrete stave manufacture and stave silo construction.

The November 1938 *Journal* introduced a new approach to presenting practice-oriented information in a section called "Job Problems and Practices." It was a way to record problems that arose in practice, and their solutions. It was a place to ask questions and look for the answers.

By 1939, the question of adopting increased allowable unit stresses for high yield-strength steel reinforcement was of current interest. Prestressing was also beginning to attract attention. Several methods had already been devised and used to a limited extent in both the United States and Europe, and various laboratories were studying prestressed concrete construction and prestressed precast units.

One of the Institute's best sellers through the years had been *The Handbook of Reinforced Concrete Building Design*. Its contents appeared for the first time in the 1928 *Proceedings* in a paper by Arthur R. Lord. In the intervening years, the need for a new handbook arose, especially since the code had undergone numerous changes. The need resulted in the organization of Committee 317, A. J. Boase, author-chairman. Later in 1939, the committee produced a new handbook, *Reinforced Concrete Design Handbook*, published cooperatively (as was the previous one) by ACI, PCA, the Concrete Reinforcing Steel Institute, and the Rail Steel Bar Association.

The Institute continued to maintain an interest in masonry. One report presented results of a comprehensive series of tests on concrete masonry units made with seven different aggregates and the effects of two different types of consolidation: tamping and vibration. Another report addressed the problem of building rainproof masonry units.

REVISIONS TO BUILDING CODE

By 1940, many advances in design and construction had occurred since the adoption of the tentative ACI Building Code in 1936. The code committee proposed further revisions that included changes in allowable unit stresses and a simplified section on floors with supports on four sides. The chapter on flat slabs was completely revised to take advantage of the principles of continuity that were coming into general acceptance. There had been major revisions in the chapter on columns and walls. The section on footings had also been revised after an extensive study of means to improve practice in the design of isolated square or rectangular footings.

The committee on precast floor systems for houses had critically examined precast joists and superimposed concrete floor systems. Although at least one joist had been patented in 1902 (by E. L. Ransome), and various systems had been in use for some time, precast joists had only recently become a significant commercial factor. The committee's extensive report covered general engineering considerations and requirements, manufacturing, and recommended practices for the design and construction of precast joist floors.

In response to a need for an outline of good practices for measuring and mixing the ingredients for concrete and for placing the finished product, ACI Committee 614 issued its proposed recommended practice on the subject. This report was the forerunner to another of today's recommended practices issued through the Institute.

FINAL JOINT COMMITTEE REPORT

The final report of the third Joint Committee, organized in 1930, was released in June 1940. Since the 1924 report, significant advances in materials and equipment included increases in the strength of cement, a more widespread understanding of the basic principles of mixtures with greater attention to field control, growth in ready-mixed concrete production, and the increased use of vibration for consolidation. In structural design, the major development undoubtedly had been the increased interest in rigid frame analysis, which recognized the essentially monolithic character of reinforced concrete and provided a more accurate method of stress computation, and hence a more uniform factor of safety.

Important departures from the 1924 report were recommendations for the use of high early-strength cement, recognizing that special cements might be desirable for special uses. In proportioning, emphasis was placed on the durability of concrete. Design sections gave consideration to the principles of continuity and elastic frame analysis . The new column provisions took into account the results of the latest research, particularly the ACI column investigation.

Pier Luigi Nervi's 1936 design of a hangar near Rome, Italy, had a lamella-type shell roof composed of precast reinforced concrete lattice members with only six supporting buttresses. The large ribs were solid, cast-in-place members.
ACI archives. Photo courtesy of Pier Luigi Nervi.

The artificial harbors, given the code name "Mulberry," at the Normandy beaches of France in World War II were instrumental in providing a supply system that helped the Allies win the Battle of Normandy. A major element in the feat was the huge concrete caissons built in Great Britain, floated across the English Channel, and then sunk off the French coast to serve as breakwaters for the harbors.
Photo courtesy of the U.S. Navy.

It was 1940 before additional research was completed related specifically to the effect of plastic flow and shrinkage and to improvements in the method of giving effect to the thrusts and moments in proportioning arch sections. The report of ACI Committee 312 on Plain and Reinforced Concrete Arches summarized much of this work and presented a suggested specification for reinforced concrete arch design. The recommendations represented a rather marked change from then current practice. A new method was presented for design of the arch rib based on ultimate strength formulas and a new approach to the question of factor of safety for members subjected to direct load and flexure.

Intensive work was done by the building code committee following discussion of the proposed revisions at the 1940 convention, and 1941 marked the submittal and subsequent adoption of a new code. Another outstanding contribution was ACI Committee 611's *ACI Manual of Concrete Inspection*, authored by chairman J. W. Kelly. More than five years in preparation, the manual not only told concrete inspectors what they should do, but also the underlying reasons for why they should do it that way. The subject of tolerances was first dealt with in a systematic manner in John R. Nichols' paper, "Tolerances in Building Construction."

The year 1940 marked completion of two notable transportation projects at opposite ends of the country. The Lake Washington Floating Bridge in Seattle, WA, was the largest pontoon bridge in the world and the first to be built of reinforced concrete. The floating structure

SEA-GOING CONCRETE

One of the first instances of the use of reinforced concrete in boat construction was M. Lambot's 1849 canoe-type vessel of cement mortar on a framework of rods and mesh in France.

World War I

It took war to bring about large concrete ship building programs. World War I saw the construction of concrete vessels in both Europe and the U.S. The U.S. Shipping Board Emergency Fleet Corp. designed and constructed a small number of concrete ships, including the S.S. Faith, S.S. Atlantis, and S.S. Selma. The Selma, launched in 1919, was a 7500-ton (6800 tonne) tanker with a reinforced, expanded shale, lightweight concrete hull. While the concrete ships were used some after the war, they could not compete economically with steel hulled vessels.

World War II

With World War II, again came increased interest in concrete as a material for ships—oil barges or lighters and a few self-propelled vessels. Design and construction generally followed that used in World War I. Following the tradition of naming ships after people, the Maritime Commission approved names for the World War II ships that were significant in the field of cement and concrete for 15 of the self-propelled concrete vessels under contract with McCloskey & Co., Tampa, FL. In accordance with the usual practice, numbers were given to non-propelled concrete barges and names to self-propelled vessels. The ships were named as follows:

- *S.S. Vitruvius* (Marcus Vitruvius Pollio)—Concrete engineer for Augustus Caesar during the "Golden Age" of Roman construction of public buildings and aqueducts.
- *S.S. Saylor* (David O. Saylor)—First to manufacture portland cement in the U.S. (Coplay, PA) in about 1872.
- *S.S. Talbot* (Arthur Newell Talbot)—Professor at the University of Illinois famous for his studies in reinforced concrete design and construction; he was the first recipient of the American Concrete Institute's Henry C. Turner Medal in 1928.
- *S.S. Humphrey* (Richard Lewis Humphrey)—First president of the American Concrete Institute. Cement and concrete expert for U.S. Geological Survey; consulting engineer associated with the railroads and cement manufacturing industry.
- *S.S. Meade* (Richard Kidder Meade)—Chemist, Edison Portland Cement Co. 1902; Northampton Portland Cement Co., 1903; Dexter Portland Cement Co., 1904; founder of *Chemical Engineer*, 1904; Director of Meade Testing Laboratory in Allentown, PA, 1908-11.
- *S.S. Slater* (Willis A. Slater)—Well known for his work in concrete research at National Bureau of Standards, University of Illinois, and Lehigh University and on such projects as the tests of Stephenson Creek Dam and the Concrete Ship Program of first world war. He was a Wason Medalist in 1919 for his ACI paper, "Structural Laboratory Investigation in Reinforced Concrete Made by Concrete Ship Section, Emergency Fleet Corporation." Long active in ACI, he was the first chairman of the publications committee organized with the inauguration of the *ACI Journal* in 1929.
- *S.S. Wason* (Leonard Chase Wason) —President, Aberthaw Company, specializing in reinforced concrete, who built bridges, mills and residences, Harvard Stadium, and the largest concrete standpipe for water in the world; second president of ACI.
- *S.S. Smeaton* (John Smeaton)—English civil engineer (1724-1792) credited with first serious attempts to grapple with the question of the cause of the varying hydraulic properties of different lime cements; built Eddystone Lighthouse in 1756

was composed of 25 reinforced concrete pontoons. The Pennsylvania Turnpike was completed with the placing of more than 4 million yd^2 (3.34 million m^2) of 9 in. (230 mm) thick reinforced concrete pavement in 2-1/2 months.

ALKALI-AGGREGATE REACTION

The period 1940-41 is remembered for the attention directed to Parker Dam and alkali-aggregate reaction. This was the first of a collection of contributions on this subject by T. E. Stanton, H. S. Meissner, R. W. Carlson, Bailey Tremper, and others—opening an important new approach to the diagnosis of some concrete "ills." A long-time study of cement performance in concrete was begun by the Portland Cement Association, in both laboratory and field. Reports of this study appeared in the *ACI Journal* through subsequent years. Working in collaboration with the PCA project, a Joint Research Project on Durability of Concrete was organized under the sponsorship of the Highway Research Board, ASTM International, and ACI.

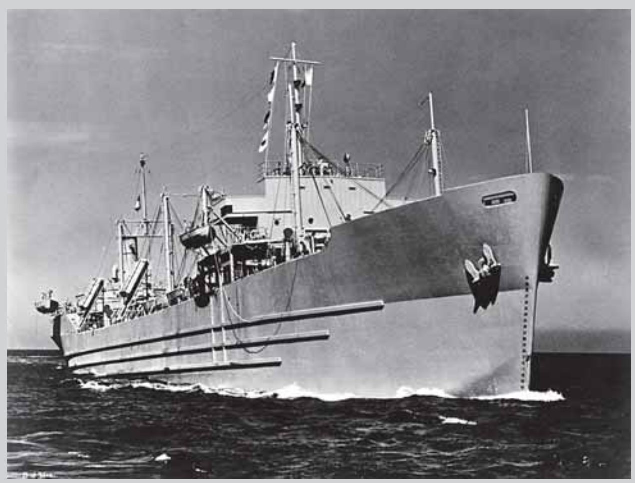
A proposed recommended practice for the design of concrete mixtures was submitted in early 1942. The committee, recognizing that it was almost impossible to develop a procedure that would fit all jobs and any combination of conditions, outlined a basic concept of mixture proportions based on the water-cement ratio. A new specification for cast stone was proposed to supersede the 1929 tentative specification.

Among the concrete industry's notable events of the period was the construction of the Tennessee Valley Authority's (TVA) original network of 16 dams between

to 1759, developing "a cement the most perfect possible to resist the extreme violence of the sea." The lighthouse stood for 120 years and was removed when the foundations were threatened by erosion of underlying rock.

- *S.S. Aspdin* (Joseph Aspdin)—Generally credited with being the inventor or originator of portland cement in 1824. This cement, as he originally prepared it, was obtained by lightly calcining a mixture of lime and clay and grinding the product; it was so named because its color resembled the chalk cliffs at Portland, England.
- *S.S. Grant* (John Grant)—British, 19th century; first to go thoroughly into the question of cement testing, and his experiments and researches made him an authority on the subject.
- *S.S. LeChatelier* (M. H. LeChatelier)—French chemist who developed the chemical formula for portland cement, establishing minimum and maximum limits of the component parts. Several tests on cements are based on his early work.
- *S.S. Vicat* (L. V. Vicat)—French, early 19th century, studied cement chemistry, developing basic knowledge in this field, greatly influencing modern tests and technical knowledge and practice.
- *S.S. Lesley* (Robert Whitman Lesley)—Founded the cement firm of Lesley and Trinkle, Philadelphia, PA, 1874; associate of Saylor; took patents on manufacture of cement; performed an important service in commercial development and introduction of American portland cement; was first president of American Portland Cement Manufacturers (Portland Cement Association); and served as treasurer of NACU/ACI in the early years.
- *S.S. Thacher* (Edwin Thacher)—Rensselaer Polytechnic Institute, 1863; inventor and patentee of Thacher's cylindrical slide rule, improved duplex slide rule, developed bar for reinforcing concrete, and system for concrete-steel floors.
- *S.S. Pasley* (C. W. Pasley)—British, 19th century; began in 1828 to investigate methods of improving on natural and Roman cements, trying to produce an artificial hydraulic cement. He worked independently of Aspdin toward the same end, but two years later than Aspdin; developed tensile strength testing techniques.

Many months before D-Day in Normandy (World War II), the Bureau of Yards and Docks, U.S. Navy, designed a landing craft of concrete and called on Corbetta Construction Co. to develop a practical method of construction. The outcome was a unique solution—a thin-wall concrete vessel combining precast sections, shotcrete, and cast-in-place concrete. The thin-wall [3/4 in. (19 mm) and 1-1/2 in. (38 mm) walls] concrete LCT duplicated the over-all dimensions and carrying capacity of the steel LCT. How well did the concrete LCT standup? The ship outrode a hurricane and made landings on gravel-strewn beaches under simulated wartime conditions and stood up well.



Dry-cargo, self-propelled concrete ship built during World War II by U.S. Maritime Commission. The hull shell was 6-1/2 in. (165 mm) and contained from three to five layers of closely-spaced reinforcing. Cover over the steel was 3/4 in. (19 mm) on the outboard face and 1/2 in. (12 mm) on the inboard face.
Photo credit: ACI archives. Photo courtesy of Lewis H. Tuthill.

Thomas A. Edison developed a mass production system of building concrete houses in one-piece metal molds circa 1910. R. G. LeTourneau took the method to new heights in the 1940-1950 decade. One of the most notable attempts at large-scale concrete prefabrication of homes was the LeTourneau process invented in 1946. The house-molding machine was used to build a neighborhood in Longview, TX, in the late 1940s and later in Haifa, Israel, in the 1950s.

The process was only used for housing projects with over 100 units due to the high cost of transporting the machinery and site development. A concrete slab was cast in place. A prefabricated cage containing reinforcing rods, electrical and plumbing conduits, and windows and doors was placed on the slab. A large rolling assembly containing the metal inner and outer formwork was then lowered over the cage. After the concrete had been placed and cured, the assembly was raised to reveal a complete concrete house. *ACI archives. Photo courtesy of Government Press Division, State of Israel.*

1933 and 1944. The massive effort was spurred by economic pressures of the Great Depression and later by wartime demands for electric power. TVA's 480 ft (146 m) Fontana Dam on the Little Tennessee River was the United States' highest dam east of the Rocky Mountains.

WORLD WAR II REGULATIONS

World War II brought with it the need for maximum utilization of critical materials and increased efficiency in the use of labor. The seriousness of the problem was reflected in the proposal that the ACI Building Code be modified in furtherance of the proposed National Emergency Code for the conservation of steel and other strategic materials, chiefly for defense construction of a temporary nature where time was urgent and steel supplies were low. However, the predominant view was that significant savings could be made without modifying the ACI Building Code. Rather than code changes, some type of emergency regulations seemed preferable.

This latter concept resulted in issuance by the War Production Board of a set of "National Emergency Specifications for Design of Reinforced Concrete Buildings" to conserve steel in buildings constructed for the government. The directive required the use of larger structural members and higher tensile stresses than normally prevailed. Wherever practicable, the width and depth of members were increased to minimize use of compressive and web reinforcement. Allowable compressive stresses in concrete were reduced. Stresses for steel increased from 18,000 to 20,000 psi (124 to 138 MPa) for structural grade bars and 20,000 to 24,000 psi (138 to 165 MPa) for intermediate and hard grade bars. These temporary measures also called for the use, where practicable, of unreinforced concrete. For guidance on the latter point, ACI Committee 322 issued proposed recommended stresses for unreinforced concrete. Because military vehicles and movement of unusually heavy loads related to the war effort were far in excess of the loadings contemplated when many highway bridges were built, the committee on safe loads for existing bridges published a proposed method for estimating their capacities. Problems in the design of bomb-resistant air raid shelters were analyzed on the basis of the degree of protection acceptable in the structure under consideration.

Realizing that the procedure for adopting a new standard or for changing an existing one requires considerable time, ACI established emergency standard-making procedures during World War II (which could be used again in the event of future emergencies).

Among some of the more notable wartime construction events (although not related to concrete) were the activation of the Naval Construction Battalions (Seabees)—Admiral Ben Moreell, ACI's 1941 president, was credited with the idea—and the construction of the Alaska (Al-Con) Highway by the Army Corps of Engineers.

In the face of statements from the Office of Defense Transportation (ODT) about curtailing passenger traffic, ACI cancelled, for the first time in 38 years of Institute history, the 1943 annual convention scheduled for Chicago except for a "token" brief meeting. The 1944 convention in Chicago drew 376 attendees. The 1945 convention in New York City was again curtailed at the request of ODT.

During the war period, great technical progress was made in the practice of reinforced concrete design. Faced with a shortage of some of the common construction materials (e.g., steel) and antiquated building codes, the government's emergency measures encouraged the concrete designer and constructor to develop startling advances in economy of design, utility of structure, and speed of construction. The concrete reinforcing bar industry was being encouraged by the War Production Board Conservation Division to develop improved deformed bars to conserve steel and a number of new or modified types of bars were under development. ACI Committee 208 was asked to determine a standard bond test and shortly thereafter issued a proposed test procedure to determine relative bond value of reinforcing bars.

In the spring and summer of 1941, when it was feared that production of steel plate might not be sufficient to meet the demand for more ships, the U.S. Maritime Commission investigated the development of reinforced concrete vessels. Construction of shipyard facilities, and later, hulls, began during 1942 and deliveries of concrete vessels started in 1943. There were five concrete shipyards in operation, offering five different designs. More than 100 vessels were built: oil barges, lighters, and dry-cargo vessels. The ships did not differ much in design from those built during World War I. Steel vessels of similar type and cargo capacity would have required 20 to 40% more steel (most of it plate) instead of the relatively plentiful steel reinforcing bars in concrete vessels. The concrete ships and barges consistently performed favorably; they handled well even in the most turbulent seas and were resistant to fire and damage from close explosions.

It appears that the costs of the concrete ships in the program were not out of line when considering the shortage of steel and wartime conditions. All the hulls were reported dry and with little condensation; a cargo of Canadian wheat loaded in bulk against the concrete hull arrived in San Francisco without a kernel being sprouted or any grains swelled or stuck together. Seaworthiness was demonstrated under extreme conditions by the S.S. Aspdin when it headed into a hurricane off Cape Hatteras in September 1944. According to the captain's report, the ship "behaved admirably throughout the hurricane. She pitched somewhat, but there was no rolling, panting, weaving, or pounding......The wind was estimated at 120 mph (190 kmh) and the waves from 50 to 100 ft (15 to 30 m) in height." It was reported that sailors, after becoming acquainted with the special characteristics (and idea) of a concrete ship, generally preferred to stay with the concrete ships.

Reinforced concrete also played a major role in construction of the seafaring World War II "Mulberry" harbors at the Normandy beaches of France during and following D-Day. The total project was probably the greatest military engineering enterprise undertaken since the Persian armies crossed over the Bosphorous on a pontoon bridge in 400 BC. Large "Phoenix" reinforced concrete caissons were built in various docks in Great Britain, towed across the English Channel, and sunk into position as breakwaters forming temporary harbors. The largest caissons were 197 ft (60 m) long, 58 ft (17 m) wide, and 59 ft (18 m) high. A list of those involved read like a "Who's Who" of British engineering and construction. With artificial harbors, the Allied armies were able to profit from a supply system instrumental in winning the Battle of Normandy.

AIR-ENTRAINED CONCRETE

The previous trickle of information on air-entrained concrete became a flood with the publication of a 64-page symposium by a number of experts guided by Frank H. Jackson. Increased durability of air-entrained concrete; effect of entrained air on strength, yield, and mixture proportions; inability of air entrainment to correct unsound aggregate; effect of sand grading and richness of mix; air-entraining cements; and the addition of agents at the mixer were discussed in detail.

The issues related to the use of admixtures in concrete were thoroughly reviewed by an Institute committee. Its report discussed accelerators, air-entraining agents,

Concrete shell structures show up in everyday service. Left: Built around 1930, this was a Shell Oil Co. service station (now a repair shop) in Winston-Salem, NC. Although eight of these stations were built, this is the only one remaining and is now listed on the National Register. Right: A 1962 Gulf Oil Co. service station was much bigger and featured multiple shells in dramatic fashion.
ACI archives. Photos courtesy of JoAnn Sieburg-Baker (left) and Gulf Oil Co. (right).

A group of ACI presidents sit for a rare photograph in 1952 (with presidential year noted). Standing (left to right): Fred F. VanAtta, assistant secretary; Robert F. Blanks (1948); Harrison F. Gonnerman (1946); Harry F. Thomson (1951); A. T. Goldbeck (1952); Frank H. Jackson (1950); Stanton Walker (1947). Seated (left to right): Morton O. Withey (1943); Douglas E. Parsons (1945); Harvey Whipple, secretary-treasurer; Raymond E. Davis (1942); Roderick B. Young (1940); Herbert J. Gilkey (1949).

gas-forming agents, natural cementing materials, pozzolans, retarders, water-repelling agents, and workability agents.

The first *ACI Book of Standards*, issued as a separate publication in 1945, was a slim one; it contained six standards: the 318-41 Building Code; three recommended practices: on use of metal supports for reinforcement (319-42), design of concrete mixtures (613-44), and measuring, mixing and placing concrete (614-42); and two specifications: on concrete pavements and bases (617-44), and cast stone (704-44). The book did not contain proposed standards nor standards ratified prior to 1937 (all of which were under review in one way or another).

The second Institute symposium on air-entrained concrete in 1946 added greatly to the growth and acceptance of air entrainment to enhance concrete durability. Subject matter included laboratory studies of concrete containing air-entraining admixtures, mixture proportioning experiences in ready-mixed concrete operations and paving jobs, types of equipment for dispensing air-entraining agents, and devices for measuring the amount of air actually entrained.

Air entrainment continued to get attention in 1949 with new information on factors affecting air entrainment, experiences and tests with air-entraining agents, air-entrained concrete in pavements, and a method of determining the air content of fresh and hardened concrete. The results of tests at the Bureau of Reclamation and the Bureau of Standards furnished basic data on a variety of lightweight aggregates and their uses in concrete. Committee work resulted in adoption of a recommended practice for the application of portland- cement paint to concrete surfaces.

OTHER DEVELOPMENTS

Two new standards were adopted for precast concrete floor units and the construction of farm silos. The first specified minimum requirements of materials, manufacture, and testing of such members and defined and established design requirements for I-beam and hollow-core joists The second contained recommendations for use in the design of concrete stave, block, and monolithic silos for the storage of grass or corn silage.

After several years of intensive work, ACI Committee 315 completed a "Proposed Manual of Standard Practice for Detailing Reinforced Concrete Structures" in 1946 with the cooperation of the Concrete Reinforcing Steel Institute. Until then, there had been little uniformity in the preparation of engineering and placing drawings, with a consequent waste of effort in interpreting them and frequent misunderstandings. The manual was the only publication of its kind and was recognized as an important tool for draftsmen, designers, and engineering students. Within 30 days after its release, it was at the top of the ACI best-seller list.

ACI Journal publication had begun with the November 1929 issue on the basis of ten issues a year. Depression years resulted in schedule changes settling to six issues a year, and continuing during the war years. The *ACI Journal* returned to a ten-issue schedule in 1946.

An extensive study of the physical properties of hardened portland cement paste appeared in the *Proceedings* pages through 1946 and 1947, and later resulted in a Wason Medal for Materials Research for authors T. C. Powers and T. L. Brownyard.

Two concrete storehouses for the U.S. Navy's supply depot in Mechanicsburg, PA, were the first structures built entirely of prefabricated concrete elements utilizing the thin-shell technique. The project in its entirety constituted a pioneering undertaking. This was true for design and framing arrangements, as well as for fabrication and erection procedures. Another building method—tilt-up construction—had progressed on a relatively small scale until 1946 when real progress began in its application. In that year, more than 1950 houses and 35 commercial and industrial buildings were completed or under construction.

FORMATION OF TAC

In 1947, the Technical Activities Committee (TAC) was formed to provide better control of Institute affairs. The Institute's technical work had for some years been shared by a program committee, an advisory committee, and a publications committee. These had been consolidated into two committees, and with the new TAC, into one. Consideration was being given to holding occasional meetings around the country in addition to the annual convention, and the first regional meeting was held in October 1947 in Birmingham, AL. For many years, the staff at headquarters in Detroit consisted of only three people; by 1947, the staff had increased to eight.

The first four chapters of the long-time study of cement performance in concrete appeared in 1948. Resistance of concrete to destructive agents was of primary interest, although precast concrete and concrete houses also received attention. An important new committee on the structural design of concrete pavements for highways and airports was organized. To encourage uniformity in delineation of reinforcing steel on design drawings, the *ACI Detailing Manual*, a manual of standard practice for detailing reinforced concrete structures, was adopted as a full standard in 1951. It has become widely used in engineering offices and educational institutions throughout the country. Approved at the same time was the standard on recommended practice for winter concreting.

The ACI Committee 115 annual research session always had strict time limits for the presentation of brief reports. Prof. George W. Washa, University of Wisconsin and 115 secretary (left), and Prof. Stephen J. Chamberlin, Iowa State University and 115 chairman, apparently had four eyes on the watch during this session in 1948.

LONG-RANGE PLANS

The Institute had survived two global wars and the worst economic depression in U.S. history. The future looked bright, but further preparations were called for. The Board of Direction moved to create a long-range plan, and adopted a number of long-range goals that included:

- doubling the Institute membership in ten years;
- increasing the number of and quality of technical papers, and broadening the scope to include more practical information;
- increasing the quantity and scope of technical committee reports;
- improving the quality of convention programs;
- encouraging more discussion of papers and reports; and
- holding regional meetings and developing local conferences.

(There were to be a number of long-range goal reports in the years to come.)

For many years, methods used in the design of reinforced concrete footings had been based largely on studies by A. N. Talbot published in 1913. In the meantime, there had been many developments in materials and design methods. This led to new studies by Frank E. Richart at the University of Illinois on reinforced concrete wall and column footings—studies that would later affect design procedures. At the same time, C. P. Siess and N. M. Newmark, also at the University of Illinois, proposed a new method of designing flat slabs.

A 1949 Iowa half-mile paving project introduced the precursor of slipform paving machines. Named after the Iowa highway engineer who conceived it, the 10 ft (3 m) wide, self-propelled "Jimmy Johnson" slipform paver made two passes to pave a 20 ft (6 m) wide pavement. Slipform paving technology advanced rapidly in the 1950s and 60s.

After 24 years in the "Uptown" region of Detroit—18 of them in the New Center Building—the Institute moved into a new leased one-story concrete masonry structure in the northwest area of Detroit in late 1949. ACI had moved within the New Center Building (the first lease was signed in 1931) several times, but the space available had not kept pace with ACI needs.

THE EARLY 1950s

By 1950, more information on precast and prestressed concrete became available in papers on corrosion protection of thin precast sections, spacing of moment bars in precast joists, proposed specifications for minimum bar spacing and protective cover in precast concrete framing members, extent and acceptability of cracking in precast concrete framing members, patents and codes relating to prestressed concrete, and prestressed concrete construction procedures. Prestressed concrete was relatively new in the U.S. So much had been written about prestressed concrete that in 1950, one author said: "To date 43 books and more than 500 articles have been published; almost as many as the number of prestressed concrete structures which have been built in the world up to this time." The whole field of prestressed concrete design was in a fluid state; there was disagreement among designers about safety factors, design notations, steel stresses, and many other considerations. The industry was not yet ready to write a code for prestressed concrete as it had for reinforced concrete.

Raymond C. Reese traced the development of reinforcing bars from the original plain round or square forms to the present deformed patterns through the early work of Morton O. Withey and Duff A. Abrams to the 1949 report of Arthur P. Clark's tests. Noting that ASTM had adopted a standard for deformed bars, he emphasized the need for revision of design specifications to take into account the characteristics of the improved bars. The new-style deformed bars, with higher, closely-spaced deformations, were proving their superiority in bonding to the concrete. The ACI committee on bond stress reported allowable unit stresses in concrete reinforced with the new-style deformed bars.

Prior to building the first headquarters facility in Detroit, architect Minoru Yamasaki (left) views a model of the proposed building with Building Committee chairman Henry L. Kennedy (center, 1953 ACI president) and 1956 ACI president Frank Kerekes.

William A. Maples was executive director of ACI from 1953 to 1975.

The building code and detailing manual were modified in l951 to allow for the improved bond characteristics of deformed bars conforming to ASTM Designation A 305. A new standard recommended practice for the application of mortar by pneumatic pressure was issued. To avoid the cumbersome term "pneumatically-placed mortar," the word "shotcrete" was used in the report. It discussed the advantages and disadvantages of pneumatically-placed mortar (shotcrete) and established recommended practices for placing and mixing shotcrete, qualifications and duties of workers, preparation of surface before shotcreting, reinforcement, sequence of application, and curing.

Another sign of changing times was the fact that the Institute inaugurated a service that made issues of the *ACI Journal* available on microfilm, recognizing that public and private libraries were facing problems in providing storage space for technical proceedings.

As a continuation of its 1944 reports, ACI Committee 212 presented a compilation of information on admixtures in as simple terms as possible. Although recognizing the ever-increasing importance of admixtures, particularly as related to pozzolanic materials and air-entraining agents, the committee was not yet ready to present usage recommendations. Precast reinforced concrete floor systems made from I-beam and hollow-core joists were still popular and were described in ACI 711-46 ("Minimum Standard Requirements for Precast Concrete Floor Units"). However, other systems had been developed and were adding to the popularity of precast construction. Tilt-up construction of buildings was extensively used in the southwestern part of the U.S.

In 1952, the Concrete Reinforcing Steel Institute (CRSI) published the *CRSI Design Handbook* after seven years of work under the direction of Raymond C. Reese. The handbook, intended to make the selection and design of reinforced concrete structures almost as simple as those of steel, contained tables and charts for the design of practically every type of beam, column, slab, and wall for virtually every reasonable loading condition.

In 1952, the Institute sponsored a symposium on ultimate load/ultimate strength design (the terms were being used interchangeably). The symposium reviewed research and fundamental concepts, offered practical design examples, and discussed load factors. Several countries, e.g., Brazil and Czechoslovakia, permitted ultimate load design as an alternate method and Russia had made it mandatory. While speakers encouraged more research, they suggested that the application of ultimate load design theory would provide a more realistic concept and simplification of design equations as compared to the straight line theory.

The highlight of the 1952 convention was a special luncheon in honor of Harvey Whipple, who after 32 years as secretary-treasurer of the Institute, retired to become an editorial consultant. Many of those in the industry heard retiring president H. F. Thomson remark:

> "With the close of this convention, our organization passes an important milestone or rather a 32nd milestone as that is the length of service by Harvey Whipple, as our secretary and subsequently our secretary-treasurer. To many of our members and friends, his personality has epitomized the energy, the judgement, and the foresight of the Institute. He has earned the title among this generation of 'Mr. ACI.'"

Fred F. Van Atta was named acting secretary-treasurer in 1952 following Whipple's retirement. Upon his resignation, William A. Maples was selected in the fall of 1953 and served as secretary-treasurer/executive secretary/executive director until his retirement in 1975.

The Centennial of Engineering celebration in Chicago in 1952 marked the 100th birthday of the formal establishment of engineering in the U.S. as distinct from military engineering on a recognized professional basis. The American Society of Civil Engineers was founded in 1852. The term "civil" at that time was used to differentiate the work of the civilian engineer from that of the military engineer. ACI was one of the first to list itself among the Centennial participants and held its 1952 regional (fall) meeting in Chicago.

The intense and growing interest in prestressed concrete was forcefully demonstrated by an attendance of more than 900 at a 1952 conference sponsored by ACI and ASCE. The first U.S. prestressed bridge had been built in 1950 and, in the intervening two years, there were several major projects under way, with 34 plants producing prestressed concrete elements on a production basis.

The committee on reinforced concrete chimneys, in 1953, proposed a standard specification for the design and construction of such structures, to replace a tentative standard adopted in 1936. Included were recommended loadings and methods for determining stresses in concrete and reinforcement resulting from these loadings. The specification covered specialized requirements for mixing and placing concrete, recommended practice for linings where required, and chimney accessories.

To provide for the specialized requirements of the highway field, a manual of standard practice for detailing reinforced concrete highway structures, prepared in cooperation with CRSI and the American Association of State Highway Officials (AASHO), was adopted in 1953 as a companion piece to the earlier detailing manual for structures. The two publications were eventually combined into one manual.

Although shell construction had its beginning in the great domes of antiquity, there was increased interest in reinforced concrete and precast shell construction in the U.S.—especially for hangars, warehouses, and auditoriums—resulting in some spectacular structures. The development of the jet aircraft engine was changing the future of aviation and also affecting concrete developments. Durable structural refractory concrete and construction methods were developed to withstand the deteriorating effects of heat, temperature shock, and cycling when engines were tested during development and production.

A Selection of Concrete and World Events: 1930-1954

This chronology lists some of the events that occurred during 1930 to 1954—a selection of various happenings from numerous resource materials. No claim is made for completeness. No relationship between events is to be inferred. The listings for each year are not necessarily the most important events that took place in those years—but are interesting and/or notable events.

1930-1932

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1930		
Deficit budget, cost-cutting, reduction of *Journal* pages result from the Depression. Committee structure completely overhauled creating nine departments and 39 committees. All committees appointed annually. First formal specification for ready-mixed concrete.	First progress report of column study published. Coolidge Dam in Arizona dedicated. National Ready Mixed Concrete Association and Wire Reinforcement Institute organized. Low-heat cement and cooling coils selected for use on Hoover Dam.	London Naval Reduction Treaty signed by U.S., Britain, Italy, France, and Japan. Max Schmeling of Germany claimed heavyweight boxing title. Bobby Jones of the U.S. won the "Grand Slam" of golf. Pluto discovered by astronomers. Chrysler Building completed in New York City.
1931		
Budget and space limits required limit on papers, papers 25 pages and longer would be given "special scrutiny," those 10-15 pages would be welcomed. Review of recent volumes suggested papers too heavily research oriented, not enough on use of research.	Tentative specification for ready-mixed concrete offered. The fourth report of the University of Wisconsin long-time tests of concrete was published, as were the first and second progress reports of the Illinois/Lehigh column tests. Empire State Building, which used cinder-concrete floors, completed in New York City. ASTM established Committee C13 on Concrete Pipe. Construction of Hoover Dam began.	British Parliament enacted Statute of Westminster proclaiming Britain and dominions completely equal. Japan invaded and overran Manchuria. Freon was developed (later used for refrigeration).
1932		
Finances are bleak. Economy moves included staff salary decreases, elimination of Abstracts section of *Journal*, sale of advertising in *Journal*, and establishing Life Memberships, where members prepay dues on an actuarial basis. Staff reduced from five to three and move to smaller quarters.	Concrete vibrators were reported used on California dam. Concrete for counterweights for Arlington Memorial Bridge, Washington, D.C., was proportioned to be 271 lb/ft^3 (4340 kg/m^3) using iron ore aggregate. First double-drum paver introduced. Water-reducing admixtures introduced.	Manchuria became Manchukuo, a Japanese puppet state. Olympics held in Los Angeles. Kidnapping and slaying of Charles Lindbergh's son received worldwide attention. The neutron was discovered. Amelia Earhart first woman to fly solo across the Atlantic. Construction of Golden Gate Bridge began.

Year	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1933	*Journal* issues reduced from ten to five issues per year as Depression continued to affect finances. It was necessary to borrow money. Bylaws revisions included Corporation and Student Member grades. Bylaw changes restricted presidents to a 1-year term.	Freyssinet arch bridge method used in U.S. An 8-h accelerated strength test for field control developed for Hoover (Boulder) Dam. First concrete placed on Hoover Dam. Compaction of concrete with vibratory tampers investigated at the University of California. Ornamental concrete work for Baha’i Temple Dome, near Chicago, began; the foundation was constructed in 1921. ASTM adopted C94 Specification for Ready Mixed Concrete.	U.S. Prohibition Amendment repealed. “Bank holiday” declared freezing all funds in U.S. banks. U.S. dropped the gold standard. President Roosevelt launched New Deal program to combat Depression. Game “Monopoly” invented. Highway engineers proposed divided highways for greater safety.
1934	Effects of the Depression were diminishing. Suggestions for new programs and restoration of many curtailed programs were numerous. Membership still declining but rate had slowed.	“Plastic flow” in rigid frames subjected to sustained loads for 2 years was reported. Effect of aggregate size on mass concrete studied for Hoover Dam. National Concrete Masonry Association formed (formerly CMA). First shell dome constructed in the U.S. for the Hayden Planetarium in New York City. U.S. Army Corps of Engineers used concrete pump to build locks on the upper Mississippi River.	President von Hindenburg died and Adolf Hitler assumes absolute power in Germany. IBM introduced first popular electric typewriter.
1935	Awards established to encourage student participation. Awards were for theses in field of concrete. More papers on design and construction recommendations were sought. Membership had stabilized.	First rail-mounted slipform canal liner used. First scientifically controlled soil-cement road constructed near Johnsonville, SC. Cement and Concrete Association formed in Britain. Hoover Dam set construction records that stood for years.	Italy invaded Ethiopia. Germany rejected Versailles Treaty. The U.S. Congress passed Social Security System (old age insurance). Parking meter invented. First radar developed in Britain. The Zephyr, a stainless steel train, set speed record of 112 mph (180 kph) from Denver to Chicago.
1936	ACI and American Society for Testing and Materials agreed to confine work to avoid overlap. ACI would work in design and construction practices, ASTM would do materials and testing standardization. Plans approved to seek larger office quarters. Membership trend had turned and reached 1214.	Concrete Manual of USBR published. Pozzolan used in Bonneville Dam concrete. Folded plate shells used for the first time in U.S. tests reported on use of welded-wire fabric as slab reinforcement. Economics of high-strength concrete [to 6000 psi (41 MPa)] studied. First experimental prestressed concrete piles driven in New York Harbor.	King George V of England died. King Edward VIII, his successor, abdicated, and was succeeded by King George VI. Rhineland reoccupied by Germany in violation of the Locarno Pact. Spanish Civil War began. Cortisone discovered. Douglas DC-3 began passenger service.
1937	A new standardization procedure established first Standards Committee and spells out process for standardization. Process included automatic expiration after three years unless standard was revised or readopted. Board studied direction Institute should take. Some staff salary cuts restored and new membership campaign started.	Long-span shell roof spanned 107 ft (33 m) at Universal Atlas Cement Plant. Properties of concrete containing fly ash reported. Whitney reported a new method of designing members subject to bending. Research on effects of sodium and calcium chloride deicers was underway with some results reported. Lightweight concrete pavement deck used on San Francisco-Oakland Bay Bridge.	Golden Gate Bridge, San Francisco, dedicated. Airship Hindenburg destroyed during docking at Lakehurst, N.J. following Atlantic crossing. Amelia Earhart lost in Pacific Ocean during attempted around-the-world flight. Nylon introduced.

1933-1937

1938-1942

ACI EVENTS / CONCRETE EVENTS / WORLD EVENTS

1938

ACI Events: An official policy to encourage and seek practical papers translating research into practice was adopted. *Journal* frequency was increased from five to six times per year. Membership was up to 1559. Committee on architectural concrete of exposed aggregate type organized.

Concrete Events: A shell dome for a water clarifier tank was first U.S. prestressed structure. Bonneville Dam was dedicated. Effectiveness of curing compounds was being researched. Vacuum concrete potential recognized. Air entrainment identified as a beneficial process for concrete.

World Events: Germany took over Austria. Douglas C. Corrigan flew "the wrong way" to Los Angeles and landed in Dublin. Xerography developed. Orson Welles radio broadcast of "War of the Worlds" caused panic among radio listeners in U.S. Japanese troops had taken control of most of China.

1939

ACI Events: Standardization procedure was revised so that after four years without action a committee would be appointed to recommend revision, readoption, or other action. The first *Reinforced Concrete Design Handbook* (SP-3) on working stress design was published. A new guide for committees was developed and the committee structure altered.

Concrete Events: A large-scale concrete apartment project was completed in New York. Bond between concrete and steel was a current question. Concern was raised about overvibration and revibration of concrete. Publicly funded projects constituted two-thirds of construction.

World Events: Germany invaded Poland, beginning Hitler's march across Europe, causing World War II. Uranium fission theory was developed. The jet engine was developed. Pan American Airways began regular flights between U.S. and Europe. FM (frequency modulation) radio invented. John Steinbeck published *Grapes of Wrath*.

1940

ACI Events: War in Europe made it difficult for members in that area of the world to obtain U.S. funds. A flexible policy was established regarding dropping them for nonpayment of dues. Publication schedule for discussion changed to consolidate it into two issues. Subject of tolerances first dealt with in a systematic manner in John R. Nichols' paper, "Tolerances in Building Construction."

Concrete Events: Final report of the Third Joint Committee on Concrete and Reinforced Concrete was presented. Lake Washington Floating Bridge opened in Seattle. Tolerances for concrete construction were being proposed. Four million square yards of pavement were placed in 2-1/2 months for the Pennsylvania Turnpike.

World Events: U.S. started first peacetime military draft. Winston Churchill became British Prime Minister. Plutonium fission discovered. The Battle of Britain fought in the skies over British Isles. The retreat from Dunkirk left the western continent in Axis hands. Tacoma Narrows Bridge collapsed due to wind stresses.

1941

ACI Events: A new Publication Committee formed, combining program and publication functions. A committee set to work to prepare a publications policy. Advertising was limited to one *Journal* issue per year. The first Building Code under the "ACI 318" label was issued. The first *ACI Manual of Concrete Inspection* (SP-2) was published.

Concrete Events: Inclined axis, high-discharge transit mixer introduced. Alkali-aggregate reaction investigated as cause of concrete deterioration. Multiple arch bridge built over spillway of Grand Coulee Dam in state of Washington.

World Events: Pearl Harbor, HI, was attacked and the U.S. enters the war. The Atlantic Charter was issued by the U.S. and Great Britain. The first practical use of penicillin. Germany invaded Russia. Jeeps adopted for general use by U.S. Army. The U.S. Navy's Construction Battalion (Seabees) was activated.

1942

ACI Events: Junior Member grade established to help recent graduates in the financial transaction from Student Member status. ACI turned its attention to helping the war effort. Means of speeding the results of important committee work into print were given priority. A formal Publications Policy was published.

Concrete Events: Grand Coulee Dam, with more than 10.9 million yd^3 (8.3 million m^3) of concrete, opened ahead of schedule. "Emergency" building code proposed to save reinforcing steel. A vacuum method for measuring air content of fresh concrete was reported. The Contra Costa Canal in California, was being placed by new machine methods.

World Events: Tokyo was bombed using carrier-based B-25 bombers. Bataan and Corregidor fall in the Philippines. North Africa was invaded by U.S. and British troops. Battle of Midway turned tide in the Pacific. First nuclear chain reaction accomplishment at University of Chicago by Compton and Fermi. First electronic digital computer constructed at Iowa State University. U.S. Army engineers built Alcan Highway in eight months.

Year	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1943	Wartime restrictions necessitated holding only a token convention. A post-war planning committee was established to speed a return to normal activity when hostilities ceased.	Vacuum mats used on Shasta Dam in California to remove excess water. Hydraulic jacking for vertical slip-forming developed. Emergency rules to conserve reinforcing steel were issued by the U.S. War Production Board. Tests began on timber-concrete composite beams in Oregon. Five concrete shipyards were in operation during World War II.	Italy surrendered unconditionally to the Allies. President Roosevelt and Prime Minister Churchill met in Casablanca to plan second front. German army defeated at Stalingrad.
1944	Charter was revised to reflect actual activity of the Institute and to present it in more contemporary language. Larger office space acquired in anticipation of staff increase. A study was authorized to investigate possible demand of a bound collection of ACI standards. The Construction Practice Award was established.	Hollow concrete caissons several hundred feet long were floated to Normandy Beachhead to provide artificial harbor in support of D-Day invasion. Gasoline-resistant coatings and concrete tanks for gasoline storage were reported. Shortage of steel met by using concrete for variety of applications including bathtubs and ballast. An 80 acre (32 hectare) industries building for Chrysler Corp. in Chicago featured extensive use of precast concrete.	D-Day in Normandy. Allies crossed the English Channel and invaded the continent. General MacArthur returned to the Philippines. The Battle for Leyte Gulf was largest naval action ever fought. The Battle of the Bulge was Germany's last major offensive action. The GI Bill began to put millions of veterans through college.
1945	Wartime restrictions again necessitated a smaller convention. ACI staff was increased by one. Membership reached 2227 and income was about $43,000; the latter was the largest in Institute history. First *ACI Book of Standards* (six standards) issued as a separate publication.	Wartime restrictions on portland cement were lifted. A committee report was issued on admixtures. The wartime work on concrete ships was reported. A method was proposed for predicting 28-day strength of concrete from 3- and 7-day strengths.	Germany surrendered, ending the war in Europe. Adolf Hitler commited suicide. The Yalta Conference mapped allied strategy against Japan. First atomic bomb was exploded in New Mexico, then was used on Hiroshima and Nagasaki, Japan. Japan surrendered, ending World War II. United Nations Conference adopted charter.
1946	A Board Committee was appointed to study raising funds for an ACI-owned building. The *Journal* returned to a schedule of ten issues per year. The Advisory Committee and the Publication Committee were combined into the Technical Activities Committee.	Tests on prestressed concrete pipe containing a steel cylinder were reported. A four-year study on field use of cement containing vinsol resin concluded that appropriate air entrainment constituted a major improvement in concrete manufacture.	Philippines became independent nation. The United Nations began work and League of Nations was dissolved. War crime trials began at Nuremberg, Germany. Churchill denounced Soviet Union in "Iron Curtain" speech at Fulton, MO.
1947	First Regional Meeting was held in Birmingham, Ala., the forerunner of fall conventions. The Alfred E. Lindau Award was established. Membership exceeded 3400, passing 1929 high. Income passed $100,000 for the first time. A bylaws revision provided for election of all Board members at large rather than by region. First *ACI Detailing Manual* published.	Mangfall Bridge, Darching, Germany, designed using prestressed trusses. Long-time cement investigation at Hoover Dam reported. Powers and Brownyard reported on hardened paste studies. Precast concrete was enjoying a new surge of interest. Work began on Montana's Hungry Horse Dam, a 564 ft (172 m) concrete arch dam.	Marshall Plan to aid in the rebuilding of Europe was proposed. India and Pakistan gained independence. The world land speed record was set at 394.2 mph (634 kph). First supersonic flight by U.S. Air Force Capt. Chuck Yeager. Housing, flood control, and highway construction received major attention.

1948-1950

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS

1948

ACI Events: An index of the *ACI Journal* covering 1937-1947 was published. The manual *Detailing Reinforced Concrete Structures* was adopted as a standard, as was the 1947 Building Code. The trend in membership was steeply up, reaching almost 4400.

Concrete Events: Tilt-up construction was being recognized as an economical construction method. Cast-in-place barrel shell at Chicago airport spanned 257 ft (78 m). Concrete was the major material in the rebuilding of war-torn countries. Norwegians tested silica fume as a concrete admixture.

World Events: Israel proclaimed an independent state. Polaroid camera introduced. Indian leader Mohandas K. Gandhi was assassinated. Citation won U.S. Triple Crown of horse racing. U.S. and Britain airlift food and coal to Berlin when USSR began land blockade of city. A 200 in. (5000 mm) reflecting telescope became operational at Mount Palomar, CA.

1949

ACI Events: The *Journal*, past and present, became available on microfilm. New leased quarters were acquired for staff in a building in northwest Detroit.

Concrete Events: The Reinforced Concrete Research Council was formed. Concrete highway median barriers were introduced in New Jersey. The American Concrete Pressure Pipe Association was formed. John Hancock building in Boston used cellular steel decking filled with vermiculite concrete to reduce formwork. Slipform paving introduced on O'Brien County, IA, project.

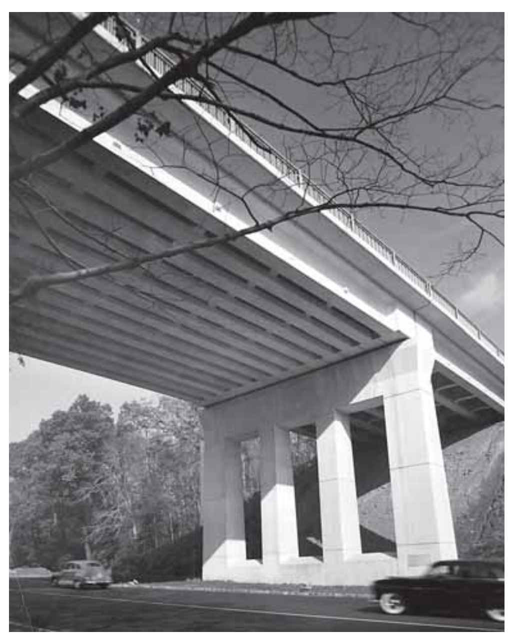
World Events: North Atlantic Treaty Organization (NATO) was formed. United Nations dedicated headquarters in New York City. U.S. atom bomb monopoly ended when Soviet Union exploded its own device. Hans Liebherr of Germany developed tower crane that could be easily broken down for mobility.

1950

ACI Events: A 20-year (1929-1949) cumulative index was published. Membership passed 5000. Sales of the *Concrete Primer* exceeded 75,000. Institute formed first joint committee with the American Society of Civil Engineers.

Concrete Events: First hyperbolic paraboloid shell built in U.S.; first prestressed pavement laid; and lift-slab construction was introduced. Portland cement production reached 225 million barrels in the U.S. Walnut Lane Bridge, Philadelphia, PA, became first prestressed concrete bridge built in North America.

World Events: U.S. Senate investigated charges by Senator McCarthy that Communists have infiltrated government. North Korea invaded South Korea. An attempt was made on President Truman's life. U.S. decided to produce hydrogen bomb. "Peanuts" comic strip with Charlie Brown, by Charles M. Schulz, debuted.



Walnut Lane Bridge, built in 1950 in Philadelphia, PA, was the first major prestressed concrete bridge in the U.S. The bridge's 13 parallel 160 ft (49 m) long main span girders were also the longest prestressed girders in the U.S. for a number of years.
Photo courtesy of the Portland Cement Association.

Year	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1951	San Francisco convention, first on the West Coast, took place. The convention approved a Building Code revision, a revised detailing standard, a revision to the pavement standard, and a new standard on shotcreting. A dues increase was also passed.	Schmidt Test Hammer developed. Current research looked at spacing of reinforcement, prestressing thin beams, automatic freezing and thawing test equipment, determining air content of hardened concrete, and use of radioactive salts for studying concrete properties.	President Truman relieved General MacArthur of his command in Korea. U.N. voted arms embargo against Mainland China. The first television transmission between U.S. west and east coasts occurred. The U.S. Constitution amended to limit president to two terms. Chrysler introduced power steering for automobiles.
1952	Harvey Whipple retired after 32 years. Fred F. Van Atta becomes Acting Secretary-Treasurer, but resigned in September. William A. Maples was named Acting Secretary-Treasurer.	The Centennial of Engineering recognized 100th birthday of civil engineering in U.S. Concrete Industry Board of New York was established. Prestressed girders and slabs used in buildings in midwest U.S. Ultimate load design procedures were being investigated and proposed. Expanded Shale Clay and Slate Institute formed.	King George VI of England died and was succeeded by Queen Elizabeth II. The first jet passenger service was inaugurated between London and Johannesburg, South Africa. The first hydrogen-fueled thermonuclear device was exploded at Eniwetok Atoll in the Pacific. Vaccine for polio developed.
1953	William A. Maples was appointed Secretary-Treasurer. A Joint ACI-ASCE Steering Committee was recommended to consider revising or rescinding the 1940 Joint Committee Report; it was later rescinded.	The 24-mile precast, prestressed Lake Ponchatrain Causeway was completed in Louisiana. Current research was on creep, silicone waterproofers, gap graded aggregates, grouts, glass prestressing cables, prestress beams, strength of T-beams, and model studies of short highway bridges. Heavy media separation of river gravel for aggregate was used for the first time in the U.S.	Korean Armistice was signed. Joseph Stalin died. Edmund Hillary conquered Mt. Everest. Willie Mosconi won the World Pocket Billiards Championship for the eighth time. Rocket-powered U.S. plane was flown at more than 1600 mph (2500 kph).
1954	The staff position of Technical Director was created to better serve committee and public needs. There were 12 standards in force and 50 committees active. Membership was about 7000 and income was about $184,000.	The Precast/Prestressed Concrete Institute was organized. High-density concrete for radiation shielding was being researched. Construction of the Mackinac Straits Bridge piers were underway using the preplaced aggregate technique.	First atomic-powered submarine was commissioned. Roger Bannister of Britain was the first human to run a mile in under 4 min. French withdrew from Indochina. Measles vaccine was developed. Frozen TV dinners were developed and marketed.

ACI Past Presidents 1930-1954

This pictorial presentation features the past presidents who have guided the American Concrete Institute to leadership in the concrete industry from 1930 to 1954.

Duff A. Abrams
1930-1931

S. C. Hollister
1932-1933

Arthur R. Lord
Feb. 1934-June 1934

Phaon H. Bates
Aug. 1934-Feb. 1936

Franklin R. McMillan
1936

J. C. Pearson
1937

John J. Earley
1938

Frank E. Richart
1939

Roderick B. Young
1940

Ben Moreell
1941

Raymond E. Davis
1942

Morton O. Withey
1943

Roy W. Crum
1944

Douglas E. Parsons
1945

Harrison F. Gonnerman
1946

Stanton Walker
1947

Robert F. Blanks
1948

Herbert J. Gilkey
1949

Frank H. Jackson
1950

Harry F. Thomson
1951

A. T. Goldbeck
1952

Henry L. Kennedy
1953

Charles H. Scholer
1954

1955-1979: A New Home and an Expanded Mission

It is interesting to note that ACI's celebration of its 50th anniversary in 1954 coincided with the 50th anniversary of two agencies active in concrete research: the University of Illinois Experiment Station, noted for its research on concrete structures and structural members, and the Iowa State University Experiment Station, which conducted research on concrete pipe. It was the 25th anniversary of the Waterways Experiment Station of the Army's Corps of Engineers—the Corps' principal research facility in concrete, hydraulics, and soils mechanics. It is also interesting, in light of ACI's early history and interest in concrete masonry, to note that the Besser Manufacturing Co. completed its 50th year of business making concrete block machinery. Just the year before, in 1953, Harvard University had commemorated the 50th anniversary of the dedication of Harvard Stadium. This structure was believed to be the first massive reinforced concrete permanent arena for American college athletics.

The only cast-in-place concrete above the foundation in the Philadelphia Police Administration Building was the elevator-staircase core. The rest of the superstructure was precast and prestressed.
Photo courtesy of the Portland Cement Association.

ACI realized a significant step in expansion of its service in 1954 when the Board of Direction authorized the position of Technical Director, which was to expand into today's fully staffed engineering department.

As ACI embarked upon its second 50 years, engineers were discussing the pros and cons of ultimate design theory. The industry was also devoting attention to heavy aggregates for nuclear reactor shielding and, at the opposite end of the spectrum, to cellular concrete. The Institute published information on design of blast-resistant structures, folded plate roofs, and hyperbolic paraboloid shells.

New committees were activated to deal with construction problems. Because of the extensive use of concrete masonry and lack of uniformity in design and construction, ACI formed Committee 331 to develop methods of structural analysis and design and to recommend construction practices. A second committee had a more limited mission—to explore the feasibility of preparing a recommended practice for use by the small builder and contractor in residential concrete work. Another committee was organized to report on recommended practice for concrete formwork.

Another important decision, based on recommendations of a joint ACI-ASCE task group, was to discontinue the 1940 "Joint Committee Report of Recommended Practice and Standard Specifications for Concrete and Reinforced Concrete." The joint report was allowed to die out because the ACI Building Code and other more recent standards and manuals adequately covered the material.* This action left only the ACI 318 Building Code in the field of design practices for reinforced concrete, placing considerable responsibility on ACI's total committee effort.

Almost four years of work by ACI Committee 318 culminated in revisions of the Building Code. The most important change in this 1956 revision was recognition of the ultimate strength method for design of sections—included as an appendix to the Code. New provisions for shear provided against failure in diagonal tension near points of contraflexure where main reinforcement cutoffs and the lack of compression due to flexure would have allowed sudden failure from progressive cracking. Column design was also revised and simplified. A chapter was added on precast concrete.

Another important committee report was "Evaluation of Compression Test Results of Field Concrete." This report described statistical methods as valuable tools for assessing results of strength tests, and was later developed into an ACI standard. The second edition of the *Reinforced Concrete Design Handbook* offered more current examples and tables. Tables included higher strength concretes; lower strengths were dropped. (This book of design aids was eventually allowed to go out of print when strength design superseded working stress design.)

*The first Joint Committee was formed in 1903 at the "beginning" of reinforced concrete construction in the U.S.

A NEW BUILDING AND EXPANDED PUBLICATIONS

As a first step in providing a permanent headquarters for the Institute, the Board of Direction in 1955 authorized the purchase of a building site in northwest Detroit. The site faced a municipal golf course and was surrounded by a neighborhood of newly built homes. Yamasaki, Leinweber and Associates were engaged as architects for the project, with the design supervised by Minoru Yamasaki. Ammann and Whitney were named structural engineers; Pulte-Strang Inc. was selected as contractor. Groundbreaking was in March 1957.

The Institute moved into and dedicated its new building in 1958. Designed as a showpiece in concrete as well as a functional center for ACI's international operations, the new headquarters was the culmination of several years of planning and fund raising. The principal structural feature was the folded plate reinforced concrete roof, which cantilevered front and rear from the monolithic concrete corridor walls. The roof was detailed to be cast in place, but the contractor elected to precast the roof units. Execution of the construction leaned heavily on good, conventional construction practices. The finished building displayed concrete in many varied forms: a cantilevered precast folded plate roof, thin exposed aggregate panels, decorative precast grills, and cast-in-place fluted wall surfaces as well as plain and reinforced concrete.

In 1956, the *ACI Journal* was expanded from ten issues per year to 12 issues per year, reflecting the growing demand for more information on concrete. Institute membership reached 8000.

The *ACI Journal* published a comprehensive review on lightweight aggregates and lightweight concretes, covering cellular or foam concrete, no-fines concrete, and light-weight aggregate concrete. While lightweight aggregate—pumice—was used by the Romans in walls and domes in some of their buildings, a big factor in the increasing use of lightweight aggregates was the radical change in building design in the latter part of the 19th century. The old method of designing buildings to carry loads by means of heavy load-bearing walls was discarded in favor of a design method in which the load was carried by a framework of beams and columns. Lightweight aggregates and the new design method made possible the construction of sky-scrapers and long-span bridges. The savings in wall, floor, and bridge deck weight was important; lightweight concrete also helped solve heat and sound insulation problems. U.S. engineers and producers were leaders in developing lightweight aggregate concrete.

" . . . the concrete engineer or builder need not take a back seat in any discussion devoted to science and technology . . ."

—*Douglas McHenry*
ACI President, 1958

The Institute previously published separate manuals for detailing of reinforced concrete building and highway structures. Because there were so many items common to both of these manuals, and because there was a demand to have both manuals available for ready reference, they were consolidated into a single manual. The manual also incorporated the revisions of the new Building Code (ACI 318-56). A separately bound *ACI Standards—1956* contained all the latest Institute standards. This single book has now grown to the six-part *Manual of Concrete Practice* containing standards and committee reports. Also issued in separate form were large-size reproductions of the design charts that appeared in Charles S. Whitney's and Edward Cohen's "Guide for Ultimate Strength Design of Concrete." A new committee was authorized to prepare material to serve as a basis for the section on structural concrete in specifications. The committees concerned with concrete pavements were quite active in issuing reports. Under consideration by the committee on bond stress was a proposed test procedure to determine relative bond values of reinforcing bars, later adopted as a standard. While large concrete silos had been slipformed, 1956 marked construction of the first slipformed apartment building (in Memphis, TN). In 1957, a number of concrete structures were subjected to blasts and radiation as a part of the Atomic Energy Commission's atomic test shots at its Nevada test site; the structures held up well.

CHAPTER BEGINNINGS

1957 also marked the beginning of the ACI chapter program. Acting on the recommendation of the committee on regional organization, the Board of Direction authorized the trial establishment of a Southern California chapter of ACI. Objectives of the chapter were:

1. To work for active and continuous local interest and participation in Institute affairs.
2. To plan and conduct meetings and conferences for solving technical problems. Ideas and information on such problems and solutions could be passed on to appropriate national committees to expedite needed action on corrective measures or new methods.
3. To organize and carry on advisory work with other agencies and groups for correlation of code requirements, explanation and use of the ACI Building Code and standards of practice, with the object of improvement of design and construction.
4. To follow and assist in sound development of new methods and techniques, encouraging local sources to write articles and papers, and expand efforts in engineering education.
5. To encourage research projects and scientific investigations to develop test data and techniques useful to the designers and builders of concrete construction, producers of concrete materials and products, and to the public.
6. To aid in expediting information service to the membership, by suggesting sources of information on specific problems.

The first general meeting of the Southern California chapter was held in Los Angeles in November 1957. The provisional chapter proved so successful that, in the following year, Institute membership amended the Bylaws to allow the establishment of chapters.

PRESTRESSED CONCRETE

The first U.S. conference on prestressed concrete (ACI was a co-sponsor) had been held at the Massachusetts Institute of Technology in 1951. Attendees reached consensus that it was now time to standardize nomenclature and design criteria for prestressed concrete to avoid delay in acceptance of practical applications. ACI was urged to prepare, as soon as possible, a proposed standard in such form "that it will not restrict the development of various known and future methods and their applications to industry and construction." The ACI committee on prestressed concrete, organized in 1942, was reorganized as a joint ACI-ASCE group in 1952 to take on the task.

The World Conference on Prestressed Concrete held in San Francisco in 1957, with an attendance of some 1200 participants from 43 nations, dramatized the enormous development that prestressed concrete had undergone as a structural material. San Francisco was an appropriate place for the conference since Peter H. Jackson, a San Francisco engineer, was definitely at the cradle of prestressed concrete. The details and methods of his patent, filed in 1886 and granted in 1888, essentially conformed with modern post-tensioning. Developments in the U.S. during the 1950s were probably more rapid than anywhere else in the world, even though the material was relatively unused in the U.S. prior to 1949, when the Walnut Lane Bridge was built in Philadelphia. The U.S. had many incentives to catch up with European practice.

ACI issued "Tentative Recommendations for Prestressed Concrete" in early 1958. It was a guide for design and construction of safe, serviceable, linear structural members prestressed with high-strength steel. Emphasis was on flexural members—beams, girders, and slabs. Most of the recommendations were applicable to both buildings and bridges. The report constituted a recommended practice, not a building code or specification. Tentative recommendations for thin-section reinforced precast concrete construction were published in the same period.

ST. LAWRENCE SEAWAY

The St. Lawrence International Seaway and Power Projects—completed in 1959—was an outstanding example

> "When we make certain that the proper materials are correctly batched and mixed, the concrete will be what it should be."
>
> —*Lewis H. Tuthill*
> ACI President, 1961

of political, engineering, and construction cooperation between two countries. It was a unique construction effort in that, in one undertaking, the U.S. and Canada each used their own methods of concrete construction. In the International Rapids section of the St. Lawrence River, a $600 million power project was built by Hydro-Electric Power Commission of Ontario and the Power Authority of the State of New York. The three major structures were the powerhouse and dam on Barnhart Island, Long Sault Dam, and Iroquois Dam. Basic concrete mixture proportioning requirements for the power dam were primarily the same on both sides of the border, the main difference being in exterior concrete. U.S. builders used 6 in. (152 mm) maximum size aggregate as compared to 3 in. (76 mm) used by the Canadians. The U.S. used a blend of portland and natural cement in Barnhart Power Dam interior concrete, while Canada used an all-portland mixture, except where heat reduction for shrinkage control was considered imperative; there they used fly ash as a partial cement replacement. The U.S. contractors used a Type II cement while the Canadians used a Canadian standard cement comparable to U.S. Type I.

All transportation of concrete on the U.S. side was by bucket. On the Canadian side, conveyor belts were used for transporting all concrete from the plant. Steel forms were used by U.S. builders; the Canadians used wood. The U.S. used horizontal joints with no waterstops; the Canadians used 8 in. (203 mm) keyways and horizontal waterstops.

In placing concrete, the thickness of layers specified by the Canadians was 12 and 20 in. (305 and 508 mm) by the Corps of Engineers (construction agency for the U.S. St. Lawrence Seaway Development Corporation). A major difference was in height of lift. The Corps of Engineers restricted height of lift to 5 ft (1.5 m), except where the cross section of the monolith was 16 ft (4.9 m) or less in width, in which case the lift was restricted to 10 ft (3 m). The Canadian Seaway Authority did not restrict height of lift. The Corps required that 120 h elapse between lifts; no time limitation was imposed by the Canadians. Another major difference was in curing. The U.S. required moist curing for 14 days; the Canadians required 7 days.

The 120-h delay between placing successive lifts and the 5 ft (1.5 m) lifts forced U.S. contractors to spread out their operations more than the Canadians. The 14-day curing period and the 5 ft (1.5 m) lifts required by the U.S. also increased the costs of winter protection. Thus, practically all concrete on the U.S. projects was placed when heating would not be required and production was geared to concreting during warm weather. The Canadians, however, placed concrete through the winter months.

The final accomplishments were the same—schedules were met on time, and the international structure took form to serve both countries.

The seaway construction encompassed numerous locks, dredging and excavating canals, relocation of highways and railroads, modification of bridges, and construction of retaining walls—with some of the work being coordinated with various power projects.

CONCRETE PRIMER REVISED

Much in demand during the previous 30 years, the *Concrete Primer* was expanded and revised in 1958. Great improvements had been made in machinery and methods, but the fundamentals of making durable concrete remained unchanged. The main changes took into account the concept of air entrainment, recognition of reactive aggregates, the use of high early-strength cements, and the use of high-frequency vibration in placing fresh concrete. All of this information was available at 50 cents per copy!

ADVANCES IN MATERIALS AND METHODS

This period also featured growth in the lift-slab method of construction; by early 1958, at least 41 structures involving 2 million ft^2 (185,800 m^2) of prestressed concrete lift-slabs had been built. In the late 1950s, pumps with small-diameter, flexible lines were developed for average-size concrete placement jobs, and contractors started pumping concrete more often.

More attention was being devoted to high-strength steel for reinforcing bars. Steel with yield points in excess of 50,000 psi (345 MPa) came into use in the early 1940s in Sweden and Austria. American practice had proved the possibility of using deformed bars and demonstrated their advantages, i.e., dispensing with end hooks in some cases, ensuring better bond, and reducing the size of cracks. European practice benefited by U.S. experience and advanced it further by using steels of higher strength, which enabled higher permissible stresses, and thus, more economical designs.

Two reports on form construction practices and another on design assumptions for lateral pressure of

The lift-slab method of construction featured roof and floor slabs that were cast on a base slab with a separating membrane between slabs. Powerful jacks seated on columns raised the slabs to their final position where structural connections between slabs and columns were made.

The mid-1960s saw completion of the Oosterschelde Bridge in the Netherlands, the longest bridge in Europe at the time. The 3 mile (4.8 km) bridge featured a precast, prestressed continuous hollow box structure supported on 54 mammoth piers.
ACI archives. Photo courtesy of Netherlands Consulate General Commercial Division.

concrete on vertical formwork were preliminary steps in preparation of ACI's recommended practice for design and construction of concrete formwork. ACI also proposed a procedure for proportioning structural-grade lightweight aggregate concrete and a recommended practice for hot weather concreting. A new committee was activated to develop a handbook containing data and design aids for use in designing reinforced concrete by the ultimate strength method. Tentative recommendations for design of prestressed concrete, issued by a joint committee of ACI and ASCE, were widely used.

10,000 MEMBERS

By 1959, Institute membership had reached 10,000; there were 50 technical committees and three chapters in operation. The year marked several international milestones: the Institute held a regional meeting in Mexico City, Mexico,* a three-member delegation was appointed to collaborate with the Comite Europeen du Beton in the exchange of information, and several ACI standards were translated into Spanish and published cooperatively with the Instituto del Cemento Portland Argentina. Many ACI standards and handbooks would be translated in the years to come.

The late 1950s saw the development of plastic forms for architectural concrete. The early 1960s were also notable for the AASHO Road Test, a $25 million project designed to study the performance of highway pavements and short-span bridges subjected to controlled traffic loadings.

A 1960 *ACI Journal* readership study found that the five most-read types of papers were, in order: construction practice, structural design-construction, structural design, structural research, and materials research. At the same time, a new committee was organized to expedite the publication of a series of monographs on specialized subjects in the concrete field. A guide to more than a half-century of important writings in concrete progress rolled off the press with publication of the *ACI 55-Year Index: 1905-1959*. In 1961, after more than six years of work, Committee 622 issued its "Recommended Practices for Concrete Formwork," later adopted as an ACI standard.

Research and application in materials and methods continued to expand concrete knowledge and the use of

*There had previously been meetings in Canada—an annual convention in Toronto in 1934 and a regional meeting in Montreal in 1956.

lightweight aggregate concrete and expansive cements. During this period, there was increasing interest in thin-shell construction of roofs, especially the hyperbolic paraboloid shape. The first in a series of compilations of articles, "Concrete for Radiation Shielding," was published.

In a move to make ACI publications of more value to members outside the U.S., the Institute started to include Spanish, French, and German translations of the synopsis that accompanied each paper in the *ACI Journal*. The *Concrete Primer* was published in Japanese, Spanish, and Italian, and several years later in German. Over the preceding years, Institute papers and publications had been translated into 20 languages.

With the growth of Institute chapters came the new "Guide for Chapter Organization and Operation." ACI members in Japan petitioned to form a chapter that was officially installed in 1962 as the Institute's first international chapter.

SHEAR AND DIAGONAL TENSION

A joint committee (326) of ACI and ASCE had been formed in 1950 with the assignment of "developing methods for designing reinforced concrete members to resist shear and diagonal tension, consistent with the new ultimate strength design methods." A program of tests of beams without web reinforcement was initiated at the University of Illinois under the sponsorship of ASCE's Reinforced Concrete Research Council. The results focused attention on the complexity of shear and diagonal tension and on the possibly unconservative 1951 design procedures.

Shear and diagonal tension became the major research theme in the field of reinforced concrete for the 1950-1960 decade. A few structural failures added momentum to intensive efforts devoted to research. Several investigations were initiated, sponsored, and conducted by many organizations, including Joint ACI-ASCE Committee 326, the Reinforced Concrete Research Council, various governmental agencies, several universities, and the PCA. The intensity of research efforts is illustrated by the number of articles that appeared in technical literature. Prior to 1950, published papers on shear and diagonal tension averaged about four per year. In 1954, eight papers were published; the number increased to 17 in 1955, 23 in 1956, 35 in 1957, and more than 40 in 1958. In early 1962, the Joint ACI-ASCE committee consolidated all this information from experimental and analytical investigations into a form useful to practicing engineers. The committee also offered new design methods for reinforced concrete members with and without web reinforcement, for members without and with axial load acting in combination with bending and shear, and for slabs and footings, including the effect of holes and transfer of moments from columns to slabs.

EPOXIES AND BOOM PUMPS APPEAR

Epoxy resin compounds, first introduced as structural adhesives in the U.S. in the late 1940s, had found their way into the highway and construction fields by the mid-1950s. In 1962, an ACI committee issued "Guide for Use of Epoxy Compounds with Concrete." The guide described proper procedures for the use of epoxy resin compounds for skid-resistant overlays, waterproofing, patching, crack and joint sealing, bonding new or hardened concrete to old concrete, grouting, and coatings to prevent chemical attack.

The committee on residential concrete work issued a guide for construction of concrete floors-on-grade inside residences. In late 1962, the committee on nomenclature published the first increment of a glossary of terms on cement and concrete technology. Another breakthrough, in the growing use of concrete pumps, occurred around 1962 when a pump and placing boom were mounted together on a truck. By the late 1960s, articulated, roll-and-fold booms had become readily available.

CENTURY 21 EXPOSITION

It was especially appropriate that ACI held its 1962 fall meeting in Seattle at the Century 21 Exposition. Engineering and architecture combined talents to create some outstanding concrete structures at the Seattle World's Fair. The Federal Science Pavilion, one of the main theme features of the Fair, was a masterpiece of concrete design, technology, and construction. Six buildings were built completely of precast, prestressed components. The dazzling white concrete buildings were grouped around five open-ribbed concrete vaults (arches) rising 100 ft (30.5 m) in height. Concrete was featured in the immense coliseum with its massive structural frame and its unique roof suspension, in small, thin-shell exhibit structures, in an exhibition hall with a long-span folded plate concrete roof, and in the prestressed concrete parking structure. Seattle didn't limit the futuristic theme to the exposition grounds only. A mile-long monorail connecting Seattle's business district with the World's Fair site consisted of two lines of prestressed concrete hollow box girders.

THE EARLY '60s

In late 1962, the Board, acting on a recommendation of the Technical Activities Committee, approved a regrouping of ACI technical committees. By then, the ACI committee structure had grown to 70 committees. The committees were divided by major function into five groups: 100—research and administration, 200—materials and properties of concrete, 300—design and construction practices, 400—structural analysis, and 500—special products and special processes.

ACI's first Canadian chapter, the Ontario Chapter, was activated in 1963, and grew into one of the Institute's more active chapters.

Glen Canyon Dam, in Arizona, was one of the outstanding structures of 1963. The $325 million dam was a key unit in the U.S. Bureau of Reclamation's upper Colorado River redevelopment project. The dam was 710 ft (216.4 m) high, 340 ft (103.6 m) thick at the maximum section, 1550 ft (472.4 m) long, and 25 ft (7.6 m) thick at its crest.

Recognized as one of the foremost experts on concrete in the U.S., Bryant Mather (ACI president, 1964) was a featured speaker at conferences around the world. In explaining why he had become so involved with committee work, Mather said, "ACI committees are where the action is."

"The only good specification is that which requires only those things that need to be done to make the concrete suitable for its purpose. A good specification contains no requirements that can be ignored or slighted and omits no requirements that must be met. It is not possible to write such a specification; it is only possible to try to do so."

—Bryant Mather
ACI President, 1964

In 38 months—6 months ahead of schedule—the concreting team had placed 4.8 million yd^3 (3,570,080 m^3) of concrete.

The year 1963 featured another revision of the ACI Building Code, including a chapter on prestressed concrete. The most innovative feature of ACI 318-63 was a provision that allowed structural members to be proportioned by either working stress design or ultimate strength design methods. A commentary, to give insight into reasons behind the code provisions, was published as a separate document. The Institute also established minimum requirements for thin-section precast concrete construction. Recognizing that trained concrete inspectors are essential, ACI issued a guide on organization and conduct of training courses for such personnel.

A major project was completed with the 1963 publication of the first edition of SP-4, *Formwork for Concrete*. Written by Mary Hurd and reviewed by the ACI formwork committee, this formwork manual has been revised through six editions, with total sales exceeding 100,000 copies. It is still widely used as a textbook and reference for practicing engineers.

The years 1963-64 were active ones both technically and administratively. A committee to study coordination in the concrete industry was organized. It had a mission to study problems arising due to rapid evolution of field construction methods and new techniques and how best to promulgate information. The Board of Direction also established a committee on international relations. It was directed to consider means of developing coordination, cooperation, and unification between ACI and those societies and agencies of other nations with interests related to those of ACI.

ACI's 60th year, 1964, marked the adoption of a new official logo and the motto, "progress through knowledge." The insignia was designed to express the dignity, solidity, and stability of the Institute itself and concrete as a material. At the same time, it was an expression of the Institute's worldwide operation and influence. The ACI monograph series was launched with publication of Monograph No. 1, *Lessons from Failure of Concrete Structures*. The Institute issued a recommended practice for concrete inspection. ACI Committee 340 issued a handbook, *Ultimate Strength Design of Reinforced Concrete Columns*, as an interim report that provided design aids for use in the ultimate strength design of eccentrically loaded reinforced columns in accordance with ACI 318-63.

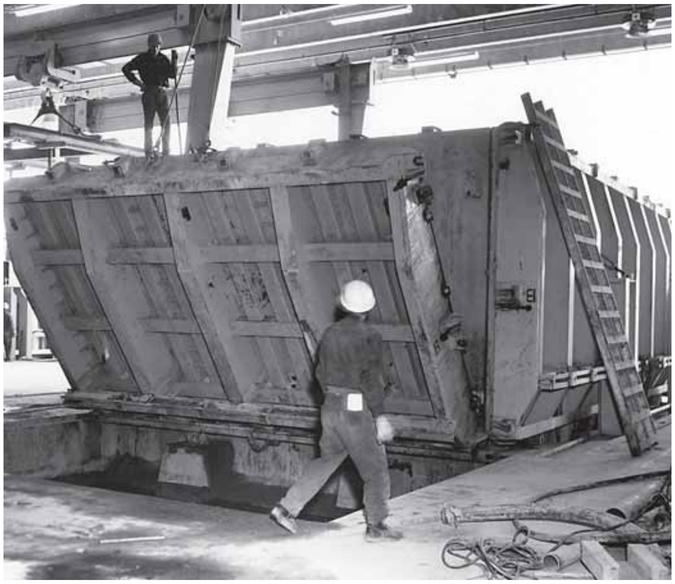
Several of the focal points of the 1964-1965 World's Fair in New York were eye-catching concrete structures. The New York State Pavilion featured 16 monolithic columns supporting a suspended plastic roof and three concrete observation towers of 100, 180, and 230 ft (31, 55, and 70 m) heights. The columns and observation towers were erected by the slipform method. The roof of the main building of the Eastman Kodak Pavilion was a free-form thin concrete shell covering a 60,000 ft^2 (5570 m^2) area. The IBM Pavilion featured a 25,000 ft^2 (2320 m^2) shell roof that was shotcreted.

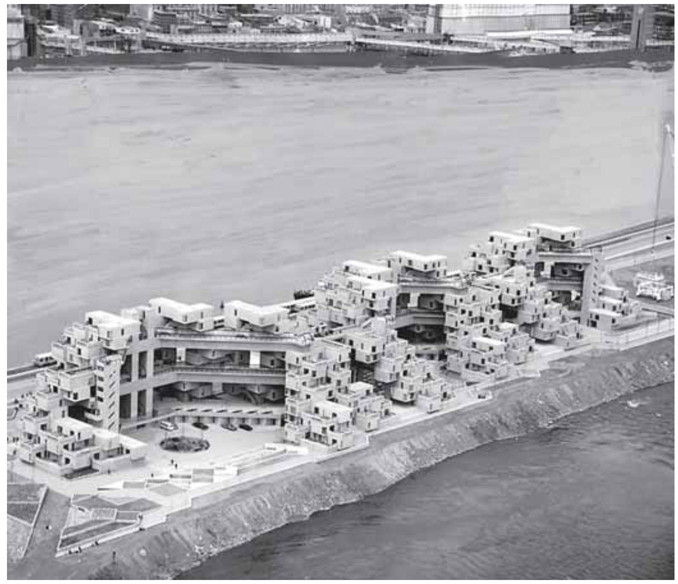
As a result of pioneering work by engineers of the Iowa Highway Commission, slipform paving was becoming more common. By 1964, slipform pavers had been used in 23 states, and Iowa built the 1000th mile of slipform pavement in that state.

EXPANSIVE CEMENT AND OTHER DEVELOPMENTS

Research and development on expansive cement concretes continued in the U.S., France, and the Soviet Union; U.S. research was conducted at the University of California and PCA. Two basic uses were envisioned for expansive cement in the U.S. In "shrinkage-compensating concrete," restrained expansion induced compressive stresses that approximately offset tensile stress caused by drying shrinkage. In "self-stressing concrete," restrained expansion induced compressive stresses high enough to result in significant compression of the concrete after drying shrinkage had occurred. 1963 saw the first U.S. use of an expansive cement to produce a self-prestressed pavement with anchored steel strands. A new shrinkage-compensating concrete was used the same year to eliminate shrinkage cracks in a folded plate concrete roof. To further the development and dissemination of technical information on expansive cement concrete, ACI created a committee in 1964.

The Japan National Council on Concrete (JANACC) was formed in 1965, probably the first organization of





Habitat '67 in Montreal, QC, Canada, was a landmark in the history of precast concrete housing. The project featured mass production of housing modules using large metal molds and erection with mammoth lifting equipment. The 365 precast modules were stacked in a 12-story configuration and connected by post-tensioning (top right). Top left: The modules were cast in steel forms resting on a prestressed concrete casting bed. Exterior sides of the forms were hinged at the base. Bottom: A giant 100-ton (91 tonne) crane hoisted the precast modules into position.
ACI archives. Photos courtesy of David J. Fitzgerald, Francon Limitee.

its kind in Asia, adopting a structure and purpose quite similar to ACI. Concurrently, the Japan ACI chapter was dissolved. A few years later, JANACC modified its name to the Japan Concrete Institute.

In the mid-1960s, the Board created four committees to develop and guide the Institute's growth: a Long-Range Planning Committee to look at ACI growth up to the year 2000, a Committee on Education to study the function and place of the Institute in technical education at all levels, an Information Storage and Retrieval Committee to explore ACI's position in this field, and a Research Committee to investigate ACI's role in initiating and guiding research in concrete.

The first Charles S. Whitney Medal was presented to the University of Illinois Engineering Experiment Station in 1966. The Charles S. Whitney Medal, in honor of the late ACI past-president Whitney, is bestowed for noteworthy engineering development work in concrete design and construction. The citation for the station read: "for over 60 years of internationally outstanding contributions to the science and arts of concrete design and construction."

Shotcrete had become the accepted term for gunite, pneumatically applied mortar or concrete, sprayed concrete, and gunned concrete. ACI issued a revised recommended practice that covered both the dry-mix process and the recently introduced wet-mix process for shotcrete.

ACI Committee 301 had been organized in 1956 for the express purpose of preparing material to serve as a basis for the section on structural concrete in job specifications. The work led to the adoption of "Specifications for Structural Concrete for Buildings" in 1966.

Conversion from the U.S. Customary Units system of weights and measures to metric, and now the International System of Measurements (SI), has been discussed and argued for decades. ACI, through official action of its Board of Direction, recognized the advantages of the International System in 1966 and required that all ACI publications show metric equivalents for weights and measure, as well as U.S. Customary units. At the same time, quantities such as bags, sacks, barrels, or gallons where phased out of Institute publications. Concrete mixtures proportions were to be expressed in pounds per cubic yard (and kilograms per cubic meter). The water-cement ratio, formerly expressed in gallons per sack, was now stated as a simple ratio of water mass to cement mass.

PUBLICATION EVENTS

Beginning in January 1967, the *ACI Journal* took on a new look. The 6 x 9 in. (152 x 229 mm) size was phased out and the magazine enlarged to the standard size of 8-1/4 x 11-1/4 in. (210 x 286 mm). It was also decided to publish discussions monthly instead of quarterly.

Several important new publication efforts were completed the same year. The *Ultimate Strength Design Handbook*, covering design of beams, slabs, and footings, offered significant savings in time and labor to those who designed reinforced concrete flexural members using ultimate strength theory. Tables, charts, and graphs in the handbook simplified shear, bond, flexure, deflection, and other calculations. (ACI had previously issued tables and charts for column design in 1964, which would eventually be published as Volume 2 of the USD Handbook.) The handbook enabled the designer to eliminate repetitious, routine calculations by condensing into a single coefficient various factors, coefficients, and stresses that are used repeatedly. The need for such a book had become acute when ultimate strength design was accepted on par with the older working stress method in the 1963 edition of the ACI Building Code.

The first edition of ACI's "Cement and Concrete Terminology (ACI 116)" was the result of 10 years of work. It gathered and defined more than 1400 terms related to cement and concrete terminology. Concurrently, a microthesaurus on cement and concrete terminology for use in keywording and information retrieval systems was developed primarily by PCA and ACI, with about 16 other organizations serving as "reviewers." The *ACI Manual of Concrete Practice* was first published in 1967, replacing the *Book of Standards*. The new three-part manual included both standards and committee reports.

LIGHTWEIGHT AGGREGATE CONCRETE

By 1967, structural lightweight aggregate concrete had indeed come of age as an important and versatile construction material. It was used in multistory building frames and floors, curtain walls, shell roofs, folded plates, bridges, and prestressed and precast elements. Since structural lightweight aggregate concrete was a relatively new material, engineering research laboratories and the lightweight aggregate industry developed information on the material and its properties concurrently with its job site use. The University of Illinois had conducted comprehensive studies in 1931; the U.S. Bureau of Reclamation and the National Bureau of Standards carried out extensive studies in 1949, and many other laboratories studied various aspects. The time was ripe for ACI to issue a "Guide for Structural Lightweight Aggregate Concrete," containing information on properties, proportioning, and structural design. Using practices given in the guide, structures could be designed and their performance predicted with the same high degree of accuracy and factors of safety as with normalweight structural concrete.

In 1967, the 70-story Lake Point Tower in Chicago topped out at 645 ft (197 m) to join an increasing number of tall reinforced concrete buildings—most built by utilizing high-strength concrete and lightweight aggregate concrete. Specified concrete strengths in columns and shearwalls ranged from 3500 to 7500 psi (24 to 52 MPa). High-strength reinforcing steels of 60,000 and 75,000 psi (414 and 518 MPa) yield point were used. The floors were 3500 psi (24 MPa) lightweight aggregate concrete.

SETTING PRIORITIES

The Board of Direction, based on recommendations from the Long-Range Planning Committee in 1967, adopted a plan for future ACI activities and set the following priorities for staffing needs:

1. directorate of education
2. directorate of research
3. information retrieval staff
4. field staff for the *ACI Journal*
5. added technical coordinators
6. field staff for chapters
7. staff for a research and development journal.

The Board, however, gave immediate priority to employment of a director of education. Some of these priorities were to be modified in subsequent years.

In 1968, Katharine Mather, a petrographer with the Corps of Engineers Waterways Experiment Station, was the first woman to be elected to the ACI Board of Direction. It would be more than 20 years before another woman would serve on the Board.

ACI joined with PCA and the National Ready Mixed Concrete Association to develop and evaluate a new curriculum in concrete technology. The Office of Education in the Department of Health, Education and Welfare awarded a grant to develop the curriculum with a goal of developing course materials for use in vocational schools, junior colleges, and in-service job training programs. PCA served as the project coordinator.

The year 1968 marked another interesting footnote to history—the one-billionth yd^2 (836,000,000th m^2) of soil cement in the U.S. was placed outside Florence, S.C. The milestone square yard was placed in the subbase construction of I-95. (The first fully engineered soil-cement project had been built in 1935 in Florence County.)

New products continued to emerge from the laboratory. In one interesting development, concrete was impregnated with a monomer that was then polymerized to produce some remarkable properties. Hardened concrete soaked in a methyl methacrylate monomer and then subjected to gamma radiation from Cobalt 60 had a compressive strength of 20,000 psi (138 MPa), a tensile strength of 1600 psi (11 MPa), a modulus of elasticity of 6.3×10^6 psi (43,470 MPa), and a modulus of rupture of 2600 psi (18 MPa). The concrete was also impermeable and unaffected by freezing and thawing and sulfate attack.

The Ninian Central Platform, a concrete gravity base for drilling and oil production, became the largest floating object built by man when it was towed to location in the North Sea in 1978. The Jarlan-type breakwater wall that crowned the concrete structure was built by assembling rows of quadrant-shaped precast units in a mammoth assembly yard.

ACI staff added a field representative in early l969 to handle chapter liaison activities and convention management. ACI's growth in services had required expansion of staff over the years and the Institute approved the construction of a second building in Detroit adjacent to the Yamasaki-designed structure. Immediate needs for office space were met by leasing space about 2.5 miles (4 km) from the main office for some of the staff when the headquarters building became overcrowded. In 1969, a new building was virtually completed by year's end. The two-story, 10,800 ft^2 (1000 m^2) building of standard beam-and-column design was an amalgamation of cast-in-place, precast, and masonry components tied together in a pleasing combination.

ACI issued two proposed standards on cast-in-place concrete pipe: one giving recommendations for design, construction, and testing, and the other providing construction specifications. The committee on structural safety presented a series of papers on probabilistic concepts as an introduction to the application of probabilistic procedures to problems in structural applications and eventual incorporation in future building codes.

Industrialized building in the U.S. made an enthusiastic but unsuccessful start in the early 1970s. Operation Breakthrough, a program sponsored by the Department of Housing and Urban Development for the advancement of innovative building systems, drew 600 proposals, selecting 22 industrialized building systems. Operation Breakthrough did not accomplish its objectives due to a general collapse of the housing market, the 1973 freeze of federally subsidized housing programs, and high costs of many of the systems. However, one successful framing system introduced a combination of precast concrete room modules and precast elements that were bonded together monolithically at the job site. Operation Breakthrough led to some useful changes in the building industry by exposing builders to new construction methods, encouraging changes in building code requirements, and supporting state-wide building codes.

DESIGN NOTATION

A major breakthrough occurred in 1969-1970 with the development of an international agreement between the ACI and Comite Europeen du Beton (CEB) on a common notation for reinforced and prestressed concrete design. The basis of the agreement was an ACI report on notation. The proposed standard, published in 1970, was adopted in 1971. The timing was particularly propitious because new code requirements for reinforced concrete were close to adoption by the British, CEB, and ACI, and a common notation became effective nearly simultaneously.

The year 1970 marked the 60th anniversary of the ACI code requirements, "Standard Building Regulations for the Use of Reinforced Concrete" having been adopted in 1910 after being issued by NACU. A series of code preview papers appeared in 1968-1970 and offered proposals for revising the existing 1963 ACI Building Code. Another committee had been working for four years on developing design criteria for concrete nuclear reactor containment structures. Ultimately, these criteria were merged into a code issued jointly by the ACI and the American Society for Mechanical Engineers (ASME).

> "A code is not a set of rules prepared by a few for the regulation of other engineers, but a synthesis of contemporary knowledge, practices, and techniques. A code can be no better than our collective knowledge whether gained from theory, research, or experience in practice."
>
> *—Chester P. Siess*
> ACI President, 1974, and former ACI 318 Committee Chair

THRIVING EDUCATIONAL EFFORTS

While Institute chapters had held many successful educational programs, the national organization's first educational seminar was in December 1969. The seminar, presented in cooperation with the Delaware Valley Chapter, dealt with quality assurance in concrete construction and drew 187 conferees from 26 states and

THE "CONCRETE YEAR 2000" REPORT

What were some predictions of things to come back in the 1970s? A special committee published "Concrete—Year 2000" in the August 1971 *ACI Journal*. The report took a look at some of the changes that could be expected and the part that concrete might play in construction. Here are a few of the predictions:

- In meeting the demand of society to preserve the environment, the concrete industry will be required to produce cements and aggregate with greatly reduced pollution of air and water and reduced despoliation of the landscape.
- Innovations in electronics....make it possible for individuals to work in their home environment.
- Concrete buildings very likely will be systematized with components precast and heat-cured and the surfaces prefinished.
- Engineers, architects, planners, contractors, and researchers will conveniently keep abreast of the latest knowledge.....through their personal data terminals...The total information transfer system will function faster.
- Notable advancements...will come in the development of supplementary aggregates from waste materials.
- "Inspector" admixtures will be developed. By changes of color, they will indicate if the water-cement ratio is too high; if the temperature of the fresh concrete is too low or too high.
- Strengths greater than 60,000 psi (400 MPa) will be obtained for special purposes, and strengths up to 20,000 psi (138 MPa) will be routinely obtainable.

two Canadian provinces. Educational activities expanded considerably from that point on.

Recognizing the importance of the Institute's educational effort and the need for more concentrated coordination, the Board of Direction established in 1970 an Educational Activities Committee (EAC) parallel with the Technical Activities Committee and having responsibility for ACI's educational program. Four new education committees were formed: one to develop seminars and workshops, and three to prepare various types of manuals of instruction.

The first phase of the PCA-NRMCA-ACI National Concrete Technology Curriculum Project was completed, aimed at creating a two-year college level curriculum in concrete technology. Phase 1 included curriculum design and the preparation of instructional aids such as lesson outlines, visual aids, laboratory manuals, and text materials. The second phase was a two-year field test in selected schools. In addition, a filmstrip was produced to encourage high school students and others to enroll in the program and to become concrete technologists.

STUDENT PROJECTS

The spring of 1970 marked the beginning of a fun project that was to grow into an international competition. The civil engineering honors class at the University of Illinois in Urbana, studying under Prof. Clyde Kesler, built and paddled the first student concrete canoe. The next year, civil engineering students from the University of Illinois and Purdue University made history on a tiny lake in east-central Illinois, when they staged what is believed to be the world's first concrete canoe race. By 1972, the Midwest race held in Indiana featured entries

A second building was added to the Detroit headquarters facility in 1969. Ribbon-cutting at the dedication was handled by (left to right) Vice President S. D. Burks; Past President Arthur R. Anderson; Executive Director William A. Maples; President Joseph J. Shideler; and Past President Graydon E. Burnett.

The Institute expanded the Detroit headquarters with the construction of a second building in 1969. The east building (right) featured reinforced concrete beam-and-column framing, faced with two-story exposed aggregate precast panels using Michigan crushed stone aggregate.

The civil engineering honors class at the University of Illinois, studying under Prof. Clyde Kesler, built and paddled the “first” student concrete canoe in 1970. The next year, civil engineering students from the University of Illinois and Purdue University made history when they staged a concrete canoe race.
Photo courtesy of Clyde Kesler.

The “first” student concrete canoe was built in 1970 by the civil engineering honors class at the University of Illinois. By 1974-1975, an estimated 100 schools were designing, constructing, and racing concrete canoes. While most of the races took place on relatively quiet lakes or rivers, in 1975, the University of Maine sponsored the first whitewater canoe race on the Kenduskeag Stream.
Photo courtesy of the Civil Engineering Department, University of Maine.

from 17 schools. Other schools competed in concrete canoe races in Oklahoma and on the Pacific Coast. The next year, 27 schools entered the Midwest competition and races were held on the East Coast as well. Schools from both the U.S. and Canada competed. The competition consisted of more than just racing; it also included a display, technical paper, and presentation from each team—all of which made up the total score. ASCE student chapters, ACI chapters, and other local organizations became involved. ACI Committee E 801, Student Activities, awarded a best construction award at various racing sites (about a dozen sites in 1983). By 1983, over 100 schools in the U.S. were actively participating. The ACI Alberta Chapter and engineering schools in western Canada added a new twist to the competition in 1975 when the students built and raced reinforced concrete toboggans down the snowy slopes outside Red Deer, Alberta, Canada.* The same year saw 25 concrete canoes from 18 schools race down the rapids of the Kenduskeag Stream in Maine in the first whitewater concrete canoe race held in the world. In 1978, the first concrete canoe race in Great Britain was held in England. Another race took place in the Netherlands and included student representation from Germany and Belgium. Concrete canoe races later became a national competition that is co-sponsored in the U.S. by ASCE and Master Builders (MBT).

INTERNATIONAL ACTIVITIES

International activities were not confined to student programs. ACI standards were published in Spanish by Instituto Mexicano del Cemento y del Concreto (IMCYC). *Formwork for Concrete* was translated into Japanese. The Comite Europeen du Beton (CEB) and the Federation Internationale de la Precontráinte (FIP) had produced an international recommended practice for reinforced and prestressed concrete design. This effort had taken place concurrent with development of ACI’s 1971 Building Code. Coordination and crossflow of information was facilitated by the ACI-CEB Collaboration Committee. An International Seminar on Concrete for Nuclear Reactors, sponsored by ACI and held in Berlin, attracted experts from North America, Europe, Asia, and Africa.

With new building code requirements issued in late 1971, an extensive educational program was devoted to the code. The new code was introduced in a closed-circuit educational television program cosponsored by PCA and ACI. In early 1972, the program was televised simultaneously to audiences in 18 cities in the U.S. and Canada. Some 2500 engineers watched and listened as the experts who had developed the new code explained its provisions and fielded questions from the audiences relayed to them by telephones. While the techniques used were not new, it is believed that this was the first time they had been used in North America in technical society work.

The 1971 code requirements, unlike those in the 1963 edition that presented working stress design and ultimate strength design on an equal footing, fully specified only Ultimate Strength Design (USD). Working stress design, however, was still allowed as an alternate design method. Grade 60 reinforcement was now the norm. A new chapter on thin shells and an appendix on seismic design were introduced and design provisions for torsion in reinforced concrete members were included. The design of flat slabs, flat plates, and two-way slabs on beams was unified into a new method of analysis. Concrete strength requirements were placed on a statistical basis. The concept of flexural bond was replaced by that of development length. ACI 318-71 could easily be called a milestone in concrete

* Another unusual student project was the construction of the world’s first (and only?) concrete hang glider by civil engineering students at the University of Sydney, NSW, Australia. Its maiden, and only, flight took place on May 27, 1987, covering a distance of 130 ft (40 m).

codes. Along with the new code material on seismic design came the addition of seismic details for special ductile frames to the *ACI Detailing Manual*.

PORTLAND CEMENT ANNIVERSARY

The new modern building code of 1971 coincided with the 100th anniversary of the portland cement industry in the U.S. Natural cement was produced in the U.S. starting in the early 19th century, but portland cement was imported from Europe until the 1870s. On September 26, 1871, David O. Saylor, Allentown, PA, filed a patent application to cover the manufacture of "a new and improved" cement and was granted the first U.S. patent for the manufacture of portland cement. Soon thereafter, the first portland cement to be made in North America was manufactured in Coplay, PA. Ten years later, the annual production in the U.S. was about 42,000 barrels (7900 tons). After 20 years and the introduction of the rotary kiln, annual production in 1900 had grown to 10 million barrels (1.9 million tons). By 1971, the centennial of the first production of portland cement in the U.S., production had grown to more than 400 million barrels (75.2 million tons) annually.

LOOKING TO THE '70s AND BEYOND

Looking toward the next century, an Institute committee, under the chairmanship of Clyde Kesler, developed a report "Concrete—Year 2000" which appeared in the August 1971 *ACI Journal*. It discussed some of the changes that could be expected to take place in the next 30 years, and the part that concrete would play. Concrete was now used in greater quantities than any other man-made construction material. In 1970, the rate of production of concrete in the U.S. was 1.5 short tons (1400 kg) for each person.

While the application of computer programs for structural design was expanding, the technique had yet to be completely accepted. ACI published a report on acceptance of electronic computer calculations by building officials in 40 cities in the U.S. and 11 cities in Canada. Only about half of the cities responding in the U.S. had experience with computer designs. Quite often, the designer using a computer program had to consult with the building official to explain the program and its output and reliance on the seal of the designing engineer was normal. The ACI report was followed by a state-of-the-art report on computer graphics applications and a survey of more than 100 engineering organizations using computer graphics. At that time (1971), perhaps no other technology in the engineering field was changing as rapidly as computer usage.

Two other comprehensive concrete guides were published by ACI in the 1970s: one on use of admixtures and the other on the consolidation of concrete. ACI presented minimum requirements for design and construction of structural plain concrete with "Building Code Requirements for Structural Plain Concrete (ACI 322-72)." This code supplemented the ACI 318-71 code requirements.

Steel fibrous shotcrete was first placed in the U.S. in early 1971 in experimental work by the U.S. Bureau of Mines, which was investigating new methods for shotcrete for underground support. The U.S. Army Corps of Engineers used the first practical application of steel fibrous shotcrete in 1972 in a tunnel adit in Ririe Dam in Idaho. Also in the early 1970s, hydraulic vibrators were introduced for concrete paving machines.

In 1973, the Institute established a new membership category—that of Fellow. The basic requirements were: "A Fellow shall be a person who has made outstanding contributions to the production or use of concrete materials, products, and structures in the areas of education, research, development, design, construction or management...." The new membership grade was positioned between Member and Honorary Member.

Expanding its information service, the Institute purchased the magazine, *Concrete Abstracts*, and the December 1973 issue was the first issue to be published under the ACI logo. The bimonthly magazine abstracted and indexed articles and publications published worldwide on concrete and concrete technology, including materials, manufacturing, equipment, construction, performance, architecture, structural engineering, and research. The magazine received an "Idea Award" in 1975 from the American Society of Association Executives.

A 1971 survey had indicated that many cities did not have building official personnel trained in evaluating building submittals containing computer programs or computer calculations (see above) for designs in reinforced concrete. In 1973, ACI Committee 118 thus published recommended documentation for computer calculation submittals to building officials. Recommendations were directed largely toward assuring that computer calculation submittals would be orderly and as easily understandable by the reviewer as long-hand calculations.

The 1974 fall Atlanta convention ushered in a new era of convention programming. For the first time, an educational workshop (on slab design), with a separate registration fee, was offered by the Educational Activities Committee. The success of that program led to a repeat at the Boston spring convention (1975) and an additional workshop on pile driving specifications. The 1975 fall convention in Vancouver featured three educational programs.

COOPERATIVE EFFORTS

In 1975, a cooperative effort by ACI and ASME resulted in a new code of considerable significance to production of electric power by nuclear-powered generating stations. The Joint ACI-ASME Technical Committee on Concrete Pressure Components for Nuclear Service completed a code covering the design, construction, inspection, and testing of concrete reactor vessels and containments, together with requirements for the quality assurance that is essential for such safety-related structures. This document was followed shortly thereafter by ACI Committee 311's guide for the

Executive Vice President George F. Leyh served as ACI's chief staff officer from 1975 until 1998.

certification of nuclear concrete inspection and testing personnel in accordance with the ACI-ASME code.

The publication in early 1975 of the six-volume "National Concrete Technology Reference Shelf" brought to a close a seven-year educational effort by PCA, ACI, and the National Ready-Mixed Concrete Association. The National Concrete Technology Curriculum Project, initiated in 1968, had developed course content and teaching materials to train technicians for the concrete industries, and also included development of career guidance materials.

EXPANDING SIGHTS

In late 1975, the Board of Direction named George F. Leyh executive director of ACI to succeed William A. Maples on his retirement. The Institute's international programs continued with a number of cosponsored seminars and conferences in Latin America, Europe, and North America. The First Panamerican Symposium on Concrete Education was held in Mexico City during the ACI 1976 fall convention there. The symposium was sponsored jointly by ACI, the Panamerican Federation of Engineering Societies (UPADI), and IMCYC. It was appropriate that the second Panamerican symposium was scheduled for 1979 in Washington, D.C., in conjunction with ACI's 75th anniversary celebration.

The Board of Direction approved a historic landmarks program in 1975 to identify and designate historic concrete projects, structures, and sites that represented significant advancements in application of concrete technology. This would also increase public awareness of concrete industry contributions to man's technical progress. The Ward House, built between 1873-1876 in Port Chester, NY, and the first and oldest extant reinforced concrete building in the U.S., was designated a Concrete Engineering Landmark by ACI in 1978, the first such designation by the Institute. The building had been placed on the National Register of Historic Places in 1976.

The 1975 annual convention brought a new audience into contact with ACI. ACI Committee 120 cosponsored a symposium on "Restoration of Historic Concrete Structures" with the National Park Service, Association for Preservation Technology, and the National Trust for Historic Preservation.

U.S. BICENTENNIAL

Recognizing that the U.S. Bicentennial in 1976 offered a unique climate for presenting U.S. contributions to the technology of concrete and reinforced concrete, the ACI committee on history published *A Selection of Historic American Papers on Concrete: 1876-1926*. Men of vision were remembered, and significant landmark articles on concrete, long out of print, were collected in this volume. The classic papers were by Thaddeus Hyatt, William E. Ward, Arthur N. Talbot, Arthur R. Lord, C. A. P. Turner, Ernest L. Ransome, and Duff A. Abrams—whose thinking, experiments, practices, and teachings influenced their contemporaries as well as their successors in concrete technology.

The year 1976 highlighted international activity for ACI. The fall convention, cosponsored with IMCYC, was held in Mexico City and drew participants from 24 countries. The Bicentennial spring convention in Philadelphia attracted conferees from 15 countries. The Philadelphia meeting featured a symposium sponsored by ACI, Comite Europeen du Beton, Federation Internationale de la Precontrainte, and the Prestressed Concrete Institute (PCI), comparing design practices in Europe and the U.S.

ACI assumed responsibility for administering and conducting the qualifying examination for Level III Inspection Engineers required by ACI 359, "Code for Concrete Reactor Vessels and Containments." This examination had previously been given by the National Council of Engineering Examiners.

Another grade of membership was approved in 1977 when members ratified a Bylaws revision creating the grade of Sustaining Member. The grade was created to

> "Throughout the many years of the Institute's history, the chartered goals have been achieved by the efforts of thousands and thousands of members, past and present, who have given, and are currently giving willingly of their time and talent so that ACI can progress and fulfill its obligations."
>
> *—George F. Leyh*
> ACI Executive Vice President, 1975-1998

encourage participation from those organizations desiring to make a greater financial contribution to the work of ACI.

LATE '70s TECHNOLOGICAL ADVANCEMENTS

Technological developments in the 1970s continued to foster activation of new Institute committees on such subjects as offshore concrete structures, concrete guideways, ferrocement, polymers in concrete, and industrialized concrete construction.

It is not surprising that by the late 1970s the industry and ACI were concerned with energy and resource conservation. Concrete uses less energy in production of the finished structure than comparable construction materials (timber excluded). Also, the raw materials that make up cement and concrete constitute a large part of the earth's crust and therefore are readily available. Concrete is adaptable and can serve several purposes, as well: structural support, thermal insulation, sound insulation, and decorative finish. Special concretes such as polymer concretes and fiber-reinforced concretes were finding application. Concrete railroad ties were replacing timber ties on some rail routes. The height of concrete-frame buildings had increased to 75 stories.

Concrete was also becoming more user-friendly. High-range water-reducing admixtures, often called superplasticizers, were introduced in North America in 1976 and could produce flowing concretes or workable concretes with very low water-cement ratios. These admixtures had been used in Japan since the 1960s and in Europe since 1972. The material found early acceptance in North America in the precast prestressed industry and would eventually find its way into ready-mixed concrete applications. Superplasticizers produced flowing concrete without strength loss and allowed casting concrete with ease around very congested reinforcing cages. For the contractor who had to place the concrete, as well as the designer who needed full-strength reinforcement-packed concrete columns without voids, superplasticizers made use of concrete much more attractive. The 1970-1980 era saw a number of organizations involved in investigations on performance of silica fume in concrete. The availability of superplasticizers had opened up new possibilities for the use of silica fume as part of the cementing material needed to produce very high-strength concrete [>15,000 psi (>100 MPa)].

Canadian engineers and builders set a new record with completion of the CN Tower in Toronto in early 1976. It was the world's tallest free-standing structure, reaching a height of 1815 ft (550 m). The tower was slipformed at more than 20 ft (6 m) daily. The concrete structure reached 1480 ft (45 m) and was topped off with a 335 ft (102 m) steel transmission mast.

NEW BUILDING CODE DESIGN AIDS

ACI Building Code Requirements were issued in late 1977 in a new, easy-to-read format. Two important design aids became available in 1978 for use in simplifying application of ACI 318-77: Volume 2 of the *Design Handbook* in accordance with the strength design method for column design, and a supplement to the *Design Handbook* covering design and analysis of reinforced concrete slab systems.

ACI and Comite Europeen du Beton (CEB) officers discussed international code work at ACI headquarters in a 1975 meeting. Left to right: Joseph H. Walker, ACI President; Andrew Short, CEB President; Yves Saillard, CEB Deputy President; Raymond C. Reese, ACI past president; and William A. Maples, ACI Executive Director.

ACI also issued a guide for design and construction of fixed offshore concrete structures. In offshore work around the world, various combinations of precast concrete, slipformed concrete, and prestressing were combined to create mammoth concrete oil drilling platforms.

During the 1970s, large concrete structures for the petroleum industry in the North Sea were among the more spectacular concrete construction developments. Typical features of such projects were large-scale slipforming, extensive prestressing, and very stringent quality requirements. Each structure was designed and built to endure for 30 years or more in a very hostile marine environment. The platforms were built partly in drydock and partly in a floating position. One of the largest off-shore drilling, production, and storage facilities became operational in mid-1977 in the Dunlin Field, midway between Norway and the Shetland Isles. The concrete caisson, built in drydock in Holland, measured 340 x 340 ft (104 x 104 m) and 105 ft (32 m) high; the caisson supported four concrete towers, each 367 ft (112 m) high, in turn supporting a mammoth steel deck structure. The 250,000-ton (227,000-tonne) concrete structure was towed a distance of more than 622 miles (1000 km) from Holland to Norway. By 1981, even larger platforms were in operation. Statfjord B platform in the North Sea had a total height of the concrete structure itself of 568 ft (173 m), requiring 183,000 yd^3 (140,000 m^3) of concrete. The 1973-1981 period saw 14 concrete gravity platforms built for the North Sea oil fields.

The newest and longest cable-stayed concrete bridge in North America opened to traffic in 1978. The Pasco-Kennewick intercity bridge in the state of Washington featured a continuous concrete girder 2503 ft (763 m) long supported by steel cables anchored atop two pairs of concrete towers. The segmental deck was made up of precast, post-tensioned concrete segments.

SIGNIFICANT NEW PROJECTS

The period 1977-1979 was a time of significant progress for ACI. Staff and committees were busy implementing many decisions from the Board of Direction and membership. Among the most important projects initiated were publication of two monthly magazines, a revitalized education program, and greatly increased promotional efforts for Institute publications. ACI had record publication sales and 1978 marked the first time that sales exceeded $1 million. There was also record attendance at educational seminars.

A survey in 1978 asked members how they evaluated ACI publications, programs, and activities. Answers revealed that ACI was regarded as an authority in the field and the publications program was often mentioned as ACI's strongest service. Members expressed a need for publications that were applied rather than theoretical. A large proportion of members indicated they used the *ACI Manual of Concrete Practice* and the design manuals and handbooks, and rated these publications and ACI's educational seminars high in usefulness.

Many times during the Institute's history, consideration had been given to publishing two distinct magazines. Studies were again initiated in 1976, and in 1977 the Board of Direction approved publishing two monthly periodicals starting in 1979. Headquarters staff spent much of 1978 preparing and staffing for this new endeavor.

The inaugural issue of *Concrete International: Design & Construction* in January 1979 marked another milestone in the 75-year history of the American Concrete Institute. The Institute began publication of two monthly periodicals. The *ACI Journal* was redesigned to a digest-size format and featured papers on research, design, and analysis of an archival nature. The new *Concrete International* contained articles on construction methods, design practices, architectural concrete, projects of note, testing and inspection, and news of ACI and the concrete industry.

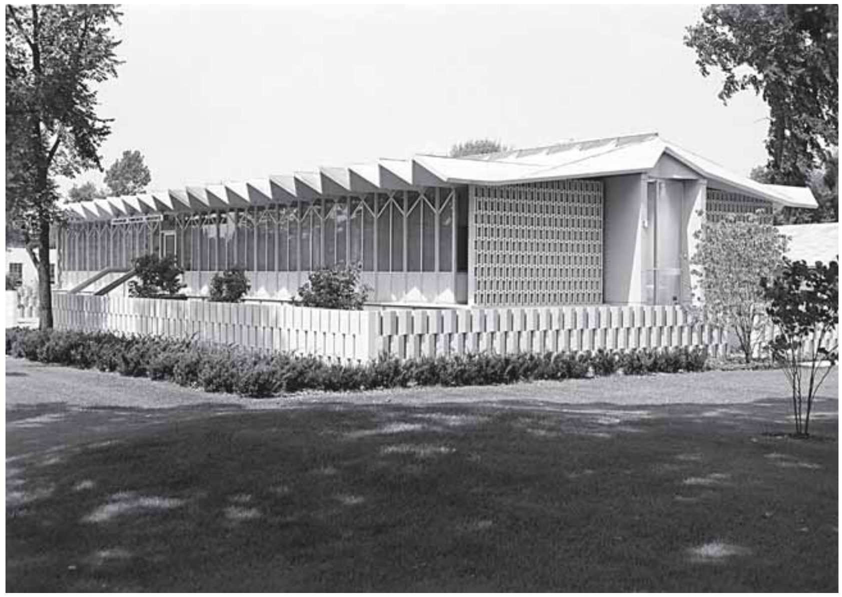
A Selection of Concrete and World Events: 1955-1979

This chronology lists some of the events that occurred during 1955 to 1979—a selection of various happenings from numerous resource materials. No claim is made for completeness. No relationship between events is to be inferred. The listings for each year are not necessarily the most important events that took place in those years—but are interesting and/or notable events.

	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1955	The second edition of the *Reinforced Concrete Design Handbook* and the third edition of the *Manual of Concrete Inspection* were published. Bibliography No. 1 on prestressed concrete was published.	Concrete houses built in the desert at Yucca Flats, New Mexico, stood up well to atomic blast. Precast roof slabs were effective deterrent to fire. Properties of initially retarded concrete and set-retarding admixtures were subjects of current research. Commercially produced slipform paver appeared.	Winston Churchill resigned as Britain's Prime Minister. Giant U.S. labor unions, AFL and CIO, merged. Federal Republic of West Germany became a sovereign state. Warsaw Pact signed. U.S. used its first atomically generated power. Disneyland in California opened.
1956	Site purchased for ACI-owned headquarters building. *Journal* schedule was increased to 12 times per year. Membership was over 8000 and income passes quarter-million dollar mark. A revised Building Code was adopted with an appendix that introduced ultimate strength design to the Code. Committee 301, Specifications for Concrete, organized.	Kelly Ball Test was developed. Current research was considering creep and creep recovery, cracking resistance of hydraulic cement, concrete strength under combined stresses, stresses in shells, stress losses in prestressed beams, and fire resistance. Construction began on Brasilia as new capital of Brazil. Federal-Aid Highway Act passed to start construction of U.S. interstate highway system.	A Nobel Prize was awarded for the invention of the transistor. Liners Andrea Doria and Stockholm collided in the Atlantic. The first trans-Atlantic telephone cable system was put into service. FORTRAN was developed.
1957	ACI's permanent headquarters building was erected in Detroit. Funds were provided by a voluntary building fund that subscribed about $212,000. Membership had grown past 9000.	Twenty-four-story prestressed concrete high-rise building was completed in Honolulu, HI. Portland Cement Association dedicated Structural Development Laboratory and Fire Research Center at Skokie, IL site. Current research was looking at shear strength of simply supported beams, concrete containing portland blast-furnace slag cement, and instruments for measuring pore pressure in concrete.	First underground nuclear explosion was detonated. USSR successfully tested intercontinental ballistic missile. Soviet Union launched first man-made satellites (Sputnik I and II) into Earth orbit.

1958-1960

ACI EVENTS | CONCRETE EVENTS | WORLD EVENTS



ACI built its first headquarters building in 1957-1958. The principle structural frame was the precast folded plate reinforced concrete roof that cantilevered front and rear from the monolithic corridor walls.

1958

ACI Events: The new headquarters building was occupied. Official dedication took place during fall convention, which was held in Detroit. A color photograph of the new building was the first to appear on the *Journal* cover. Henry L. Kennedy Award was established to recognize outstanding technical and administrative service to the Institute. The establishment of local chapters was authorized and the first, Southern California, was organized.

Concrete Events: The first mile-a-day concrete paving project was constructed. Chapter 11 of the long-time study of cement performance was published. High-strength steel and 6000 psi (41 MPa) concrete used in columns of Dallas apartment building to reduce size. Fatigue strength of prestressed beams was being researched.

World Events: Conquest of space moved forward with the U.S. launching of five separate satellites. Aluminum beer cans introduced. Charles de Gaulle elected Premier of France. Jet service between U.S. and Europe began.

1959

ACI Events: Small parcel of property surrounded by ACI property was purchased to preserve the appearance of the site. A committee on long-range objectives was formed. The *Journal* cover was modernized by the addition of a photograph. Fall meeting was held in Mexico City. Membership passed the 10,000 mark.

Concrete Events: Executive House Hotel in Chicago became world's tallest concrete building at 371 ft (113 m). A 700 ft (213 m) long prestressed concrete trestle was built in South Carolina. Continuously reinforced concrete pavements were studied. Exposed aggregate panels and plastic forms were being used to obtain pleasing architectural concrete. St. Lawrence Seaway opened, connecting the Great Lakes and the Atlantic Ocean.

World Events: U.S. space agency selected trainees for forthcoming manned space flights. U.S. grew to 50 states with the admission of Alaska and Hawaii. Fidel Castro assumed power in Cuba.

1960

ACI Events: The Monograph Series was approved. The Charles S. Whitney Medal for noteworthy engineering development in design or construction was established. The Publications Policy was revised with an emphasis on shorter contributions. Convention in New York was first to exceed 1000 attendance.

Concrete Events: Pier Luigi Nervi's unique ferrocement sports arena in Rome was site of the Olympic Games. AASHO was studying performance of pavement and highway structure in a full-scale test in Illinois. Current research was looking at the correlation between flexural and tensile splitting strength, autogenous healing mechanisms, and stress corrosion failures in prestressed concrete. New Jersey installed reinforced concrete barriers to separate opposing lines of highway traffic.

World Events: John F. Kennedy became the youngest man to be elected U.S. president. U.S. reconnaissance plane was shot down over the USSR. First meteorological satellite Tiros I launched. First nuclear-powered aircraft carrier USS Enterprise launched.

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1961		
The publication schedule for the *Journal* was changed so volume year coincided with calendar year. A cumulative index of *ACI Proceedings* from 1905 through 1960 (55 years) was published. Joe W. Kelly introduced the "Memo from the President."	Marina Towers in Chicago claimed "tallest concrete building" title at 585 ft (178 m). Freezing and thawing tests on lightweight aggregate concrete were reported. Rectangular stress distribution in ultimate strength design was offered for design consideration. Passage of the Federal-Aid Highway Act secured funding for the National System of Interstate and Defense Highways with much of the system being concrete pavement. American Society of Concrete Contractors organized.	Yuri Gagarin of the Soviet Union became the first human space traveler in a one-orbit flight. Alan B. Shephard, Jr., and Virgil I. Grissom of the U.S. follow shortly with suborbital flights. The "Berlin Wall," separating East and West Berlin, was built. The United Nations headquarters was dedicated. Roger Maris of the New York Yankees broke Babe Ruth's home run record with 61 in a single season.
1962		
An Institute chapter was formed in Japan. The "regional" meetings officially became full-fledged fall conventions. The first separate symposium volume was published. ACI Committee 326 published an extensive report on shear and diagonal tension. The second color photograph appeared on the *Journal* cover. Members submit suggestions for a new ACI symbol and motto.	Concrete shells were popular in construction and in literature—eight papers on shells appeared in the *ACI Journal*. Researchers were looking at shear in prestressed I-beams, yield hinges in columns, splitting phenomenon in bond failure, creep rates under repeated loads, lightweight aggregate effect on strength and durability, and false set. Concrete was used extensively in structures at the Seattle World's Fair.	John Glenn of the U.S. completed a three-orbit space flight. First communications satellite Telstar launched. Soviet missiles in Cuba provoked a U.S. naval blockade. Algeria became an independent nation.
1963		
The first edition of *Formwork for Concrete* was published. A revision to the Building Code was published in a restructured format. Keyword indexing was added to *Journal* papers. The committee numbering structure and grouping were reorganized. Board goes on record in favor of metric equivalent in ACI publications.	The terminal at Dulles International Airport, Washington, D.C., was a major concrete achievement. The research was in such areas as ultra-high-strength concrete, influence of cement paste content on creep, lightweight aggregate concrete, shear in members of circular cross section, and fatigue of prestressed beams. A record 2 miles (3 km) of concrete highway was paved in one day.	U.S. President John F. Kennedy was assassinated. Valentina V. Tereshkova of the USSR became the first woman in space with a 48-orbit flight. A limited nuclear test ban treaty between the U.S. and the USSR was signed.
1964		
The new ACI logo and motto were introduced. ACI entered into joint sponsorship of the Monograph Series with Iowa State University Press, and the first monograph was published. An architectural contest for third-year students was held at the annual convention with a donated cash prize to the winner. The annual convention in Houston reconvened for one day in Monterrey, Mexico—the first convention held in two cities. A 5-year supplement to the *55-Year Index* was published.	Glen Canyon Dam in Arizona completed—contained almost 5 million yd^3 (3,823,000 m^3) of concrete. Ongoing research was considering shrinkage and creep in lightweight prestressed beams, galvanized reinforcement, and effect of finishing methods on bridge-deck concrete properties. Spans of Chesapeake Bay Bridge built of precast concrete components. The American Concrete Pavement Association was founded. Montreal's Place Victoria became the tallest concrete building at 624 ft (190 m).	"Hello Dolly" was a big hit on Broadway. U.S. Congress passed Civil Rights Act. Verrazano-Narrows Bridge opened; longest suspension span at the time. Nikita Khrushchev was ousted as Soviet premier. The U.S. began major involvement in Vietnam War. Ranger VII yielded close-up photographs of the moon's surface. Alaska hit by massive earthquake.

1965-1966

ACI EVENTS | CONCRETE EVENTS | WORLD EVENTS

Two ACI past presidents helped publicize a new logo and motto, "Progress through knowledge," in 1964—Roger H. Corbetta (1963 president), left, and Raymond C. Reese (1962 president). The insignia was designed to express the dignity and stability of the Institute itself and concrete as a material. At the same time, it was an expression of the Institute's worldwide field of operation and influence.

1965

ACI Events: There were 16 active local chapters. The annual convention in San Francisco reconvened in Hawaii for a 2-day program. Coordination in the concrete industry and international cooperation were prime objectives of the Institute. A long-range planning committee was appointed to develop plans through the year 2000. ACI and ASTM reviewed and renewed the agreement about spheres of work. First commentary to the Building Code was published. Income exceeded $500,000.

Concrete Events: Computers for designing in concrete were becoming popular. Research was reported underway on factors that influence concrete resistance to deicers, strength under triaxial stress, volume changes in paste at early ages, bond in lightweight concrete, tensile strength of concrete, columns with special large bars, and slender columns bent in double curvature. The Japan National Council on Concrete (later the Japan Concrete Institute) was formed from a former ACI chapter. The National Precast Concrete Association was organized.

World Events: The first space walks were accomplished. One Soviet and four U.S. space flights, one lasting almost 14 days, were completed. Rhodesia proclaimed independence. The two-year New York World's Fair closed. The silicone chip was introduced in the U.S. First indoor baseball game played in Houston Astrodome.

1966

ACI Events: A technical committee on education was formed, launching ACI into this new field. Monograph Nos. 2 and 3 were published. Additional property in Detroit was purchased near headquarters to provide for expansion. ACI suggested possibility of a federation of organizations in the concrete field to improve coordination. Policy to include metric equivalents in ACI publications was adopted.

Concrete Events: Portland Cement Association celebrates 50 years. The 3-1/8 mile (6 km) Oosterschelde Bridge opened in Holland. U.S. delegation toured Russian building projects as part of technical exchange program. Over 102, 000 yd^3 (78,000 m^3) of concrete were placed at Mossyrock Dam in Washington in just 23 days. Researchers were studying epoxy-bonded composite beams, finite element analysis of members, and shell behavior. The Concrete Society in England and Architectural Precast Association in United States were organized.

World Events: Mainland China launched a "cultural revolution" in power struggle. Prime Minister Hendrik Verwoerd of South Africa was assassinated. France withdrew armed forces from NATO. Soviet Lunar 9, followed by U.S. Surveyor 1, made soft landings on moon surface.

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1967		
Policy was established to submit all standards for adoption by American National Standards Institute. The 3rd edition of the *Reinforced Concrete Design Handbook* was published. The *ACI Journal* was published in the larger magazine format. The first "ultimate strength" design handbook (SP-17) was published. The *Book of Standards* was succeeded by the *ACI Manual of Concrete Practice*.	The 70-story Lake Point Tower, Chicago, at 645 ft (197 m), built of lightweight structural concrete, opened. Topics under study included blast resistance of slabs, load transfer, frames under cyclic loads, effects of variable repeated loads, integration of seismic systems in flat plate structures, strength under high temperature, and concrete with nylon fibers. Habitat '67 in Montreal constructed from prefabricated concrete units. First continuous reinforced concrete pavement on I-70 near Pocahontas, Ill.	Expo '67 World's Fair was held in Montreal. The "six-day" Arab-Israeli War resulted in large territories changing hands. The first successful human heart transplant was accomplished. Large-scale protests against the Vietnam War began. Green Bay Packers football team defeated Kansas City Chiefs in first Super Bowl.
1968		
The Institute's Education Department was formed. A growing staff required renting additional space and beginning plans for building larger quarters. The Distinguished Service (Bloem) Award was established. Katharine Mather first woman elected to Board of Direction. The first glossary of cement and concrete terms was issued.	Relationship of cement properties to performance were reported by U.S. National Bureau of Standards after long-time tests. Researchers were looking at corrosion of steel in lightweight concrete, rapid tests for strength potential of cement, accelerated testing, connections between precast members, and behavior of deep slabs at ultimate capacity. Polymer-impregnated concrete showed high strength. Morrow Point Dam in Colorado was the first double-curvature, thin-arch dam constructed.	U.S. shocked by assassinations of Martin Luther King, Jr., and Senator Robert F. Kennedy. The Warsaw-Pact nations invaded Czechoslovakia and overthrew the Alexander Dubcek regime. U.S.S. Pueblo seized in the Sea of Japan by North Korea. France was paralyzed by general strike. Apollo 8 with three-man crew orbited moon. Cable television introduced.
1969		
The titles of Executive Secretary and Assistant Secretary were changed to Executive Director and Deputy Executive Director. The first "Technical Committee Manual" to guide committee operations was published. A 10-year supplemental index was published. The first educational seminar was held. Ground was broken for a free-standing addition to the Detroit headquarters building. A standard was proposed for cast-in-place pipe.	Construction began on the Shell Oil Building, Houston, TX, said to be the tallest concrete building at 714 ft (218 m). Ferrocement for boats was capturing the imaginations of many. Canada dropped the "barrel" as a shipping unit for cement. Reinforcing concrete with glass fibers was reported to be successful. A patent was issued for a steel wire-fiber reinforcing technique. Concept of square concrete pipe initiated.	Neil Armstrong and Edwin "Buzz" Aldrin of the U.S. became the first men to walk on the surface of the moon. Charles de Gaulle resigned as president of France. Peace talks to end Vietnam War began in Paris.
1970		
The new headquarters addition was occupied. The second floor was leased out. An education tour of European construction was organized. The Educational Activities Committee is formed and several education committees appointed.	Atlanta airport construction teams placed 326,000 yd^3 (249,000 m^3) concrete pavement in 40 days. Current research was looking at accelerated strength tests, ultrasonic tests for microcrack detection, interaction of frames with filler walls, and behavior of thin-walled members. University of Illinois students built and floated a ferrocement canoe, starting a wave of building and racing activity that became annual events. First practical use of steel fiber-reinforced shotcrete by U.S. Army Corps of Engineers.	Aswan High Dam completed in Egypt. Thor Heyerdahl and crew sailed from Morocco to Barbados in papyrus boat. To accommodate the new 747 jumbo airliner, most major airports were building new runways and facilities. First tower of New York's World Trade Center topped out. U.S. Gross National Product reached $1 trillion.

1967-1970

1971-1974

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1971		
A vastly changed Building Code with ultimate strength design (USD) was issued. A Specification Review Committee is formed. The Raymond C. Davis Lecture Series is authorized. Monograph 6 and six symposia volumes were published. The first standard on notation was issued. The new Code changes were explained in a series of ACI-PCA closed-circuit television seminars. ACI Committee 318 established an annual supplement revision policy and five-year cycle for Code revision.	Studies on low-cycle fatigue, prolonged monomer saturation, moisture movement through low-density concrete, cold-formed mechanical splicing systems, ferrocement at cryogenic temperatures, beam-column connections, behavior under triaxial stress, accelerated testing, and shrinkage compensating concrete are underway. Precast monorails for Disney World in Florida were shipped 3400 miles (5470 km) from plant in Washington. The effect of melamine resin additions on concrete showed high-strength and water-reducing possibilities. Portland cement industry in U.S. was 100 years old. First fiber-reinforced concrete pavement placed on Ohio I-71 weigh station entrance.	Sixty-three nations signed treaty banning nuclear weapons on the seabed beyond the 12-mile (19 km) limit. Mainland China was seated in the U.N., replacing the Formosa government. Load factor design introduced for steel highway bridges. Pocket calculators introduced.
1972		
Membership exceeded 15,000 and income was more than $1 million. An educational tour of construction in Australia and New Zealand was organized. The Arthur R. Anderson and Roger H. Corbetta Concrete Constructor Awards were established. Committees on conventions, planning, and industry advancement were established. First Chapter Roundtable held.	First cantilevered box girder, segmental bridge in the U.S. built in Texas. World's tallest load-bearing concrete block building, a 196 ft (60 m) high hotel in Disney World, used epoxy adhesive instead of conventional mortar. *Engineering News-Record* named Fazlur Khan its "Man of the Year." Concrete Sawing and Drilling Association organized. The U.S. Navy was researching deep ocean concrete structures.	Japan and China renewed diplomatic relations, ending an official state of war beginning in 1937. The arrest of five men at the Watergate Complex offices of the U.S. Democratic Party touched off a political scandal that brought down the Nixon administration. The U.S. President visited Mainland China, opening communications for the first time in 20 years.
1973		
The first education bulletin was published. *Concrete Abstracts* was purchased and published under ACI auspices. The membership grade of Fellow was established.	Designers specified 7500 psi (52 MPa) concrete for One Thousand Lake Shore Plaza, Chicago. Concrete was pumped 473 ft (144 m) vertically for Indiana National Bank, Indianapolis. Expansive cement concretes, polymers in concrete, and probabilistic code format were symposia topics. Offshore oil discoveries in the North Sea lead to designs in concrete sea drilling platforms. Sail-like sculptural Sydney Opera House, Australia, built with precast and prestressed components.	Great Britain, Ireland, and Denmark formally entered European Common Market. East and West Germany established formal relations. The Greek monarchy was abolished and a republic was established. The U.S. put a manned space laboratory into orbit.
1974		
Membership passed 16,000. The Education Department produced a tape cassette program on the *Strength Design Handbook*. The Joe W. Kelly Award was established. The first nuclear containment structure standard was published.	Econocrete highway paving system was introduced. Attention was devoted to industrialized construction, durability, fiber-reinforced concrete, and concrete under extreme temperature. Research was underway on confined lightweight concrete, time-dependent behavior of an 855 ft (260 m) structure, acoustic emission test for evaluating concrete, and 12,000 psi (83 MPa) concrete.	Richard M. Nixon became the first U.S. president to resign. India exploded a nuclear device, becoming the sixth nation to do so. The emperor of Ethiopia was deposed after a 58-year rule. Sears Tower, 1454 ft (443 m) high, in Chicago, was highest example of tubular building design. U.S. Mariner 10 satellite transmitted pictures of both Venus and Mercury.

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS

1975

ACI Events: George F. Leyh became Executive Director, succeeding William A. Maples who retired after 27 years with ACI. Six symposia volumes were published. The sixth edition of the *Manual of Concrete Inspection* is published. The result of several years of cooperative effort with the Portland Cement Association and the National Ready Mixed Concrete Association was the publication by a commercial publisher of the *National Concrete Technical Reference Shelf*.

Concrete Events: Water Place Tower, Chicago, assumes the position of tallest concrete building at 847 ft (258 m). The first World of Concrete exposition was held in Houston, TX. Topics of interest were offshore structures, progressive collapse, safety, and sulfur-infiltrated concrete. Toronto's CN Tower 1815 ft (553 m) tall shaft was slipformed and post-tensioned. Concrete Foundations Association organized.

World Events: U.S. involvement in Vietnam ended. The Suez Canal was reopened for the first time since 1967. Two attempts were made on the life of U.S. President Gerald R. Ford. Personal and affordable computers began to appear.

Water Tower Place, Chicago, a 75-story reinforced concrete building was higher than any reinforced concrete building when it was built in 1972-1975. The 859 ft (242 m) tall building featured a concept combining tubular design for the upper 63 stories with conventional design for the lower 13. Column concrete strengths varied from 9000 to 4000 psi (62 to 28 MPa). Lightweight aggregate concrete was used in all floor slabs.

1976

ACI Events: ACI assumed task of administering Level III Nuclear Inspection Engineer examination. A special historical volume of significant papers of the past was published as a U.S. Bicentennial project. The Cedric Willson Award was established. The third edition of the *Field Reference Manual* was published. Chapter Activities Award established.

Concrete Events: Portland Cement Industry Museum dedicated in Coplay, Pa. The Post-Tensioning Institute was organized. The Rapid Analysis Machine for determining cement content of fresh concrete was developed by the Cement and Concrete Association. Topics being researched included: internally sealing concrete, self-stressing cements in reinforced concrete, early strength gain characteristics, seismic resistance of precast panel buildings, high temperature effects, control of corrosion in marine environments, and steel fiber concrete mixture proportioning.

World Events: The U.S. commemorated 200 years as a nation, the oldest existing democracy. The World Trade Center in New York was completed. Lockheed SR-71 Blackbird plane set new world speed and altitude records. The failure of Teton Dam led to changes in the design and construction of dams.

1977

ACI Events: Plans were approved to publish two monthly periodicals. Institute agreed to hold its annual convention in conjunction with the World of Concrete exposition in 1980. A new, reformatted Building Code was adopted.

Concrete Events: The Koror-Bebelthuap Bridge on the Palau Islands was completed and claimed record as longest box girder bridge at 790 ft (240 m). Topics being discussed included: polymer concrete, limit design, accelerated strength tests, seismic design, refractory concrete, and bridge design. The Masonry Society was founded.

World Events: The British-French Concorde supersonic jet approved to land in selected U.S. cities. Nationwide farmers' strike by the American Agriculture Movement. Israeli-Egyptian peace talks began. The 799-mile (1285 km) Trans-Alaskan Pipeline completed at a cost of $9 billion.

ACI EVENTS | **CONCRETE EVENTS** | **WORLD EVENTS**

1978

ACI Events: Income exceeded $2 million. The second edition of V. 2, Columns, of the *Strength Design Handbook* (SP-17) was published. A slab design supplement to V. 1 of the *Design Handbook* was published. The *ACI Journal* and *Concrete Abstracts* were available in microfiche editions. The member grade of Sustaining Member was established. Chapters were formed in Iran, Colombia, and Ecuador.

Concrete Events: Cement shortage slowed construction in some parts of the U.S. Interest was focused on lessons from structural performance, expansive cement, evaluating strength of existing structures, vibrations of concrete structures, slump loss, control of cracking, segmental construction, and fiber-reinforced concrete.

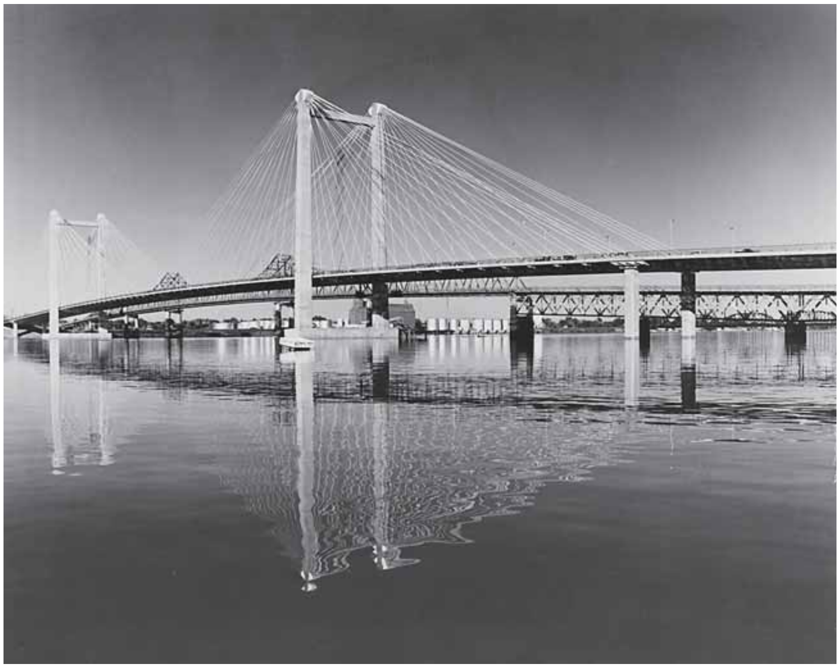
World Events: Environmental concern over the Snail Darter halted plans for TVA Tellico Dam. U.S. Senate approved treaty, turning control of Panama Canal over to Panama by the year 2000. Representatives of Israel and Egypt agreed to terms of peace treaty, ending 30 years of conflict. The Atlantic was crossed for the first time in a hot air balloon.

1979

ACI Events: The first monthly issue of the new magazine *Concrete International: Design & Construction* was published. The new digest-size *ACI Journal* was published. ACI celebrated its 75th anniversary. Publication sales passed the $1 million mark. Membership climbed over 14,200. Building code requirements for concrete masonry structures issued.

Concrete Events: The Pasco-Kennewick Bridge completed, purportedly the longest cable-stayed concrete bridge in North America at 2503 ft (763 m). Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, Miss., marked its 50th year of operation. Washington state's Denny Creek Bridge, the first in the U.S. to be erected by a three-stage incremental launching system with traveling formwork, neared completion. Construction began on the Long Key Bridge, the first of the concrete segmental spans that would provide a new highway linking the Florida keys.

World Events: Two U.S. space satellites photographed Venus. The U.S. space lab fell to Earth in Australia. U.S. gasoline hit $1.00 per gallon. Personal stereo, or "Walkman," was introduced by Sony. Two Soviet astronauts orbited Earth for a record 175 days. Spaceships Voyager I and Pioneer II passed by the planets of Jupiter and Saturn and transmitted photographs and atmospheric data back to Earth.



The first cable-stayed bridge with a concrete superstructure to be built in the U.S. was the Pasco-Kennewick Intercity Bridge crossing the Columbia River in Washington state, which opened to traffic in 1978. The main spans were 407 ft (124 m), 981 ft (299 m), and 407 ft (124 m). The bridge girder, structurally continuous along its entire length, was assembled from large precast prestressed concrete elements.

ACI Past Presidents 1955-1979

This pictorial presentation features the past presidents who have guided the American Concrete Institute to leadership in the concrete industry from 1955 to 1979.

Charles S. Whitney
1955

Frank Kerekes
1956

Walter H. Price
1957

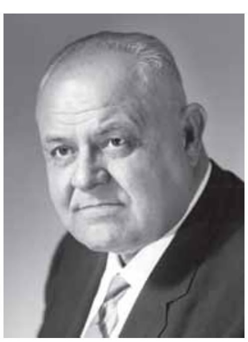
Douglas McHenry
1958

Phil M. Ferguson
1959

Joe W. Kelly
1960

Lewis H. Tuthill
1961

Raymond C. Reese
1962



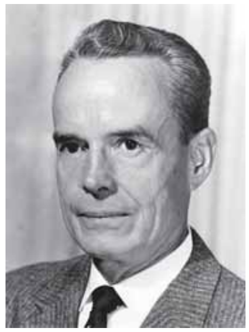
Roger H. Corbetta
1963

Bryant Mather
1964

A. Allan Bates
1965

Arthur R. Anderson
1966


Clyde E. Kesler
1967


Graydon E. Burnett
1968

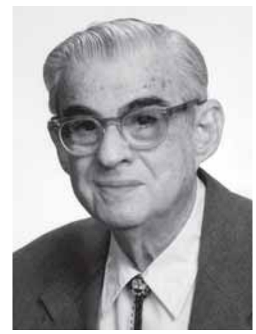

Joseph J. Shideler
1969

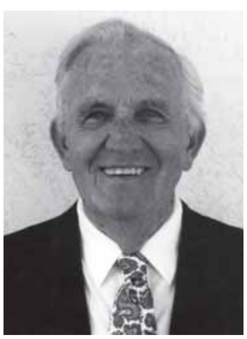

S. D. Burks
1970


W. J. McCoy
1971


Edward Cohen
1972


Robert E. Philleo
1973


Chester P. Siess
1974


Joseph H. Walker
1975


Russell S. Fling
1976


Richard C. Mielenz
1977


John L. Goetz
1978

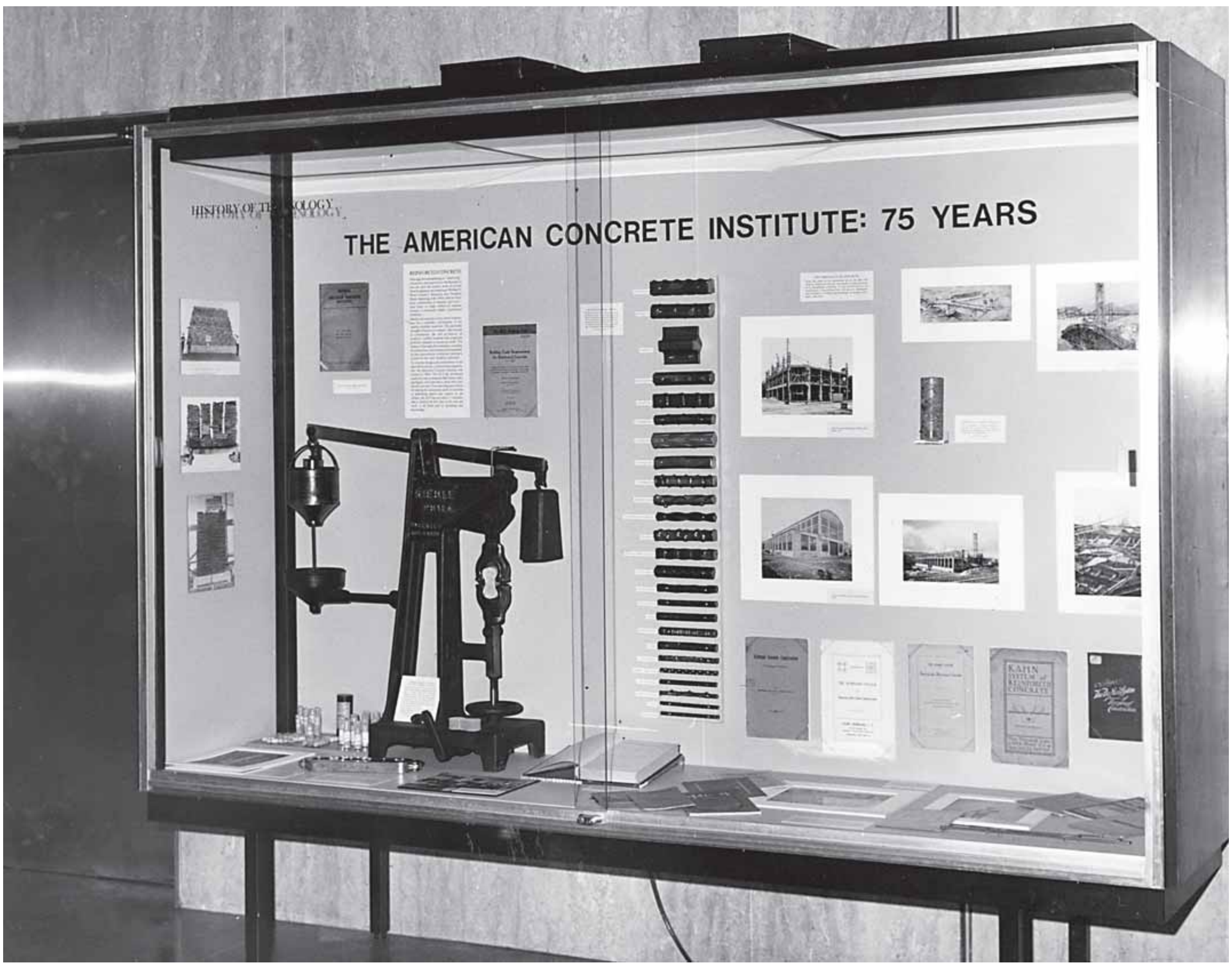

John F. McLaughlin
1979

1980-2004: Advancing Technology through the Millennium

As ACI celebrated its 75th anniversary in 1979, the U.S. Army Engineer Waterways Station in Vicksburg, Miss., celebrated its 50th anniversary. The year was full of anniversaries. The Prestressed Concrete Institute celebrated its 25th anniversary having been founded in 1954. The Concrete Reinforcing Steel Institute, founded in 1924, was into its 55th year.

Just two years earlier, ASTM Committee C-1 on Cement had celebrated its 75 years of service. The committee first met in 1902 and initiated laboratory tests for nine cements that led to the first ASTM cement specifications. C-1 has maintained liaison with ACI since 1913.

A major step in ACI's standardization work was the adoption in 1979 of "Building Code Requirements for Concrete Masonry Structures" and its commentary. The Institute also added five new specifications to its package of standards—one on drilled piers and four on



During ACI's 75th anniversary convention in Washington, D. C. in 1979, the Smithsonian Institution's Museum of History and Technology featured a display depicting 75 years of ACI and concrete history. The exhibit contained samples of reinforcing bars from the early days to 1979 along with other artifacts and publications, including the ACI Building Code.

use of epoxy adhesives and mortars.

It had been a busy and productive 75 years.

NEW ACTIVITIES

In 1980, ACI took a leadership role in establishing a certification program for concrete technicians for the purpose of improving the quality of concrete, in response to increased demand for certification by many governmental agencies. The proposal had not developed overnight, but had been discussed and debated for several years. Voluntary certification of those who conducted field tests on fresh concrete was offered as a benefit to companies in production of quality concrete. Certification also provided the technician an improved potential for advancement and added status and recognition.

After several years of planning and program developments, the program for certification of concrete field testing technicians Grade I became operational in early 1983. The voluntary program established a uniform national program that set uniform standards, qualifications, and training—thus increasing reliability of field test results. ACI headquarters acted as a central agency, supplying organizations with necessary materials to conduct local certification programs. Intended to upgrade the quality of concrete construction and to prepare the industry for possible widespread mandatory certification of technicians, the Grade I program included a written examination, an actual performance of ASTM tests on fresh concrete, and recording of test results. In connection with the program, ACI established procedures for qualifying trainers and examiners, and maintained a registry of approved trainers and examiners at Institute headquarters.

ACI published a series of manuals and workbooks to assist in establishing and operating the certification program. In conjunction with the PCA, videotape instructional guides on both the field testing and laboratory testing of concrete were produced. A typical program for Grade I certification included a 16-h training course covering principles of quality concrete and ASTM sampling and testing procedures followed by the two exam sessions—written and performance.

By mid-June 1983, 11 sponsoring organizations had received Institute approval to manage local certification programs, and the list of organizations continued to grow.

PUBLICATION GROWTH

The debut of *Concrete International* was deemed a success, and a new bi-monthly schedule for the *ACI Journal* evolved in the early 80s. With growth in the number of standards and committee reports, the *ACI Manual of Concrete Practice*, formerly printed in three volumes, was expanded to five volumes. Recognizing that ACI documents are used and/or referenced around the world, the Board approved publication of Institute standards in both U.S. Customary units (inch-pound) and in “hard” SI/metric units whenever there was sufficient demand for the latter. Both versions were to be processed through the Institute’s standardization procedures.

The *Design Handbook in Accordance with the Strength Design Method* was revised in 1981 in accordance with ACI 318-77 and combined with the 1973 supplement. Division I provided information for the design and analysis of beams, slabs (one-way action), brackets, footings, and pile caps. Division II treated the design of slabs performing in two-way action.

A good example of how ACI information products were expanding was the growth of the *ACI Manual of Concrete Practice* in just 15 years. In 1967, the MCP consisted of three volumes; 1456 pages reflected the work of 32 technical committees. By 1982, the *Manual* comprised five volumes with 2932 pages offering the work of 69 technical committees.

Late 1981 saw further growth in liaison with members residing outside the U.S. and with concrete organizations in other countries. For the first time the Executive Committee of the Board met in sessions outside North America with a visit to South America and regional conferences in Colombia and Ecuador. Thus began the practice of ACI presidential (and/or members of the Executive Committee) visits to Institute international chapters, combined with meetings with other concrete/ engineering organizations in those countries.

> “(There are) three basic, wide impact improvements in concrete materials technology of this (20th) century. The first of these improvements (1918), the understanding of the relationship of strength to water-cement ratio was the result of a painstaking laboratory investigation involving about 50,000 tests. The second discovery (1940), the durability benefits of air entrainment, was a fortuitous accident. (The third), superplasticizers (1960-), was the product of sophisticated research in organic chemistry . . . . Curiosity seems to be the one guarantee that progress in cement and concrete technology will continue.”
>
> *—Peter Smith*
> ACI President, 1982

COMMITTING TO THE CONTRACTOR

Over the years, ACI had developed—according to some critics—a reputation of being too research oriented and appealing more to the structural engineer and college professor than to the constructor. Demonstrating ACI’s commitment to serving the constructor, the Institute formed a new Construction Development Department in 1982. This department was responsible for identifying the most important needs of contractors who work with concrete, and developing programs, publications, and services to meet those needs. One goal was increased contractor participation in technical committees.

Cement making—yesterday and today. David O. Saylor is regarded as the founder of the U. S. portland cement industry. He organized the Coplay Cement Co. in 1866 in the Lehigh Valley of Pennsylvania. Left: Coplay Cement built these vertical cement-making kilns in 1892-1893. They could not compete with the rotary kiln and use was discontinued in 1904. They were restored and now form the Saylor Park Cement Industry Museum. Right: A typical modern cement plant is a far cry from those of the late 1800s. Indicated are: (1) quarry containing clay and limestone deposits; (2) primary crusher that reduces lime to a size suitable for conveyor; (3) cement storage silos with rail and truck loading stations; (4) conveyors and pipelines hauling raw materials and coal; (5) crushed limestone and coal storage area; (6) storage area of cement clinker that will be ground into cement; (7) main plant housing grinding mills; (8) two 460 ft (140 m) long kilns; (9) electrostatic precipitator area where impurities are removed from exhaust before discharge through stack; and (10) office building.
ACI archives. Photos courtesy of Saylor Park Cement Industry Museum (left) and Dundee Cement Co. (right).

ACI had several important committees that championed interests of the contractor. A major effort was aimed at attracting contractors to become involved in writing concrete industry standards and to promote dialogue and the exchange of information between designers and contractors. The Construction Liaison Committee (CLC) had a broadly-defined responsibility for developing programs and seminars for the contractor in cooperation with the Education Department. The Construction Review Committee, a subgroup of the CLC, was responsible for reviewing all Institute technical documents for constructibility, and, of course, the newly authorized certification program offered a way to improve field testing of concrete, thus reducing problems during construction and after completion of the structure.

In an effort to reach and teach construction workers, ACI began publishing the Concrete Craftsman Series. The first of this series of pocket-sized handbooks for the worker in the field became available in mid-1982. The first handbook was a how-to-do-it illustrated guide to what craftsmen and others should know about slabs on grade. The second in the series, issued in 1984, dealt with cast-in-place walls.

The Institute moved quickly into the next phase of the new certification program. It was expanded to include concrete laboratory testing technicians (Grades I and II) in addition to Grade I field technicians already being certified.

NOTABLE PROJECTS

Willow Creek Dam in Oregon was the world's first gravity dam to be totally designed and built using roller-compacted concrete (RCC) construction methods. Following two years of design and investigation, construction began in 1981. Roller-compacted concrete had previously been used only as a portion of construction for various dams and diversion structures. The Japanese had used RCC as central fill in construction of two gravity dams. Willow Creek Dam was 1780 ft (542 m) long, 169 ft (53 m) high, and contained 425,000 yd^3 (307,000 m^3) of roller-compacted concrete. RCC—a no-slump concrete that could be hauled in dump trucks, spread with a bulldozer or grader, and compacted with a vibrating roller—offered an efficient method for producing mass concrete at high production rates and low costs.

Another massive concrete project under construction was the Oosterschelde Barrier in The Netherlands. The storm-surge barrier, designed to be closed during flood tides, consisted of 66 prefabricated concrete piers equipped with huge sliding steel gates that could be dropped within 2.5 h during storm conditions. The prefabricated concrete piers were 131 ft (40 m) high and weighed 15,000 to 18,000 tons (13,600 to 16,300 tonnes). After the piers were floated into position and sunk, they were built up an additional 43 ft (13 m) with cast-in-place concrete to accommodate the 500-ton (454 tonne) flood gates and concrete box girders supporting a highway on top.

STUDENT CHAPTERS

The distinction of being the first ACI student chapter went to Wentworth Institute of Technology, Boston, MA, in the spring of 1982 under the auspices of the ACI New

100 years of concrete paving technology. Top left: Concrete for street paving in the early 1900s was produced in steam-powered mixers. Wheelbarrows were used to charge the mixer and concrete was hauled to the roadbed by horse-drawn carts. Top right: By the early 1920s, the mixer was placing concrete directly into the roadbed. Wood forms and wheelbarrows were still in common use. Bottom left: Large mechanized equipment was the rule in a 1958 paving train (right to left): a mixer/placer, steel forms, spreader, and finishing machine. Bottom right: A modern paving operation (left to right): haul truck (agitator type), placer-spreader, slipform paver, initial burlap drag, straight edging, secondary burlap bag, and texture-cure machine. In the background (left to right): aggregate stockpile, batch plant, and cement "pigs."

Photos courtesy of Portland Cement Association (top left), Ontario Department of Highways (top right), Blaw-Knox Co. (bottom left), American Concrete Pavement Association (bottom right).

England Chapter. This marked a new era for the Institute. Wentworth, founded in 1904, offered a building construction/engineering technology program on a cooperative educational basis where students divided their time between the classroom and employment in the construction industry. The second student chapter was established later the same year at California State University, Fresno, CA, under the auspices of the ACI Northern California Chapter. Involvement with college students had mushroomed. Programs included an annual cube testing competition at Institute conventions, a photography contest, concrete canoe races, and other chapter-sponsored events.

COMPUTER REVOLUTION

It is interesting to note that *Time* magazine named the personal computer "Man of the Year" for 1982. ACI had not been asleep during the computer revolution; it had organized technical Committee 118, Use of Computers, 20 years earlier. As a trial balloon on a possible Institute service, ACI Committee E 702, at the Kansas City fall convention, offered seven mini-micro computer programs applicable to the design of reinforced concrete. Results were later published as COM-1 (83). Six programs involved design analysis and the other concerned quality control at the construction level. Each contained a brief summary of theory and logic used, and a sample run was shown along with a listing of the program.

Rapid growth of personal computers (PC) opened the doors for more productive, efficient, and interactive communication in preparation of ACI documents. ACI actively encouraged the use of computers and the telephone modem for committee communications. Documents drafted on a PC led to more productive face-to-face sessions at a convention and a faster turnaround rate among committee members. It was not too long before hotel facilities were providing services where redrafted documents could be prepared overnight and ready by the next day's meeting.

The Institute, by 1983-84, was making a serious attempt to assist designers by utilizing more computer software—a natural extension of the publication program. A new generation of engineers was indicating a preference for computer programs over design aids in the form of tables and charts. It was proposed that ACI could review computer software developed by others and offer these in the publications catalog. The seminar at the Kansas City convention proved there was keen interest in such involvement.

FUNDING CONCRETE RESEARCH

In its early years, ACI had been involved in funding research. The Board of Direction in 1920 voted to set aside $100 for use of the Committee on Concrete Products as the nucleus of a fund to secure fire tests of concrete building units. (This was at a time when the annual member dues were $10.)

ACI continued to contribute to research, culminating in the early 1930s in what was known as the ACI column investigation, carried out at the University of Illinois and Lehigh University. This research resulted in the introduction in the Building Code of an inelastic design equation for concentrically loaded columns. After the column investigation, ACI did not contribute funds for research except an annual stipend to the Reinforced Concrete Research Council. This policy changed in 1984.

In late 1984, the formation of a Concrete Materials Research Council (CMRC) was finalized to "advance the knowledge of concrete materials by soliciting and selecting research proposals, financing them, guiding the research, and publishing results." The first organizational meeting of CMRC was held during ACI's fall convention in New York City and became fully operational during 1985.

High-strength concrete was one of many topics for research. Great progress was being made in obtaining ultra-high compressive strength concretes. The ready-mixed concrete industry was making 14,000 psi (96 MPa) concrete available in certain cities in the U.S. The development of high-strength concrete had been gradual over many years and the definition had also changed with these developments. In the 1950s, concrete with a compressive strength of 5000 psi (34 MPa) was considered high strength. In the 1960s, concretes with 6000 and 7500 psi (41 and 52 MPa) compressive strengths were used commercially. In the early 1970s, 9000 psi (62 MPa) concrete was being produced. By the mid-1980s, compressive strengths over 16,000 psi (110 MPa) were under consideration for use in cast-in-place buildings and prestressed concrete members. ACI Committee 363's 1984 report was concerned with concretes of 6000 psi (41 MPa) or greater. The definition of high strength varied on a geographical basis depending to a degree on what strengths were being produced commercially.

> "...knowledge alone is not sufficient for design; experience is just as vital—it puts design thinking in a social context of cost, policies, and personal relationships."
>
> *—Anton Tedesko*
> ACI Honorary Member

The initial concept of the certification program was limited to North America, but it was clear that there was interest worldwide. A company in Saudi Arabia had developed its own program and received ACI endorsement. The ACI chapter in Singapore was developing a program, and several Institute chapters in Canada were exploring a Canadian version of ACI's program. One significant breakthrough was that the New York City Building Department now required ACI certification for all technicians testing concrete on building projects. Other cities were considering similar stipulations. Programs for laboratory technicians Grades I and II and concrete finishers were ready for implementation.

EXPANDING SERVICES

Since beginning in 1905 with only six committees and fewer than 40 committee members, ACI technical activities had now expanded to the point where there were more than 100 committees and 1600 committee members. A new committee membership category—that of associate—was approved to make it easier for those who wanted to become involved in committee work. The associate committee member could participate in committee activities (without vote) but was not required to attend committee meetings.

The first step toward what was to result in a new headquarters facility was taken in the fall of 1985 when the Board of Direction authorized acquisition of property [3 to 5 acres (1.2 to 2 hectares)] in southeastern Michigan in the Detroit-Ann Arbor area. Expanding programs and services had created crowded conditions in the facilities in Detroit. The ACI staff numbered 55 full- and part-time personnel and was expected to increase due to projected expansion of programs. A number of possible sites were investigated in 1986. As a temporary solution to space problems, a warehouse building adjacent to the existing headquarters complex was purchased in 1987. The publications inventory and shipping operations were moved into this 10,000 ft^2 (930 m^2) facility.

A new policy relating to computer software permitted ACI to market proprietary software on a trial basis. Engineers were shifting from hardcover design aids to computers in proportioning concrete structural members. ACI was to become a clearing house, serving as liaison between producers of programs and their users. The pilot effort to market medium-size programs included

A pictorial summary of ACI periodicals, 1929-2003. The first *Journal of the American Concrete Institute* appeared in November 1929 and the cover style for the first 18 years is shown in the bottom row far left. In 1947, the cover design was changed to that of the issue second from left, bottom row. That style was slightly revised in 1953 (third from left, bottom row). The cover was redesigned again in 1955 to give a more modern look (right, bottom row).

Photographs appeared on the *ACI Journal* cover for the first time in 1959. A typical cover appeared in the second row, far left. The large format was adopted in 1967 (second row, center) and the full-cover photograph was introduced in 1973 (second row, right). *Concrete Abstracts* appeared in 1973 (third row right).

ACI's 75th anniversary in 1979 marked the introduction of a new magazine, *Concrete International: Design & Construction,* and a redesigned *Journal of the American Concrete Institute* in a small format (third row, second from left). The *Journal* was changed back to the large format in 1980 (third row, left).

Two new bi-monthly periodicals debuted in 1987: *ACI Structural Journal* and *ACI Materials Journal* (top row). *Concrete International* became the new title that same year (top row) and was modernized further to *CI: Concrete International* in 2001.

the ADOSS (Analysis and Design of Slab Systems) program covering flat plates, flat slabs, waffle slabs, flat plates with beams, and continuous beams. The second program was a statistical data package (*seeSTAT*) for field testing of concrete, which offered information on effects of variables such as compressive strength, standard deviation, mixture temperatures, and slump. To facilitate review of such programs, ACI Committee 118, Use of Computers, was assigned the task of establishing procedures and selecting a group of peer reviewers similar to those used for technical papers.

The Institute had purchased *Concrete Abstracts* in 1973 and the 15-year-old magazine had become a useful industry tool in the stable of publications. The magazine, published six times a year, presented abstracts of current papers, books, and reports on developments in concrete technology from around the world. A redesign of the magazine offered ACI the opportunity to step into the world of electronic publishing. The magazine was the perfect Institute pilot program for word processor interfacing (interfacing word processor with phototypesetter) because the magazine was written in-house by the staff. Traditional methods of typesetting and printing had been used to produce *Concrete Abstracts*. The computer made it possible for staff writers to compose the contents and provide an edited disk for the printer, who in turn used the disk to drive a phototypesetter. This eliminated tedious and expensive hours of rekeying text—a savings in both time and costs. Electronic publishing was revolutionizing the publishing industry. Typewriters were becoming obsolete and computers were filling industry workspaces.

In less than three years, the certification program and activities had expanded to the point that they were no longer confined to the boundaries of the U.S. By the end of 1985, almost 4200 concrete technicians had been certified as Grade I field technicians by 65 local sponsoring groups that had conducted 240 examinations.

Reflecting increased use of new materials and processes, ACI committees were formed to meet the need for information. Typically the first action was to gather experts to present symposia on the subject, then issue a state-of-the-art report, which could then lead to a guide or recommended practice. Several practical guides became available in 1986. The application of polymer technology to concrete formed an exciting new frontier in concrete technology. A guide for the use of polymers in concrete addressed polymer-impregnated concrete

(PIC), polymer concrete (PC) polymer portland-cement concrete (PPCC), and the safety aspects when working with concrete polymer materials. Another guide brought together pertinent data on the properties and application of field-placed low-density concretes, most commonly used in roof deck systems. The third report offered recommendations for analysis and design of reinforced and prestressed concrete guideway structures for public transit systems.

To keep pace with the tremendous growth in concrete information available for publication, the Institute replaced the existing *ACI Journal* with two new bi-monthly journals in 1987, entitled the *ACI Structural Journal* and the *ACI Materials Journal*. Members' basic dues entitled them to one journal; the second journal was available for a modest subscription fee. The monthly *Concrete International: Design & Construction* subscription continued to be included as a benefit of the member's basic dues.

The first of the research proposals before the Concrete Materials Research Council was funded—a study at the University of Illinois relating to effects of curing regimen on concrete performance.

By 1986, some national, state, and local agencies were requiring ACI certified technicians on concrete construction projects. An addition to Section 14.3 in ASTM C 94-86a, "Standard Specifications for Ready-Mixed Concrete," recognized the ACI program as the "....minimum guideline for certification of concrete field testing technician, Grade I." This had substantial impact on growth of the certification program.

The Institute implemented two new certification programs in 1987: Concrete Construction Inspector Level II and Concrete Flatwork Finisher. The inspector program was seen as an "umbrella" program to cover inspection criteria for all basic areas of concrete construction, including pre-placement, placement, and post-placement activities. For the construction crafts, the finisher program was designed to upgrade workers' basic knowledge of concrete and its components, as well as update their knowledge of finishing procedures.

RECOGNITION SERIES

A popular part of Institute conventions had been the annual lecture series. The Davis Lecture Series, established in 1972 for a 15-year period to honor ACI past president Raymond E. Davis, a long-time professor at the University of California, Berkeley, ended in 1987. A new series, the Ferguson Lecture, began at the fall convention in 1988, and was dedicated to ACI past president Phil M. Ferguson, professor emeritus of the University of Texas in Austin. The year also featured the creation of annual awards for outstanding Institute chapters. Factors considered included total membership, meetings, newsletters, project award programs, and committee activities.

The new building code requirements and specifications for masonry structures were issued by the joint ACI-ASCE committee. (This committee later became a joint committee of ACI, ASCE, and The Masonry Society.) A series of seminars (similar to the popular series on the ACI 318 Building Code Requirements) was immediately produced in cosponsorship with ACI, ASCE, and the Council for Masonry Research.

The first concrete windsurfer race was held at Den Bosch, The Netherlands, in 1985. One board was built from ferrocement and one from glass-reinforced concrete (GRC).
ACI archives. Photo courtesy of International Ferrocement Information Center, Bangkok.

NEW TECHNOLOGIES

In the mid-1980s, large floor placements received a boost with development of a laser-guided, self-propelled screed. The screed greatly decreased the amount of work performed by finishers and achieved flatter floors in a shorter period. At the same time, increased production in floor finishing was provided through wider use of riding power trowels. (Walk-behind power trowels had been in use since the 1930s and a ride-on power trowel had been patented as early as 1973.)

In ancient times, brick and mortar were reinforced with straw and horse hair. Modern times found a wide range of materials used to enhance composite materials. The use of glass fibers in concrete was experimented with in the late 1950s. During the early 1960s, the potential of steel fibers as reinforcement for concrete was investigated. Only a few projects had used steel fiber-reinforced concrete (SFRC) by 1988, but there were indications that increased application was on the way. Anticipating this, ACI had already issued reports on design considerations and a guide for specifying proportioning, mixing, placing, and finishing SFRC. SFRC and synthetic fibers were receiving much attention in the research literature. The use of synthetic fibers in concrete in the U.S. was reported as early as 1963. The use of fiber-reinforced concrete (FRC) had passed from experimental, to small-scale applications, to routine precast plant and field applications involving placement of many hundreds of thousands of cubic yards annually.

The first early-entry, dry-cut saw was introduced in 1988. Electrically powered, it permitted joint cutting as soon as the slab could support the weight of the operator and the machine without disturbing the finish—usually within 2 hours after final finishing.

In March 1988, U.S. President Ronald Reagan announced that the lunar base program proposed by the National Aeronautics and Space Administration (NASA) was included in the national space policy. ACI quickly responded by establishing a technical committee on lunar concrete to develop and correlate knowledge and formulate recommendations for concrete construction on the moon. This was an exciting frontier for the future use of concrete. The title and mission were later broadened to cover concrete technology in space applications.

A major step in electronic publishing took place when the editing and typesetting of material for the two technical journals and *Concrete International* were handled directly on the computer—eliminating the need for the printer to rekey material in setting type. The next step was electronic magazine page layout and index generation. Staff and members spent considerable effort developing ACI's implementation of electronic dissemination of information and conversion of ACI documents into electronic format. (*Concrete Abstracts* became available in electronic format in 1991 and the *Manual of Concrete Practice* in 1993.)

With publication of the ACI 318-89 code requirements for reinforced concrete and the ACI 530-88/ASCE 5-88 code requirements for masonry, the Institute reached two milestones. One of the major features of ACI 318-89 was a new format that resulted in a single document (rather than two) including both the code and its commentary.* The commentary sections appeared in parallel columns adjacent to corresponding code sections. This side-by-side presentation allowed the reader to view the code statement and further explanation at a glance on a single page. To ensure adoption of seismic design provisions when the code was adopted by model codes and/or local jurisdictions, the seismic provisions were now an integral part of the code as a new chapter. Seismic design provisions had been first introduced in the 1971 Code and were contained in an appendix through the 1983 edition. A new section introduced provisions for general structural integrity. The intent was to improve the redundancy and ductility in a structure so that in the event of loss of a major supporting element or an abnormal loading event, the resultant damage would be confined to a relatively small area. The structure would then have a better chance to maintain overall stability. Publication of the metric edition, 318-89M, and the 1989 version of "Building Code Requirements for Structural Plain Concrete," ACI 318.1-89, soon followed.

The second milestone was the long-awaited "Building Code Requirements for Masonry Structures" and "Specifications for Masonry Structures." These new documents contained design and construction requirements for clay brick, concrete block, and brick/block composites. Almost 10 years in development, the two documents were the fruits of the joint ACI-ASCE committee with support of numerous organizations in the masonry industry.

NEW INITIATIVES

Three new initiatives with far-reaching impact were approved in 1989:

- A nonprofit ACI Education and Research Foundation;
- A for-profit subsidiary named Association Concepts Ltd. (later changed to Creative Association Management); and
- A Member Services Department.

The Education and Research Foundation (the name was later changed to Concrete Research and Education Foundation [ConREF]) allowed the Institute to seek funds to support basic and applied research, administer fellowships and scholarships, and to monitor research councils.

Why a for-profit subsidiary? Through the years, ACI had acquired significant resources and expertise in developing and managing technical meetings and publications. From time to time, the Institute had been asked by other organizations to develop and organize meetings, conferences, and other activities on their behalf. Creative Association Management (CAM) was formed to render such services on a formal business basis. It was the intent of CAM to utilize Institute expertise to manage smaller concrete-related societies in an effort to strengthen those organizations, thus strengthening the overall concrete industry. CAM has managed and continues to work with the American Society of Concrete Contractors, the American Shotcrete Association, Building Owners and Managers Association of Detroit, the International Concrete Repair Institute, and most recently, the Engineering Society of Detroit.

ACI was one of the first associations to develop a one-stop shopping concept to better serve members and the engineering/construction public. The year also saw expansion of international programs. The Board approved conducting international conferences as a mechanism for greater dissemination of technical information worldwide. The first conference was held in Hong Kong and others were to follow on a variety of concrete topics.

Nearly five acres (two hectares) of real estate in a new office development park in the northwest suburbs of Detroit were acquired as the future site of ACI headquarters.

AUTOMATION

While robotics technology was fairly common in the field of manufacturing, automating the diverse and specialized operations of the construction process was proving to be difficult. Nevertheless, the 1980-90 period featured some interesting developments. The Japanese construction industry, burdened with chronic shortages of skilled laborers needed to place and finish concrete, had turned its attention to automation. On-site

* The first 318 code commentary, published in 1965 as a separate publication (SP-10), gave an insight into the reasons behind the provisions of ACI 318-63.

construction robots were being used on some projects, including: floor-finishing robots, automatic form vibrators, and concrete distributors. Most of these machines were really automatic equipment rather than true robots, operating at automation levels that ranged from machines that repeated a fixed sequence to those that determined their own action based on recognizing their surrounding environments. Some were used in conjunction with human operators who supplied an appropriate level of judgement. Several of the devices, like the floor-finishing robot, had seen limited use in Europe and North America.

MATERIALS PLACING

Advances were also being made in materials placing technology. The development of latex-modified concrete allowed the paving industry to install concrete overlays as thin as 1 in. (25 mm) thick and polymer concrete overlays as thin as 3/4 in. (19 mm) using specialized placing and finishing equipment. Roller-compacted concrete, initially used in construction of gravity dams, had found a new application as a high-quality paving material for heavy-duty industrial pavements. Recent advances in cohesion-inducing (antiwashout) admixtures were allowing placement of concrete underwater without the use of conventional tremies.

MANY MILESTONES

At the end of 1990, total Institute membership reached more than 20,000 for the first time. From its founding in 1904, it took ACI five years to reach 1000 members. After that, membership numbers fluctuated sharply through World War I, the Great Depression years, and World War II. The 10,000 mark was attained in 1959, 15,000 in 1972, and 20,349 in 1990.

A little-known milestone was reached in 1991 when the U.S. Army Corps of Engineers cast its eight millionth articulated concrete mattress at its yard in St. Francisville, LA. The mats were used to protect Mississippi River banks and levees from erosion.

A persistent recession affected the construction industry in the early 1990s. In many respects, ACI weathered the recession quite well without serious impact on most of its programs. The new headquarters facility moved closer to reality with inauguration of a capital fund-raising drive and development of a preliminary building design. The Institute chartered its 78th chapter in Denmark—its first chapter in Europe. The mission of the Concrete Materials Research Council (CMRC) was revised so that all concrete research would be covered; CMRC became the Concrete Research Council (CRC), reporting to the Concrete Research and Education Foundation (ConREF). Of great significance, ConREF and CRC were the recipients of a sizable grant from industry sources to finance a research project at the National Institute of Standards and Technology (NIST). The role of ConREF and CRC was to monitor the research and help ensure that the results could be transferred into practical technology.

At the ground-breaking ceremonies (1995) for the new headquarters facility, Executive Vice President George F. Leyh shared the shovel with four ACI presidents and/or future presidents (left to right): Dean E. Stephan, 1994 president; Leyh; Robert F. Mast, 1995 president; George C. Hoff, 1993 president; and James S. Pierce, 1996 president.

HIGH-PERFORMANCE CONCRETE

During the early 1990s, high-performance concrete (HPC) was a topic of major interest in the industry. At a workshop sponsored by NIST and the ASCE Civil Engineering Research Foundation on high-performance materials, recommendations were developed for a high-level National Research Program. An agreement was reached that any research or development activities involving HPC would be spearheaded by ACI or ConREF and CRC. It was noted that technology transfer of information might be as important as new research for HPC.

The Portneuf Bridge, a short-span post-tensioned bridge using a 60 MPa (8.70 ksi) air-entrained concrete, was built in the fall of 1992 on the north shore of the St. Lawrence River in Quebec, Canada. It was said to be the first air-entrained high-performance concrete bridge built in North America. The structure was a rigid frame with a 24.8 m (81.4 ft) clear span. By using high-strength concrete with external post-tensioning, a span-to-depth ratio of 35 was achieved, compared to 28 for a regular beam post-tensioned bridge deck.

STANDARDS ACTIVITY

International standardization continued to be of high interest. With the cooperation and agreement of ASTM, which sponsored the U.S. Technical Advisory Group (TAG) to the International Standardization Organization's Technical Committee on Concrete (ISO/TC-71), ACI became a participating member on the committee and the TAG was expanded to become a joint ASTM/ACI TAG. ASTM continued to handle the portion of TC-71 activity involving materials and testing, whereas ACI became involved with all matters involving structural design. In late 1992, ACI assumed the secretariat for ISO/TC-71.

ACI moved into its new headquarters in Farmington Hills, MI, in 1996. The 47,000 ft^2 (4370 m^2) facility was designed to meet ACI needs through the year 2030. The building is a combination of cast-in-place and precast concrete framing, along with exterior architectural precast wall panels. Inset: A latticework of beams cantilevered from a concrete column formed a semicircular canopy for the main entrance.

The staff developed ACI's first electronic product in 1991—CD-ROM (compact disc-read only memory) and floppy disk versions of the last ten years (1981-1991) of *Concrete Abstracts*; the product was titled "CA Quick Search." An electronic version (a CD-ROM) of the *ACI Manual of Concrete Practice* was first produced in 1993 with an elaborate search software system to assist users. The Institute became one of the first technical societies to have its primary technical documents incorporated on a CD-ROM. Computer software programs had become easily available in the marketplace so the Institute discontinued the sale of software developed by outside developers. A joint ACI-ASCC (American Society for Concrete Construction) effort produced the *Contractor's Guide to Quality Concrete Construction*.

In 1992, in an effort to encourage more student participation and recognition in ACI, the first Student Day was held at the spring convention in Washington, D.C. More than 100 students attended to participate in the concrete cube competition at the Federal Highway Administration's Turner Laboratories, to be recognized at the Student Luncheon, and to be guided by designated mentors from the industry at the convention.

OTHER HIGHLIGHTS

The largest ACI certification session ever held was staged during the World of Concrete exhibition in early 1993; 355 people attended the seminar for concrete finishers and 263 took the subsequent examination. Certification programs continued to grow; new programs were authorized for Concrete Transportation Construction Inspectors and Inspectors-In-Training. The inspector program covered such transportation elements as concrete pavements and their bases and concrete bridges and their substructures, and was developed primarily for use by state highway departments.

In 1993, construction started on the Three Gorges Dam in the People's Republic of China. The project would prove to be monumental in all respects: in scale, in workforce, and in use and placing of concrete. The project is scheduled for completion in 2009. This concrete gravity dam will use 35 million yd^3 (26.7 million m^3) of concrete, have a total length of 7650 ft (2300 m) along its straight axis, and a crest elevation of 607 ft (185 m). It will be the largest concrete dam in the world, nearly four times larger than Hoover Dam in the U.S.

During 1993, the scope for a Nationally-Coordinated Program for High-performance Concrete and Steel (NCPHCS) changed considerably. First, its name was revised to High-performance Construction Materials and Systems (HPCMS) and the program expanded to include the majority of construction materials. Later, the name changed again to CONMAT (Construction Materials). The Institute organized two workshops for the concrete sector. It was envisioned that about $150 million in research funds over ten years would be available from various federal agencies. In early 1994, it appeared that such funding would not be forthcoming. ACI believed involvement in research on high-performance concrete was desirable, with or without federal funding, and developed plans for initiating consortium-building activities by ConREF—which was to lead to the establishment of the Institute's Washington, D.C., office.

ACI'S 90TH YEAR

ACI's 90th year marked the execution of a design/build contract for a new headquarters facility. The Argos Group, the design-build division of Barton Malow Co., Southfield, MI, (one of the nation's largest building contractors) was selected for the project. Groundbreaking ceremonies were held in April 1994. The 47,000 ft^2 (4400 m^2) building, anticipated to meet office needs through the year 2030, would replace the three-building complex in Detroit with almost double the space. Construction started in 1995 and the new headquarters facility was occupied in April 1996.

There were other developments in materials. There was an increased use of alternative reinforcing materials for concrete exposed to harsh environments. Fiber-reinforced polymer (FRP) reinforcing bars were finding applications in chemical and wastewater treatment plants, sea walls, and underwater structures. A relatively new repair method for concrete structures consisted of externally bonding flexible sheets of fiber-reinforced polymer (FRP) composites to the concrete surface.

Laboratories and researchers around the world were expanding performance and capabilities of concrete in both material science and engineering applications. The fact that progress witnessed in laboratory research results become most useful to the construction industry when they can be quickly incorporated into ACI's documents prompted the Technical Activities Committee to establish the TAC Technology Transfer Committee (TTTC). Its task was to develop procedures that would efficiently move knowledge and innovations into ACI documents. The TTTC, in turn, established an evaluation procedure in which Innovative Task Groups (ITGs) facilitated the work of an ACI technical committees in incorporating new technology into the committee's document. Two new technologies were selected for evaluation in the fall of 1994, and corresponding ITGs were formed.

One technology was the optimization of reinforcing steel deformation patterns to substantially improve the bond development of reinforcing bars in reinforced concrete. The commensurate reduction in lap lengths promised substantial cost savings. This research was performed at the University of Kansas. The other innovation was the development of joinery for precast concrete moment-resistant frames for use in seismic areas. The concept offered a major advancement for construction in seismic regions as well as cost effectiveness in concrete construction everywhere. Research was conducted at NIST. The TTTC also offered a conduit for introducing new technologies that had potential for impact on design and construction. For example, a 1995 fall convention session offered papers on innovative design and construction techniques for segmental bridges and on a new way to transfer shear from flat slabs to columns.

Another international milestone for ACI was the establishment in 1994 of the Allied International Societies (AIS) category. AIS offered a mechanism by which agreements could be enacted with concrete-related societies similar to ACI located outside the U.S. and Canada. The intent was to aid and enhance cooperative efforts among concrete societies in cosponsored conferences, access to databases, and opportunities to participate in technical committee work. The first agreement signed was with the Concrete Institute of Australia, at which time ACI president Dean E. Stephan noted that: "it marks the first step towards greater exchange of knowledge and technical expertise which ultimately will enhance the reputation of concrete as the world premier construction material." AIS grew to include the Concrete Society of Southern Africa, New Zealand Concrete Society, Korea Concrete Institute, Instituto Brasileiro do Concreto, Instituto Chileno del Cemento y del Hormigon, Norwegian Concrete Association, and the Committee for Civil Engineering (KILW) of the Polish Academy of Sciences.

> "What can we expect for the next millennium? ....We are approaching an era where we will not only design the structure, but also design the material. We will have to design the material in order to achieve the design we want."
>
> *—Ignacio Martin*
> ACI President, 1984

One important new activity in the mid-1990s was the activation of the ACI/ConREF office in Washington, D.C. The office would be involved in identifying industry research needs, helping to develop research consortiums, developing ConREF proposals for research, and maintaining contact with federal agencies regarding research and development projects. ACI enhanced its international effectiveness by assuming the secretariat of Technical Committee 71 (Concrete) of the International Organization for Standardization (ISO). ISO TC-71 had been dormant for nearly ten years; ACI quickly gained support and hosted a plenary session to re-establish activity.

One of the major changes in the 1995 Building Code (ACI 318-95) was a completely revised and expanded chapter on precast concrete. With the increased use of precast and prestressed concrete structural members, the industry had been seeking more comprehensive code provisions as a means of achieving even greater acceptance. Toward the end of the 1989 code cycle, provisions for structural integrity of reinforced concrete were, in general, made part of the code requirements. The 1995 precast chapter was almost double the length of the 1989 chapter—the major addition was an extensive section on structural integrity.

LOOKING AHEAD TO THE 21ST CENTURY

As ACI approached its second century, the Institute issued a new plan for action in early 1997. Some of the critical issues facing the Institute and concrete industry were stated as follows:

- "The public is demanding higher quality, more durable concrete structures; they want action now, not later.
- "Materials are being continuously developed and improved, but their introduction into construction is often agonizingly slow.

- "Business, including design and construction, is becoming truly global, and universally applicable standards of quality are essential.
- "Electronic communication capabilities provide rapid interaction and are essential at all levels, whether sharing research at the local, national, or international level; getting practical information directly to construction personnel on the job site; or providing continuing education for designers."

The ACI Strategic Plan included a call for "bold and aggressive action at the forefront of worldwide activities as we approach the second century of ACI's existence." The plan detailed four major goals:

- increase ACI's strength in membership and financial resources;
- foster progress through education, technology, and research;
- enhance recognition of the Institute's role in improving concrete construction at both the domestic and international levels; and
- improve and accelerate the technology transfer process.

ACI entered into a cooperative effort (or agreement) with the Center for Science and Technology of Advanced Cement-Based Materials (ACBM). The center is a research-oriented agency cosponsored by several universities, to support and deploy innovations in the design and construction industries and the engineering profession as well as to encourage research, development, and technology transfer for wide application.

While 1996 can be remembered for completion and move-in of the new headquarters facility, other things were happening. The two-building complex in Detroit, ACI's previous home for more than 40 years, was sold to a non-profit, family-service organization. ACI launched an internet website. The Strategic Development Council (SDC), a council of ConREF, was formed to foster and encourage industry-led and industry-funded research. A new AIS agreement was authorized with the Instituto Chileno del Cemento y del Hormigon of Chile. The Institute's first provisional standard—interim documents that are intended for use while technical committees finalize permanent provisions—was approved. "Provisional Standard Test Method for Water-Soluble Chloride Available for Corrosion of Embedded Steel in Mortar and Concrete Using the Soxhlet Extractor" provided a test method for distinguishing between water-soluble chlorides that supported corrosion and those that did not.

ACI's certification program continued to be successful. More than 75,000 technicians, inspectors, and finishers had been certified since the program was launched in 1983, and more than 100 local sponsoring groups were in operation in all 50 states, the District of Columbia, Canada, Puerto Rico, Mexico, Lebanon, and Argentina. New additions to the certification program were to include strength testing technicians, shotcrete nozzleman, and tilt-up field supervisor. The Field Technician certification program received a big boost with inclusion of a requirement for this certification in the American Institute of Architects' MASTERSPEC system. Implementation of an International Code Council (ICC)* program to certify reinforced concrete inspectors also included ACI Field Technician certification as a prerequisite.

Canada's Confederation Bridge was completed in mid-1997. It was the longest bridge ever constructed over ice-covered water and is one of the longest continuous multispan bridges in the world. A total of 183 components, some weighing as much as 8800 tons (8000 tonnes), made up the main bridge. Each of these was fabricated on land and then transported and erected using special equipment. The eastern and western approach sections consisted of 14 and six spans, respectively, each of 305 ft (93 m) length; these components were also precast at land-based facilities. More than 590,000 yd^3 (450,000 m^3) of concrete had been produced to meet the demanding specifications. Seven different types of concrete were required to provide various combinations of: low permeability to chloride ions; high early strength (for post-tensioning); high resistance to ice abrasion; low heat rise in massive sections; high density for ballast; resistance to freezing and thawing and seawater attack (all exposed concrete); and controlled set.

Executive Vice President George F. Leyh, ACI's chief staff officer for more than 22 years, retired in July 1998. Leyh had begun his ACI career in 1975 upon the retirement of Executive Director William A. Maples. William R. Tolley, senior managing director of operations and services, was named interim Executive Vice President during the search for Leyh's replacement.

The Reinforced Concrete Research Council, which had served the concrete industry for nearly half a century and was formerly an agency of ASCE, was established under ACI's ConREF umbrella. RCRC was combined with the Concrete Research Council in 2001.

A new Commemorative Lecture Series had begun in 1998 with the first three lectures memorializing George Winter, an Honorary Member and long-time professor of engineering at Cornell University. The memorial honoree was to change every three years. This new series replaced the Ferguson lecture series.

STRATEGIC PLANNING

The Strategic Development Council under ConREF gained momentum. At the outset of 1998 there were three research consortia on: (1) fire-resistant high-strength concrete, (2) advanced rapid load testing technology, and (3) reuse of returned concrete slurry and process water (in ready-mixed concrete operations).

James G. Toscas was appointed the Institute's Executive Vice President in late 1998. As the Institute continued to look at plans for the next century, the major goals in the

* ICC was composed of representatives of the nation's model code bodies, charged with drawing up national codes.

strategic plan were revised to include the following:

- improve and enhance ACI's products and services;
- foster progress through education, technology, research, and standards development;
- improve domestic and international concrete construction;
- improve and accelerate technology transfer; and
- improve the organizational efficiency of ACI.

For some years, the ACI Building Code Requirements had seen major revisions on a six-year cycle. That was to change. ACI 318 doesn't become a legal document until it is incorporated in a model building code, then normally adopted by a local jurisdiction. Three model building code agencies served the U.S.: the code of Building Officials and Code Administrators (BOCA) was used primarily in the midwest and northeast; the Standard Building Code (SBC) could be found predominantly in the southeast; and the Uniform Building Code (UBC) was employed mainly in the western states. BOCA and SBC referenced ACI 318 while UBC transcribed the document with ACI permission. In 1995, the three code groups formed a new body—the International Code Council (ICC)—to publish a single model code by the year 2000 (IBC 2000). It was evident that ACI 318 would be incorporated by reference in IBC 2000, as BOCA and SBC had done before. However, there were 60-plus differences in UBC from ACI 318 and these would be carried forward into IBC 2000. ACI Committee 318 undertook the task of minimizing these differences (to 10 in ACI 318-99 instead of the 60-plus in ACI 318-95). ACI 318-99 was referenced in IBC 2000. To better coordinate with the IBC code cycle, it was decided to produce future code-requirements documents that would precede the IBC code by a year. ACI 318 was also referenced in the latest National Fire Protection Association (NFPA) code.

Ever since the term "high-performance concrete" (HPC) was introduced, there had been numerous attempts to develop a definition. All had validity, but each definition meant something slightly different. ACI's Technical Activities Committee had formed an HPC subcommittee, its first task being development of a working definition for HPC. In 1998, the subcommittee defined high-performance concrete as: "concrete meeting special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices." The subcommittee went on to explain that HPC is a concrete in which characteristics are developed for a particular application and environment. Examples of characteristics that may be considered critical for an application were: ease of placement, compaction without segregation, early age strength, long-term mechanical properties, permeability, density, heat of hydration, toughness, volume stability, and long life in severe environments.

The value of fiber-reinforced polymer reinforcement (FRP) and its performance in the construction marketplace were becoming more clearly understood and its use was increasing. FRP received much attention in literature and at conventions.

James G. Toscas was Institute Executive Vice President from 1998 until 2002.

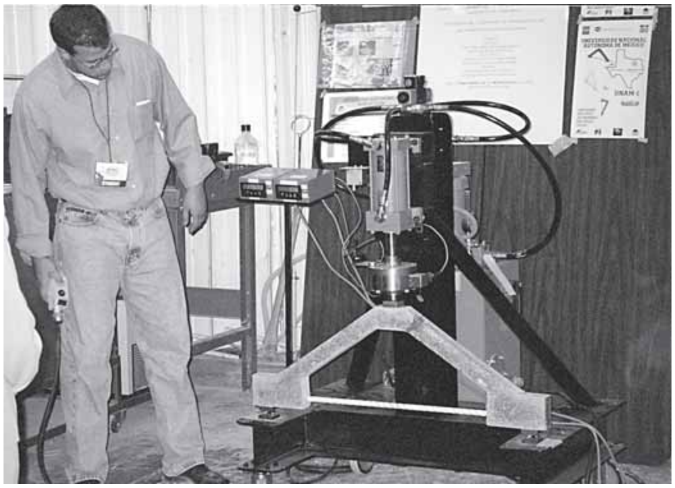
Two new certification programs, both concerned with aggregate testing, were authorized. These were aimed primarily at those who work directly or indirectly for state transportation/highway agencies. Another program for Specialty Commercial/Industrial Floor Finisher was under development. The growth in certification activity was attributed in part to the Federal Highway Administration's requirement that state DOTs provide qualified materials testing personnel as a stipulation for receiving Federal highway project funds. The Plasterers and Cement Masons Job Corps program used many ACI materials in its training curriculum and craftsman certification. The program held one of its training program competitions in conjunction with the fall convention in Baltimore, MD; young cement masons placed concrete, cut joints, applied a stamp pattern with color, and finished the sample slab.

The *ACI Manual of Concrete Inspection* received a major overhaul in 1999. First published in 1941, the manual had become the definitive industry guide to concrete inspection.

The year 1999 was a notable one when Jo Coke was elected the Institute's first female president.

A NEW DECADE

The start of a new decade saw ACI join forces with the Federal Highway Administration to help state highway



Student competitions, a regular event at conventions, have featured the building and testing of a wide variety of concrete projects: cubes, beams, bowling balls, and egg-protection devices. Pictured is the testing of a fiber-reinforced polymer concrete frame in a 2001 competition.

agencies combat concrete deterioration—especially alkali-silica reactivity (ASR). The Institute developed and presented workshops for DOT personnel, covering methods for identifying specific types of deterioration as well as the latest technology for preventing or reducing deterioration damage.

The TVG (high-speed train) railway bridge across the Rhone River in southern France, completed in 2000, was one of the largest prestressed concrete railway bridges in the world. Demanding technical and aesthetic requirements were met by the use of prefabricated high-strength concrete beam segments. The bridge was designed to withstand earthquakes and high winds, and also the braking force of a high-speed train traveling at 200 mph (320 kmph) or more. Pakistan's massive Ghazi Barotha hydro-power project was completed in 2001. The project featured a 31 mile (50 km) long reinforced concrete-lined channel using almost 1 million yd^3 (764,600 m^3) of concrete lining. The trapezoidal canal section, the top width equivalent to the length of a football field, was one of the largest in the world. The project also featured what might have been the world's largest canal machines. The ten specialized machines fine graded, conveyed, placed, and finished the large reinforced concrete lined section in three continuous passes. The year 2001 aslo marked the 100th anniversary of the invention of welded wire reinforcement; U.S. patents had been issued in 1901.

Since the first certification program in 1983, the Institute had administered exams to more than 160,000 individuals and by 2001 maintained 56,000 active certifications representing 25 countries. There were 11 certification programs and 103 sponsoring groups, 14 of which were outside the U.S. (nine in Canada, three in Mexico, one in Chile, and one in Lebanon). ACI chapters comprised 42 of these groups; the others were national organizations (such as the National Ready-Mixed Concrete Association) or state or regional groups. Many state Departments of Transportation now utilized ACI certification to meet FHWA requirements for qualified personnel. New certification programs were introduced for wet- and dry-mix shotcrete nozzleman and tilt-up concrete supervisor, along with a Spanish-language flatwork finisher program. By mid-2001, the new tilt-up certification program (in conjunction with the Tilt-Up Concrete Association) had certified 29 tilt-up supervisors and 108 tilt-up technicians. The tilt-up construction method had grown 111% in the last five years alone, emphasizing the need for trained personnel.

A new category of technical documents—the Emerging Technology Series—was established so that committees could create documents in the areas of experimental or emerging technologies. The objective was to get new technology into practice by providing basic information and concepts so that performance data could be gathered in support of further standards development.

Educational efforts continued to grow; in 2000, 136 educational seminars drew over 5000 attendees. The Institute had been delivering educational programs since 1969, through seminars held in various locations as well as in-house for industry firms. ACI introduced its E-Learning Program via the Internet in late 2001. Two courses went on line: one on fiber-reinforced concrete and the other on the ACI/TMS Structural Masonry Code. These self-paced, web-based courses were similar to ACI's traditional seminars. Another educational effort was the establishment of the Walter P. Moore, Jr. Faculty Achievement Award to recognize teaching excellence and innovation.

With the Institute's centennial just a few years away, the Board of Direction passed a resolution calling for ACI endorsement of a commemorative postal stamp in recognition of George Wells Bartholomew, Jr., for his part in building the first concrete paved road in the U.S. in 1891 in Bellefontaine, OH. The proposal went before the Citizens' Stamp Advisory Committee of the U.S. Postal Service for consideration, but unfortunately, nothing developed.

INTERNATIONAL ARENA

For many years, the Institute's International Activities Committee, organized in 1964, played a role in encouraging worldwide programs and participation. It was time to expand those efforts on a broader scale. The need for greater cohesion in ACI's international arena was recognized with the formation of the International Committee (and its subcommittees) with the objective "to develop and coordinate ways and means that promote communication, cooperation, and collaboration between ACI and organizations, institutions, or individuals of other nations with common interests. A primary goal was to foster partnership and unity among members of the concrete community." One example of ACI's international collaboration was that with Chile, which had adopted ACI 318 as the basis for its official national code and had initiated ACI certification programs.

Of the 89 Institute chapters, 34 were outside the U.S.; of the 17 student chapters, 11 were outside the U.S. The Technical Activities Committee changed the rules to make it easier for international members to participate in ACI committee work and also to expand the pool of volunteers available to serve on committees. Attendance requirements for voting members were relaxed, with the emphasis now being on members returning ballots rather than being required to attend one meeting per year.

EMERGING TECHNOLOGIES AND OTHER ARENAS

The first Emerging Technology Series document appeared in 2001: ACI 440.1R-01 "Guide for the Design and Construction of Concrete Reinforced with FRP Bars." A task group explored the formation of a new technical committee on design-build concrete construction.

2001 ACI President Daniel L. Baker led efforts, in conjunction with ConREF, to create a new Student Fellowship Program, and the first awardees were named in 2002. The award program's objective was to identify high-potential civil engineering and construction management students and help them develop into concrete industry professionals. Beyond merely funding tuition, this award provides guidance from an industry mentor, a summer internship, and expenses to attend an ACI convention. Mentoring had not been a part of any previous ACI student scholarship or fellowship program.

The late 1900s and early 2000s saw the formation of ACI's Concrete Innovations Appraisal Service (CIAS) under the aegis of ConREF. CIAS offered a way for firms or organizations with proprietary or licensed technologies to have these technologies appraised by a panel of experts. The experts would then generate a consensus report that could be used to introduce the technology to committees developing codes or documents and/or clients/customers. CIAS appraisal reports have been issued on embedded galvanic anodes for repair of concrete and rapid load testing of concrete structural members.

ACI 318-02 was seen as the most comprehensive revision of code requirements since the full recognition of strength design in 1963.* There was a change from traditional ACI 318 load factors to the ASCE load factors, as well as modified strength reduction factors. These load factors were lower than those in previous ACI code editions. An appendix introduced a codified form of the strut-and-tie design procedure. While truss analogies were implicit in design provisions for shear and torsion of earlier editions of the code, and allowance was given to methods that satisfied equilibrium and strength requirements, ACI 318-02 offered the first consistent treatment of the subject. Design provisions for flexural and compression members were modified; sections were classified based on the net tensile strain in the extreme tension steel at nominal strength. Previous code editions had been silent about anchoring to concrete; a new appendix gave code provisions for both cast-in and post-installed anchors.

The Masonry Standards Joint Committee (joint ACI-ASCE-TMS) completed a new edition of masonry standards for design and construction in 2002. Several changes from the 1999 edition were substantial. A new chapter on strength design of masonry provided a major design advancement in the code. Other changes included integrated seismic design requirements, modifications in allowable flexural tension design values, and wind speed threshold for empirical design.

With the turn of the century, environmental issues were experiencing increased attention worldwide. These issues included rules and regulations that enforce sustainable development, and economic incentives to incorporate sustainable designs. Architects and engineers were increasingly involved with building "green" structures that were more energy- and resource-efficient. Material producers were likewise concerned with energy and resource efficiency, greenhouse gas emissions, and shortages of natural materials. To address the relationship between sustainable development and concrete technology, ACI formed a task group with the mission "to encourage development and application of environmentally friendly, sustainable concrete materials, design, and construction." Previously, in 1994, various industry associations had founded the Environmental Council of Concrete Organizations (ECCO) with the goal of "improving the quality of the environment by working to

Executive Vice President William R. Tolley was appointed ACI's chief staff officer in late 2002.

* The 1956 ACI Code (ACI 318-56) was the first code edition that officially recognized and permitted the ultimate strength method of design (in an appendix). ACI 318-63 treated working stress and ultimate strength methods on an equal basis.

> "There have been a lot of changes and innovations in designing and building in concrete over the last 100 years. One constant through all of this is ACI's unwavering desire to make sure that the latest information is available to assure top-notch quality....I'd like to take my (hard) hat off and salute the past and present generations of ACI members. Without them, we wouldn't be where we are today. But at the same time, I'm going to throw down my (hard) hat as a challenge to tomorrow's generation of members to make sure they keep their eye on the goal and their desire to achieve it just as strong as those three men who started it all (in 1904)."
>
> *—Daniel L. Baker*
> ACI President, 2001

increase awareness of the environmental aspects and benefits of concrete and concrete products." The ACI committee on energy conservation also finalized a guide to the thermal properties of concrete and masonry systems. There was increased interest in durability of structures and in life-cycle costing. ACI Committee 365, Service Life Prediction, was developing guidance for predicting the service life of concrete exposed to chlorides. The interest in building or structural "greenness" led to the LEED (Leadership in Energy & Environmental Design) Green Building Rating System.

ACI's international outreach continued to broaden when Mongolia became the latest country to benefit from ACI's certification program. Two Concrete Field Testing Technician—Grade I certification sessions were conducted in Mongolia's capital city of Ulaanbaatar and in Darkhan. This might be the most remote location that ACI certification had been offered. The program also led to the formation of the ACI Mongolian chapter.

Another "first" was the opening of a bridge in Southfield, MI, constructed with 12 double-tee concrete beams reinforced with carbon fiber-reinforced polymer (CFRP) components. This project marked the first time this technology was used in a highway bridge in the U.S.

The "Cornerstone for Leadership" campaign had its official kick-off in 2002. The goal was to raise at least $5 million in endowment funds to support the new ACI Student Fellowship Program. The Board of Direction appointed William R. Tolley Executive Vice President when James G. Toscas left the Institute in 2002.

ACI 318 had been the reference for structural concrete in U.S. national codes for many years. The document had also become a primary resource for other national codes. While ACI Committee 318 membership was international in nature, the committee was interested in developing greater feedback from engineers in other nations using ACI 318 or codes

ACI CHAPTERS

Northeast U.S.
Central New York
Delaware Valley
Eastern New York
Maryland
National Capital
New England
New Jersey
Pittsburgh Area
Virginia
Western New York

Southeast U.S.
Carolinas
Central Alabama
Central Florida
Florida First Coast
Florida Gulf
Florida Suncoast
Georgia
Kentucky
Louisiana
Mid-America
Middle Tennessee
Mid-South
South Florida

North Central U.S.
Central Ohio
Greater Miami Valley
Greater Michigan
Illinois
Indiana
Minnesota
Northeast Ohio
Raymond C. Reese (Northwestern Ohio)
West Michigan
Wisconsin

Central U.S.
Arkansas
Central Texas
Dakota
Houston
Iowa
Kansas
Missouri
Nebraska
Northeast Texas
Oklahoma
San Antonio
South Texas
Tulsa

Western U.S.
Arizona
El Paso International
Intermountain
Las Vegas
New Mexico
Northern California and Western Nevada
Oregon
Rocky Mountain
San Diego International
Snake River (Idaho)
Southern California
Washington

South America
Argentina
Ecuador
Peru
Republic of Colombia
Venezuela Occidente

Africa
Egypt

Europe
Copenhagen
Italy
Paris

derived from ACI 318. This led to the First International Workshop on Structural Concrete in the Americas in October 2002. The workshop drew 42 experts from 14 countries in South, Central, and North America. It offered an opportunity for speakers to summarize the code development process in their respective nations and highlight similarities and differences between their national codes and ACI 318. At the final workshop session, task groups identified areas for future collaboration.

The first document in a newly created International Publication Series (IPS) appeared in 2002: "Essential Requirements for Reinforced Concrete Buildings (for Buildings of Limited Size and Height, Based on ACI 318-02)." The publication was issued jointly by the American Concrete Institute, Instituto Colombiano de Normas Tecnicas y Certificacion (ICONTEC), and Asociacion Colombiana de Ingenieria Sismica (AIS). The International Publication Series was developed to provide a channel through which information developed primarily by organizations outside the U.S., or proceedings of certain international conferences, could be published for worldwide distribution.

LOOKING BACK WHILE LOOKING FORWARD

It is noteworthy that the American Concrete Institute, which began in 1904 primarily as a U.S. organization, had evolved a century later into a leading international body in both membership and activities. Institute chapters were scattered across the globe. Presidential visits to international chapters had resulted in 78 seminars in 36 countries attended by 9300 individuals. In 2003, the cooperative program with societies similar to ACI in other countries was expanded. The International Partner Agreement (IPA) program replaced the Affiliated International Societies (AIS) program. Cooperative agreements were now authorized with any concrete-related organization rather than just societies. The intent continued to be to increase collaboration worldwide for the purpose of improving concrete construction by making the technical expertise of each partner available to the other through publications, meetings, Internet links, committee activities, and certification activities.

With the centennial celebration only a year away, *Concrete International* began publishing a Landmark Series of papers in 2003 and continuing through 2004. The series acknowledged some of the benchmark contributions to the knowledge of concrete in structures, materials, and construction. The reprints of *ACI Journal* articles from the past were judged to have content that is as important in the present as when it was written.

Canada
Alberta
Atlantic
British Columbia
Manitoba
Ontario
Quebec and Eastern Ontario

Mexico
Central and South Mexico
Northeast Mexico

Caribbean
Dominican Republic
Puerto Rico

Central America
Costa Rica
Honduras

Middle East/Asia
Bahrain
India
Iran
Israel
Jordan
Kuwait
Lebanon
Pakistan
Saudi Arabia
Turkey
United Arab Emirates

Far East
China
Kuala Lumpur
Mongolia
Philippines
Singapore
Taiwan
Thailand

Student Chapters
Autonomous National University of Mexico
Escuela Colombiana de Ingenieria
FIC-UANL, Northeast Mexico
Iberoamericana University
Metropolitan Universidad Azcapotzalco
Middle Tennessee State University
Southern Illinois University, Edwardsville
Southern Polytechnic State University
Temple University
UNAM (Mexico), Engineering Faculty
Universidad Catolica del Peru
Universidad Nacional de Ingenieria, Peru
Universidad Nacional Pedro Henriquez Urena (UNPHU), Dominican Republic
Universidad Popular y Autonoma, Puebla
Universidad Ricardo Palma, Peru
University of California, Berkeley
University of Illinois
University of Missouri, Rolla
University of Nevada Las Vegas
University of Puerto Rico at Mayaguez
University of South Florida
University of Texas, Austin
University of Washington
Wentworth Institute of Technology

For an updated list of ACI Chapters, visit our website, www.concrete.org.

A Selection of Concrete and World Events: 1980-2003

This chronology lists some of the events that occurred during 1980 to 2003—a selection of various happenings from numerous resource materials. No claim is made for completeness. No relationship between events is to be inferred. The listings for each year are not necessarily the most important events that took place in those years—but are interesting and/or notable events.

1980-1982

Year	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1980	For the first time, the ACI annual convention, in Las Vegas, NV, was held simultaneously with the World of Concrete exposition. The *ACI Manual of Concrete Practice*, introduced in 1967 in three volumes, was published for the first time in a five-volume set. Institute launched construction development, concrete technicians certification program. With the largest single gain in 25 years, ACI membership jumped over the 15,000 mark.	World's first large-scale highway concrete recycling project was undertaken on Interstate 94 (Eden's Expressway) in Chicago. Long Key Bridge, Florida Keys, completed—a precast, post-tensioned concrete bridge consisting of 103 spans of up to 118 ft (36 m) in length. National Ready-Mixed Concrete Association and Wire Reinforcement Institute celebrated 50th anniversary. Sixteen pairs of prefabricated steel-shelled concrete tubes, each 42 ft (13 m) high, were placed for the Fort McHenry Tunnel across the inner harbor in Baltimore, MD.	Olympic games held in Moscow but U.S. athletes stayed at home. Indira Gandhi won landslide victory at the polls in India. The first women graduate from U.S. military academies. Mount St. Helens erupted in state of Washington. The nation endured a weak economy and Iran hostage crises. World Health Organization announced eradication of small pox.
1981	ACI's Long-Range Plan, which set "pertinent objectives and goals" and recommends plans for the organization's future, was adopted by the Board of Direction. With the addition of new chapters in Israel and Korea, the number of ACI chapters climbed past 50. Institute's Executive Committee met in South America, a first for ACI. First concrete cube testing contest for students held during the Dallas, TX, convention.	The Texas Commerce Tower, Houston, the world's sixth tallest building, was completed by using concrete pumped to a height of 1030 ft (314 m)—the highest such pumping ever undertaken. The structure was also the tallest composite (both concrete and steel) building in the world. Rehabilitation of railroad track between Boston and Washington, DC, used 1.1 million concrete ties—the largest concrete tie installation in the U.S. up until that time. Bureau of Reclamation Concrete Laboratory 50th anniversary.	Fifty-two American hostages were freed from Iran. The first woman, Sandra Day O'Connor, was named to the U.S. Supreme Court. Anwar Sadat of Egypt was assassinated. Federal air controllers were fired for striking. The space shuttle Columbia made a successful test flight. IBM launched its "home" or "personal" computer. World's fastest train, the French TGV, went into operation.
1982	The first student chapters, at Wentworth Institute of Technology, Boston, MA, and California State University, Fresno, CA, were established. ACI certification program launched. ACI's first Concrete Craftsman Series, *Slabs on Grade*, was published. First of a series of roundtables/seminars in foreign nations held; ACI officials visited Israel, India, Hong Kong, Singapore, and Japan.	Cantilevering of the main span of the Houston Ship Channel Bridge, the longest post-tensioned girder span in the U.S., got underway. World's first floating prestressed concrete container dock was built in Tacoma, WA, and the 700 ft (213 m) long structure was towed 1400 miles (2250 km) to Valdez, AK. Willow Creek Dam in Oregon is the first concrete gravity dam built entirely by roller-compacted concrete methods and is essentially completed in less than a year.	Recession and year-long rise in unemployment occured in the U.S. and other industrial nations. Argentine soldiers took over the Falkland Islands but the islands were recaptured by Great Britain. The population of China passed the 1 billion mark. World's Fair was staged in Knoxville, TN.

Year	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1983	ACI 318-83 Building Code and Commentary and 318.1, Structural Plain Concrete Code, published by the Institute. ACI's local chapter movement observed 25th anniversary. Publication sales exceed $1.5 million; membership passed 16,100. Los Angeles convention drew 1176, second highest registration in Institute history; meeting in Kansas City, attracted 996, a new record for fall conventions. Program of interpreting ACI codes and specifications established by the Board of Direction.	The first diagonally braced tube structure designed and constructed in reinforced concrete was completed at 780 Third Ave., New York City. As use of high-strength concrete in tall structures increased, two experimental columns of 14,000 psi (97 MPa) concrete were erected during construction of the new 38-story Chicago Mercantile Exchange Building. First International Conference on Use of Fly Ash, Silica Fume, Slag, and Other Mineral By-Products in Concrete held at Montebello, Canada, sponsored by ACI and CANMET. First precast segmental concrete construction for a railway used in the Metropolitan Atlanta Rapid Transit Authority (MARTA) system.	First American woman to travel in space, Sally Ride, is a crew member of the space shuttle Challenger. Menachem Begin resigned as prime minister of Israel. A South Korean airliner was downed—269 killed. Terrorist attack on the U.S. Marine headquarters in Beirut, Lebanon—191 killed. Lech Walesa, founder of Solidarity, Poland's free labor union, was awarded Nobel Peace Prize. Ameritech receives FCC's first cellular phone license.
1984	Membership exceeded 17,700, the highest in 80-year Institute history. Concrete Materials Research Council established. ACI officials traveled 16,000 miles (25,700 km) and visited eight Latin American nations. Associate Member category created for ACI technical and educational committees. Fall convention featured a debate on crack width, cover, and corrosion and also a three-part symposium on offshore concrete platforms.	Work began on the 4.2 mile (7 km) Sunshine Skyway Bridge, Tampa, FL, which would be the longest concrete span in North America when completed. The span would include a superstructure of box girders supported by stayed cables from pylons atop the two main piers. Construction began on Utah's Upper Stillwater Dam, the world's largest roller-compacted concrete dam.	U.S. President Ronald Reagan visited China. Olympic games held in Los Angeles but were boycotted by Soviet Union and other nations. For the first time, a woman, Geraldine Ferraro of New York, received a vice presidential nomination from a major political party (Democrats). Statue of Liberty in New York Harbor began a major renovation. Apple Macintosh microcomputer was launched. World's Fair held in New Orleans, LA.
1985	By the end of 1985, almost 4200 were certified as Grade I field technicians. Educational committee on microcomputers established. New York City Buildings Department required all concrete field testing technicians to pass ACI's Grade I certification test. A committee on concrete aesthetics was activated. Limits for chloride content debated.	Hoover Dam on the Colorado River (border of Arizona and Nevada) celebrated its 50th anniversary. A concrete engineering masterpiece, it is still the western hemisphere's highest concrete arch gravity dam. First ferrocement windsurfer race held in the Netherlands. Construction neared completion of first phase of Chicago's cast-in-place reinforced concrete River City.	British survey team discovered hole in ozone layer over Antarctic. Reformer Mikhail Gorbachev came to power in USSR. Microsoft Windows debuted. National Building Museum in Washington, D.C., opened. Severe earthquake hit Mexico City.
1986	A guide for use of polymers in concrete issued. Some national and state agencies were requiring ACI certified technicians on concrete construction projects. Pakistan chapter established. Delaware Valley chapter held concrete beam testing competition for college and university students. Spanish translation of *Manual of Concrete Inspection* was available.	The Oosterschelde storm-surge barrier, south of Rotterdam, completed to protect the Netherlands from storms on the North Sea. One of the world's most expensive and challenging construction projects, it began in 1953 and was a concrete project of massive proportions. Lunar soil, gathered by the crew of Apollo 16, was tested to determine its suitability as an aggregate for making concrete for lunar base construction. World's first floating concrete heliport, Port of Vancouver, BC, Canada, as large as a football field, constructed from styrofoam-filled cellular concrete. Tilt-Up Concrete Association organized.	Lightweight airplane Voyager took 9 days to make first nonstop flight around the world without refueling. Nuclear disaster at Chernobyl. Space shuttle Challenger exploded on take-off, killing all on board.

1987-1990

Year	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1987	*ACI Journal* was "retired," making way for two new expanded Journals: *ACI Structural Journal* and *ACI Materials Journal*. ACI marketing of proprietary computer programs became operational. Concrete Flatwork Finisher Certification program authorized. Mission and goals for Committee on Responsibility in Concrete Construction approved. Formation of chapters in Philippines and Argentina.	Construction began on a 65-story office tower in Chicago. At 959 ft (292 m), it would be the world's tallest reinforced concrete building when completed (January 1990). Continuous placement of high-strength concrete for the 8 ft (2.4 m) thick mat foundation required delivery of at least 24 yd^3 (18.4 m^3) of concrete every 4 minutes by ready-mixed concrete trucks. Olympic Oval, University of Calgary, AB, Canada, included the first 437 ft (400 m) covered speed-skating track in the world. The long-span roof structure featured a system of intersecting segmental precast concrete arches. Patent awarded for self-propelled, laser-controlled screed.	U.S. and USSR signed treaty eliminating intermediate-range missiles. Twenty-fifth anniversary of the launch of Telestar communications satellite. New Jersey adopted first statewide recycling law.
1988	The 10,000th technician was certified in the ACI Concrete Field Testing Technician Grade I program. Ferguson Lecture Series began. Building code requirements and specifications for masonry structures issued by joint ACI-ASCE committee. Technical committee formed on lunar concrete.	Clyde Dam, New Zealand, completed. With 1,307,190 yd^3 (1,000,000 m^3) of concrete, it was New Zealand's largest dam. Dames Pointe span over the St. Johns River, Jacksonville, FL, with a 1300 ft (396 m) span, became the longest concrete cable-stayed bridge in North America. The early-entry, dry-cut saws were introduced for joint cutting in slabs. International Concrete Repair Institute founded.	First transatlantic optical fiber telephone cable linked U.S., Britain, and France. One of the nation's worst toxic waste sites, much of Love Canal in Niagara Falls, NY, was declared clean. U.S. and Canada reached free trade agreement.
1989	ACI purchased land in Farmington Hills, MI for a future headquarters. ACI chapters now totaled 77 with the formation of new chapters in Taiwan and Egypt. 318 Building Code and Commentary appeared side-by-side in one document. Concrete Research and Education Foundation (ConREF) established. Metric edition of ACI 318-89 available.	Lightweight concrete pumped to a record-breaking 1038 ft (316 m) above ground in a single lift on the 75-story First Interstate World Center, Los Angeles. American Segmental Bridge Institute organized. Instituto del Cemento Portland Argentino marked 50th anniversary. Japanese construction industry used on-site robots. Currently the world's tallest reinforced concrete high-rise, 311 South Wacker, Chicago, was topped out.	Computer viruses infected computers around the world. NASA launched Galileo space probe to Jupiter. Pro-democracy demonstrations culminated in Tiananmen Square massacre as government troops forcefully disperse demonstrators in Beijing, China. East German government opened entire border; "Berlin Wall" comes down. I. M. Pei designed controversial glass pyramid to cover new entrance to Louvre museum in Paris.
1990	Institute membership reached more than 20,000 for the first time. Chartered a chapter in Denmark—the first ACI chapter in Europe. Capital fund-raising drive inaugurated for new headquarters facility. Committee on masonry structures was named National Masonry Standards Joint Committee.	Topic of major interest was high-performance concrete (HPC). Tests of a sample of lunar soil collected by NASA determine that the material could be used as aggregate for making concrete on the moon. Poured Concrete Wall Contractors Association changed name to Concrete Foundations Association.	Iraqi forces invaded Kuwait. UN imposed economic sanctions on Iraq. U.S. mounted Operation Desert Shield. The Hubble space telescope went into orbit. South Africa freed Nelson Mandela, imprisoned 27-1/2 years.

	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1991	ACI's first electronic product—a CD-ROM containing 10 years (1981-1991) of *Concrete Abstracts*. Concrete Materials Research Council mission expanded and name changed to Concrete Research Council. Educational seminars were held as part of a convention (in Dallas) for the first time. First Lunar Concrete Technical Symposium held.	Itaipu Dam on the Parana River separating Brazil from Paraguay, was world's largest hydroelectric project. Main structure was a 3270 ft (997 m) long, 620 ft (189 m) high hollow concrete gravity dam. The 100th anniversary of concrete paving in the U.S. celebrated in Bellefontaine, OH. The 15,000-seat Connecticut Tennis Center, New Haven, CT, built entirely of precast prestressed concrete on a fast-track schedule.	Persian Gulf War broke out, expelling Iraqi forces from Kuwait. USSR was dissolved. War began in Yugoslavia as Slovenia and Croatia declare their independence. South African government repealed apartheid laws. Japan's artificial island in Osaka Bay, which was to hold Kansai International Airport, was sinking at a faster rate than originally anticipated.
1992	ACI assumed the secretariat for ISO/TC-71, the International Standardization Organization's Technical Committee on Concrete. ACI's Eastern Ontario and Quebec Chapter cosponsored the 18th Great Northern Concrete Toboggan Race in Montreal (the first toboggan race was held in Alberta in 1975). National Capital Chapter started mentor program for students.	Southern Illinois University at Edwardsville (SIUE) developed concrete kits for elementary schools to demonstrate science of concrete and introduce basic engineering principles. Denmark's Great Belt Link was underway; concrete was the prime material. Sydney Harbor Tunnel opened, longest road tunnel in Australia and featured a 3150 ft (960 m) immersed tube made of eight precast concrete units. Hong Kong's 1228 ft (374 m) high-rise reinforced concrete building completed in record time.	Peace accords ended 12 years of civil war in El Salvador. UN peacekeeping force established in what was Yugoslavia. The 500th anniversary of Columbus landing in the "New World." ACI held fall meeting in Puerto Rico. Naval Construction Battalions (Seabees) marked 50th anniversary.
1993	Largest ACI certification session ever held staged during World of Concrete exhibition. Institute developed *Manual of Concrete Practice* on CD-ROM. Traveling Fellowships were available to help skilled professionals teach concrete technology in developing countries. Concrete Construction Inspector Certification Program was available in both French and English in Canada, but keyed to Canadian standards and codes. "Hot topics" was nonmetallic reinforcement and encapsulation of hazardous waste with cementitious materials.	Construction started on Three Gorges Dam in the People's Republic of China. Natchez Trace Parkway Bridge in Tennessee was longest concrete arch bridge in U.S. Two miles (3 km) of European-style concrete pavement design was built on Detroit freeway as demonstration project. An Egyptian-theme resort erected in Las Vegas was a bronze glass-and-concrete pyramid 30 stories high. Interlocking Concrete Pavement Institute founded.	Maastricht Treaty took effect. All 12 members of European Union agreed to introduce a common currency and drop trade barriers. Czechoslovakia split into Czech Republic and Slovakia. Midwest area of U.S. flood damage exceeded $10 billion.
1994	Responsibility in Concrete Construction Committee issued proposed guidelines for discussion. Opened ACI/ConREF Washington, D.C., office. ACI certification reached 50,000. An educational committee on teaching methods and materials formed. The two Journals were expanded to reduce backlog of manuscripts awaiting publication.	Commercial traffic began through English Channel tunnel connecting Britain and France; tunnel used some 675,000 concrete tunnel liner segments. Construction started on Canada's Confederation Bridge spanning the Northumberland Strait; specifications called for a 100-year design life. Environmental Council of Concrete Organizations (ECCO) founded. Troll GBS (gravity base structure) offshore concrete structure under construction; when completed, it was 1200 ft (369 m) high—all under water.	North American Free Trade Agreement (NAFTA) went into effect between Canada, U.S., and Mexico. Nelson Mandela elected first black president of South Africa. Major league baseball players went on strike—World Series cancelled.

1991-1994

1995-1998

Year	ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
1995	Groundbreaking ceremonies marked start of new headquarters construction. Chapter on precast concrete expanded considerably in ACI 318-95. Procedures established for development of “provisional standards.” Maharashtra India Chapter launched a certification course for technicians.	Roughly 2.5 million yd^3 (1.9 million m^3) of concrete used to construct Denver International Airport runways, taxiways, and aprons. A precast, prestressed girder bridge built in Nebraska said to be the first “hard” metric bridge designed and built in the U.S. Chesapeake & Delaware Canal Bridge, a precast concrete segmental bridge, opened.	UN commemorated 50th anniversary. On 50th anniversary of bombing of Nagasaki, President Clinton announced a halt of all U.S. nuclear testing. Terrorist bombing destroyed Federal Building in Oklahoma City and killed 168. The Federal 65 mph (105 kph) speed limit [enacted in 1974 at 55 mph (88 kph) in effort to conserve fuel] was repealed. U.S. and troops from other nations deployed in Bosnia and Herzegovina.
1996	Completion of and move into new headquarters. Strategic Development Council, a council of ConREF, formed. ACI issued its first provisional standard. ACI launched an Internet website.	Hawaii’s 16 mile (26 km) H-3 highway featured large precast concrete segments and drilled shafts. Atlanta’s Olympic Stadium, built with precast components, was reconfigured into a baseball stadium for Atlanta Braves.	Centennial Olympic games in Atlanta, GA. The Interstate Highway System, authorized in 1956, and continued ever since, reached 44,117 miles (70,985 km) of interstate network. Russians and Chechens battled over hostages. “Mad cow disease” alarmed Britain.
1997	A new program of practical publications launched: “Toolbox Meeting Flyers” and “Practioner’s Guides.” ACI Young Member Award for Professional Achievement established. ACI issued new strategic plan.	Canada’s Confederation Bridge completed—one of the longest continuous multispan bridges in the world. It featured huge precast concrete spans and piers erected with self-propelled floating cranes; high-performance concrete used extensively. Lehigh Portland Cement Co. marked 100th anniversary. Hibernia oil production platform had a 345 ft (105 m) diameter serrated ice wall that protected its slipformed gravity base structure.	Fears over the environment grew as “El Niño” effect on climate produced extreme weather conditions and variations, especially in North America. Hong Kong was returned to China. Cloning of a sheep by British scientists. Federal guidelines for seismic retrofits of existing buildings introduced performance-based design.
1998	Executive Vice President George F. Leyh retired. James G. Toscas named chief executive. Introduced a new line of CD-ROM products called Concrete Tools—electronic compilations directed at specific topics. Commemorative Lecture Series began with first three lectures to memorialize George Winter. Reinforced Concrete Research Council transferred from ASCE to ConREF umbrella. Internet website containing information about ACI activities became fully operational.	Petronas Towers I and II, Kuala Lumpur, Malaysia, completed—both 1483 ft (452 m) high. Tower II claimed a concrete pumping record—1246 ft (380 m) in one lift. ASTM celebrated 100th anniversary. American Shotcrete Association organized. A 197 ft (60 m) long pedestrian bridge in Quebec, Canada, made from reactive-powder concrete.	Assembly of international space station began in earnest after U.S. attaches second component to Russian-built module launched 2 weeks earlier. Mark McGwire hits his 62nd home run of the season, breaking Roger Maris’ single season record. Detroit Red Wings hockey team won the Stanley Cup for second year in a row (1997 and 1998).

ACI EVENTS | CONCRETE EVENTS | WORLD EVENTS

1999

Concrete Repair Manual published by ACI and the International Concrete Repair Institute. Concrete Field Testing Technician Certification launched in Iran. ACI task committee published definition of high-performance concrete. Concrete Innovations Appraisal Service (CIAS) established. ACI 318-99 requirements for post-tensioning anchorage zones extensively updated as is rationale for seismic design. Jo Coke became ACI's first female president.

World of Concrete observed 25th anniversary. Staples Center arena, home of Los Angeles Kings (hockey) and Lakers (basketball), was built largely of precast concrete. A 22.5 acre (9 hectare) experimental kelp reef began to take shape in ocean waters off California by precisely placing crushed recycled concrete.

North Atlantic Treaty Organization (NATO) celebrated 50th anniversary. Panama Canal officially transferred from U.S. responsibility to Republic of Panama. The 164 ft (50 m) high Millennium Dome in London was the "symbol" of the UK government's millennium celebration. With launch of space shuttle Columbia, Air Force Colonel Eileen Collins became first woman to command a shuttle flight. World population reached 6 billion milestone.

The traditional exchange of the ACI presidential gavel took place at the 1999 annual convention between new president Jo Coke and outgoing president James R. Libby. Coke was the first female to be elected Institute president.

2000

ACI joined with Federal Highway Administration to develop and present workshops to help state highway agencies combat concrete deterioration, especially alkali-silica reactivity. Shotcrete nozzleman and tilt-up supervisor certification programs launched. ACI 318-99 referenced in International Code Council's new single model code, IBC 2000. Spanish language flatwork finisher certification program available and launched in Chile.

Society of Concrete Petrographers organized. National Stone, Sand & Gravel Association formed from a merger of National Stone Association (1918) and National Aggregates Association (1916). Total U.S. cement consumption reached 110 million metric tons. Øresund Link between Denmark and Sweden completed—used 1.3 million yd^3 (1 million m^3) of concrete and had a specified design life of 100 years. High-speed train railway bridge across Rhône River in France became one of largest prestressed concrete railway bridges in the world.

World entered new century smoothly—Y2K arrives without predicted global computer chaos. The NEAR spacecraft was first to orbit an asteroid. U.S. jobless rate lowest since 1970. Wildfires in far west destroyed nearly 500,000 acres (202,000 hectares). Blast damaged British spy (MI6) headquarters in London. Sydney, Australia, hosted summer Olympics. First crew began work at International Space Station.

1999-2000

ACI EVENTS	CONCRETE EVENTS	WORLD EVENTS
2001		
Walter P. Moore, Jr. Faculty Achievement Award established. ACI introduced E-Learning Program. There were 56,000 active certifications representing 25 countries. First Emerging Technology Series document appeared. Task groups activated to plan for centennial celebration. National D-Day Memorial complex received ACI Virginia Chapter's annual award for notable project.	100th anniversary of invention of welded wire reinforcement. Precast concrete segmental technology chosen for elevated guideways in San Juan, Puerto Rico, mass transit system. Ready-mixed concrete industry sets record with 406 million yd^3 (310 million m^3) produced annually. Slag Cement Association was incorporated.	World Trade Center towers (110 stories high each) collapsed in terrorist attack. National Institute of Standards and Technology (NIST) celebrated 100 years of service. U.S. businessman became first tourist in space aboard Russian rocket to International Space Station. Energy shortage forced blackouts in California. NASA spacecraft landed on the asteroid Eros. Two fantasy movies—"Fellowship of the Ring" and "Harry Potter and the Sorcerer's Stone" were box office successes.
2002		
ACI 318-02 Building Code was the most comprehensive revision of code since introduction of strength design in 1956. William R. Tolley named Executive Vice President. Building Code for masonry structures included strength design provisions. Fiber-reinforced concrete (FRC) bowling ball student competition debuted. American Subcontractors Association endorsed ACI's Concrete Flatwork Technician and Concrete Flatwork Finisher certification programs.	Three Gorges Dam in China moved into third and final phase of construction. The 2309 m (7575 ft) long, 185 m (607 ft) high concrete gravity dam is scheduled for completion in 2009. Turner Construction Company marked its 100th anniversary. Boston's hybrid cable-stayed Bunker Hill Bridge opened to traffic.	Britain celebrates Golden Jubilee of Queen Elizabeth II. U.S. corporate community battered by accounting scandals and bankruptcies. Twelve European countries get a new currency—the euro. Olympic winter games in Salt Lake City, UT. American Society of Civil Engineers celebrated 150th anniversary. Legislation created Homeland Security Department—the biggest reorganization of the federal government since President Truman combined the War and Navy Departments into a single Defense Department after World War II.
2003		
Cooperation with concrete-related organizations in other nations enhanced with International Partner Agreement Program. Landmark Series of papers published. Sixth International Conference covered seismic bridge design.	Sophisticated technology and post-tensioning renovate Frank Lloyd Wright's Fallingwater creation. High-performance concrete used to rebuild Chicago's Wacker Drive.	200th anniversary of Lewis and Clark journey of exploration. 100th anniversary of Wright brothers' first successful powered airplane flight in 1903. Ford Motor Co.'s 100th anniversary. Shuttle Columbia broke apart on re-entry.

2001-2003

ACI Past Presidents 1980-2004

This pictorial presentation features the past presidents who have guided the American Concrete Institute to leadership in the concrete industry from 1980 to 2004.

Charles J. Pankow
1980

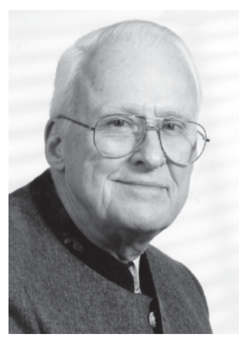
T. Z. Chastain
1981

Peter Smith
1982

Norman L. Scott
1983

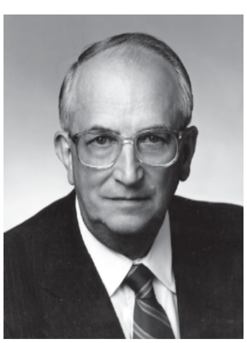
Ignacio Martín
1984

Emery Farkas
1985



Walter E. Kunze
1986

T. E. (Gene) Northup
1987

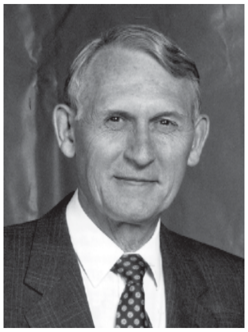


W. Burr Bennett, Jr.
1988

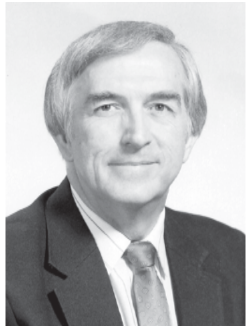
Paul Zia
1989

John M. Hanson
1990

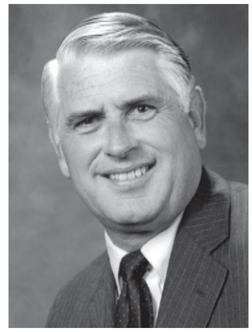
I. Leon Glassgold
1991



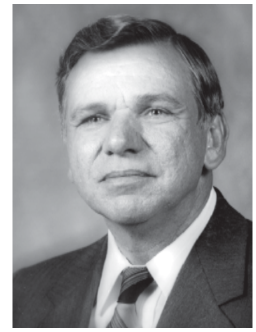
James G. MacGregor
1992



George C. Hoff
1993



Dean E. Stephan
1994



Robert F. Mast
1995

James S. Pierce
1996

Richard N. White
1997

James R. Libby
1998

Jo Coke
1999

James O. Jirsa
2000

Daniel L. Baker
2001

Terence C. Holland
2002

José M. Izquierdo
2003

Anthony E. Fiorato
2004

Epilogue

Many changes have taken place in the American Concrete Institute since that first group of 761 cement users met in Indianapolis. The aims stated in the constitution adopted in 1905 are not much different from those stated in today's charter—but it is a vastly different organization. Not only is it larger—15,562 members in 111 different countries—and truly international, but it is dealing with structures and technologies that could only be imagined in the early 1900s.

The growth of ACI is closely related to the growth of the cement industry and construction activity. The U.S. has expanded from a largely rural population to an urban population. In 1920, about one-half of the population lived in cities. Today, an estimated four-fifths of the population lives in cities. All of this has resulted in a vast construction market for buildings, highways, bridges, transportation networks, housing, water and sewage systems—all of this using various forms of concrete in structural and architectural applications.

From 1905 to 1910, ACI had eight committees, growing to 18 by 1920, and fluctuating between 20 and 30 committees until 1954. Since then, the number has increased rapidly and now consists of (not counting ad hoc committees or task groups) 18 administrative committees, 138 technical committees, 11 educational committees, eight certification committees, and seven international committees.

From a single chapter in 1958, the chapter movement has grown to 59 in the U.S. and Puerto Rico, six in Canada, one in the Caribbean, three in Europe, two in Mexico, one in Africa, seven in the Far East, two in Central America, 11 in the Middle East/Asia, and five in South America. There are also 24 student chapters.

The American Concrete Institute has contributed, through its publications, to a detailed knowledge of materials and structures and to general acceptance of concrete for a multitude of uses. As much as it contributed to knowledge, the mere act of making information available was not enough. Undoubtedly, ACI's greatest contribution to application of knowledge has been the assimilation of information and practice by volunteer committees in development and issuance of standards and guides for design and construction.

Through these past 100 years, concrete's technological growth and acceptance have been as impressive as achievements in aerospace, electronic, and atomic fields. Research, applied theory, and inventiveness have established that concrete is a construction material that conforms to new concepts in design with almost limitless applications. Concrete strengths can be phenomenal. Combinations of materials such as polymers, epoxies, and fibers with basic concrete materials offer a wide variety of products for special applications. Extreme heights in buildings are feasible and long spans for bridges and arenas are evident. Concrete has become both a structural and an architectural material.

ACI has played a significant role. Design and construction criteria have been effectively analyzed, tested, and developed by many hundreds of qualified experts and practitioners serving on scores of committees appointed by the Institute during the past 100 years.

This brief history has mentioned only a few of the committees, leaders, workers, and events. The limits of space do not allow a complete chronicle of all of the interesting developments within ACI and the industry.

A LOOK TO THE FUTURE

The history of concrete has been one of dramatic development. As each milestone of progress in plain and reinforced concrete is reached, it becomes apparent that the future of the concrete industry depends on its ability to adapt—through education, research, and development, as well as through practical techniques in design and construction—to the challenges of the 21st century and beyond.

ACI will face challenges and opportunities to function as a leader in influencing the future of construction. As engineers and constructors push forward the frontiers of knowledge, the American Concrete Institute must be a forum that brings together all segments to solve problems and influence practice so that there is indeed "progress through knowledge."

Acknowledgments

This story of ACI's 100 years is an extension of two earlier articles: "A Story of Progress: Fifty Years of the American Concrete Institute" by William A. Maples and Robert E. Wilde, published in the February 1954 *ACI Journal*, and "75 Years of Progress: The ACI Saga" by Robert E. Wilde, published in the October 1979 *Concrete International*. I thank the Institute for free access to the archives and publications; the committee reports and papers by individual authors offered invaluable information. I also recognize the assistance of staff members in searching out files and information and offering ideas. Special thanks go to the late Roger Wood, managing editor of *Concrete International* prior to his retirement, whose research into ACI history was of great help.

For further reading

There are thousands upon thousands of pages of interesting and valuable information on the many aspects of concrete and its development. Here are just a few:

Billington, D. P., *The Art of Structural Design: A Swiss Legacy*, Princeton University Art Museum, 2003, 211 pp.

Concrete Through the Ages, British Cement Association, England, 1999, 36 pp.

Cooper, J. L., *Artistry and Ingenuity in Artificial Stone: Indiana's*

Concrete Bridges 1900-1942, Historic Bridge Books, 1997, 280 pp.

Draffin, J. O., "A Brief History of Lime, Cement, Concrete, and Reinforced Concrete," *University of Illinois Bulletin*, V. 40, No. 45, 1943, 36 pp. Also reprinted in ACI Publication SP-52 (see below).

Hamilton, S. B., "A Note on the History of Reinforced Concrete in Buildings," *Special Report*, No. 24, National Building Studies, Building Research Station, England, 1956, 30 pp.

Hatt, W. K., "Genesis of Reinforced Concrete Construction," *Proceedings*, V. 12, 1916, pp. 21-39.

Humphrey, R. L., "The Progress of Two Decades," *Proceedings*, V. 20, 1924, pp. 22-42.

Johnson, A. N., "The Use of Concrete in Road Construction," *Proceedings*, V. 20, 1924, pp. 53-88.

Kerekes, F., and Reid, H. B., Jr., "Fifty Years of Development in Building Code Requirements for Reinforced Concrete," ACI Journal, *Proceedings* V. 50, No. 6, Feb., 1954, pp. 441-471.

Lindau, A.E., "Reinforced Concrete Bridges," *Proceedings* V. 20, 1924, pp. 122-134.

Macdonald, C., *Bridging the Strait: The Story of the Confederation Bridge Project*, Dundurn Press, Toronto, 1997, 128 pp.

Newlon, H., Jr., ed., *A Selection of Historic American Papers on Concrete 1826-1926*, SP-52, American Concrete Institute, 1976, 334 pp.

Peterson, J. L., "History and Development of Precast Concrete," ACI Journal, *Proceedings*, V. 50, No. 6, Feb. 1954, pp. 477-496.

Ransome, A. W., "The Mechanical Equipment for Handling Concrete," *Proceedings*, V. 20, 1924, pp. 96-105.

Stevens, J. E., *Hoover Dam—An American Experience*, University of Oklahoma Press, 1998, 326 pp.

Robert E. (Bob) Wilde, a long-time ACI staff member, has been involved in ACI projects for some 50 years, having joined the Institute in 1949. He was deputy to the executive vice president and publisher of *Concrete International* (CI) prior to his retirement. Following retirement, Bob, an ACI Honorary Member, authored the "Concrete Comments" column in *Concrete International* for more than a decade. He also authored the book, *Practical and Decorative Concrete*.

American Concrete Institute Awards

WASON MEDAL FOR MOST MERITORIOUS PAPER

The Wason Medal for Most Meritorious Paper was founded in 1917 by Leonard C. Wason, ACI past president, and has been awarded continually since that date. It is awarded each year to the author or authors of the most meritorious paper published by the Institute. All original papers are eligible. At least one author must be an ACI member.

Recipients with year of award presentation and title of paper are:

1919* **Allen B. McDaniel** for his V. 12 paper, "Influence of Temperature on the Strength of Concrete."

1919* **Charles R. Gow** for his V. 13 paper, "History and Present Status of the Concrete Pile Industry."

1919* **Duff A. Abrams** for his V. 14 paper, "Effect of Time of Mixing on the Strength and Wear of Concrete."

1920 **Willis A. Slater** for his V. 15 paper, "Structural Laboratory Investigations in Reinforced Concrete Made by Concrete Ship Section, Emergency Fleet Corporation."

1921 **W. A. Hull** for his V. 16 paper, "Fire Tests of Concrete Columns."

1922 **H. M. Westergaard** for his V. 17 paper, "Moments and Stresses in Slabs."

1923 **George E. Beggs** for his V. 18 paper, "An Accurate Mechanical Solution of Statically Indeterminate Structures by Use of Paper Models and Special Gauges."

1924 **John J. Earley** for his V. 19 paper, "Building the Fountain of Time."

1925 **Richard L. Humphrey** for two papers in V. 20: "Twenty Years of Concrete," and "The Promise of Future Development."

1926 **E. A. Dockstader** for his V. 21 paper, "Report of Tests Made to Determine Temperatures in Reinforced Concrete Chimney Shells."

1927 **A. Burton Cohen** for his V. 22 paper, "Correlated Considerations in the Design and Construction of Concrete Bridges."

1928 **Arthur R. Lord** for his V. 23 paper, "Notes on Concrete—Wacker Drive, Chicago."

1929 **Franklin R. McMillan** for his V. 24 paper, "Concrete Primer."

1930 **L. G. Lenhardt** for his V. 25 paper, "The Concrete Lining of Detroit Water Tunnels."

1931 **I. E. Burks** for his V. 26 paper, "Concreting Methods at the Chute a Caron Dam."

*Three Wason Medals were presented in 1919 for papers published in the years 1916, 1917, and 1918 that were not awarded during World War I.

1932 **Raymond E. Davis** and **Harmer E. Davis** for their V. 27 paper, "Flow of Concrete Under the Action of Sustained Loads."

1933 **Charles S. Whitney** for his V. 28 paper, "Plain and Reinforced Concrete Arches."

1934 **L. Boyd Mercer** for his V. 29 paper, "Slidng Form Work."

1935 **Raymond E. Davis, R. W. Carlson, G. E. Troxell**, and **J. W. Kelly** for their V. 30 paper, "Cement Investigations for Boulder Dam with the Results up to the Age of One Year."

1936 **Hardy Cross** for his V. 31 paper, "Why Continuous Frames?"

1937 **George A. Maney** for his V. 32 paper, "Analysis of Multiple Span Rigid Frame Bridges by the Slope Deflection Method."

1938 **Roderick B. Young** for his V. 33 paper, "Concrete—Its Maintenance and Repair."

1939 **Wilbur M. Wilson** and **Ralph W. Kluge** for their V. 34 paper, "Tests of Rigid Frame Bridges."

1940 **Herbert J. Gilkey, S. J. Chamberlin**, and **R. W. Beal** for their V. 35 paper, "The Bond Between Concrete and Steel."

1941 **R. E. Copeland** and **C. C. Carlson** for their V. 36 paper, "Tests of the Resistance to Rain Penetration of Walls Built of Masonry and Concrete."

1942 **Jacob Fruchtbaum** for his V. 37 paper, "Fire Damage to General Mills Building and Its Repair."

1943 **Hugo C. Fischer** for his V. 38 paper, "Architectural Concrete on the New Naval Medical Center."

1944 **P. J. Halloran** and **Kenneth H. Talbot** for their V. 39 paper, "The Properties and Behavior Under Water of Plastic Concrete."

1945 **W. Mack Angas, E. M. Shanley**, and **John J. Erickson** for their V. 40 paper, "Concrete Problems in the Construction of Graving Docks by the Tremie Method."

1946 **Clarence Rawhauser** for his V. 41 paper, "Cracking and Temperature Control of Mass Concrete."

1947 **Gerald Pickett** for his V. 42 paper, "Shrinkage Stresses in Concrete."

1948 **Carl A. Menzel** for his V. 43 paper, "Development and Study of the Apparatus and Methods for the Determination of the Air Content of Fresh Concrete."

1949 **Frank H. Jackson** and **Harold Allen** for their V. 44 paper, "Concrete Pavements on the German Autobahn."

1950 **Chester P. Siess** and **Nathan M. Newmark** for their V. 45 paper, "Rational Analysis and Design of Two-Way Concrete Slabs."

1951 **Harry F. Thomson** for his V. 46 paper, "Specifications Should Be Realistic."

1952 **Walter H. Price** for his V. 47 paper, "Factors Influencing Concrete Strength."

1953 **Charles S. Whitney, Boyd G. Anderson**, and **Mario G. Salvadori** for their V. 48 paper, "Comprehensive Numerical Method for the Analysis of Earthquake Resistant Structures."

1954 **David Watstein** for his V. 49 paper, "Effect of Straining Rate on the Compressive Strength and Elastic Properties of Concrete."

1955 **Rudolph C. Valore, Jr**. for his V. 50 paper, "Cellular Concrete."

1956 **Charles S. Whitney, Boyd G. Anderson**, and **Edward Cohen** for their V. 51 paper, "Design of Blast Resistant Construction for Atomic Explosions."

1957 **Lewis H. Tuthill** and **William A. Cordon** for their V. 52 paper, "Properties and Uses of Initially Retarded Concrete."

1958 **R. E. Copeland** for his V. 53 paper, "Shrinkage and Temperature Stresses in Masonry."

1959 **John R. Brotchie** for his V. 54 paper, "General Method for Analysis of Flat Slabs and Plates."

1960 **James E. Backstrom, Richard W. Burrows, Harry L. Flack, Richard C. Mielenz,** and **Vladimir E. Wolkodoff** for their V. 55 paper, "Origin, Evolution and Effects of the Air Void System in Concrete."

1961 **Robert A. Williamson** for his V. 56 paper, "Performance and Design of Special Blast Resistant Structures."

1962 **Hubert Rüsch** for his V. 58 paper, "Researches Toward a General Flexural Theory for Structural Concrete."

1963 **M. O. Withey** for his V. 58 paper, "Fifty-year Compression Tests of Concrete."

1964 **Paul Fischer** for his V. 59 paper, "Differential Temperature Moments in Rigid Frames."

1965 **J. A. Hanson** for his V. 60 paper, "Optimum Steam Curing Procedures in Precasting Plants."

1966 **B. P. Sinha, Kurt H. Gerstle**, and **Leonard G. Tulin** for their V. 61 paper, "Stress-Strain Relations for Concrete Under Cyclic Loading."

1967 **Alan H. Mattock** for his V. 62 paper, "Rotational Capacity of Hinging Regions in Reinforced Concrete Beams."

1968 **Torben C. Hansen** and **Leif Ericksson** for their V. 63 paper, "Temperature Change Effect on Behavior of Cement Paste, Mortar, and Concrete Under Load."

1969 **G. N. J. Kani** for his V. 64 paper, "How Safe Are Our Large Reinforced Concrete Beams?"

1970 **Hubert Woods** for his ACI Monograph, *Durability in Concrete Construction*.

1971 **Mark Fintel** and **Fazlur R. Khan** for their V. 66 paper, "Shock-Absorbing Soft-Story Concept for Multistory Earthquake Structures."

1972 **James G. MacGregor, John E. Breen**, and **Edward O. Pfrang** for their V. 67 paper, "Design of Slender Concrete Columns."

1973 **David R. Lankard, Donald L. Birkimer, F. Frederick Fondriest**, and **M. Jack Snyder** for their paper, "Effects of Moisture Content on the Structural Properties of Portland Cement Concrete Exposed to Temperatures up to 500 °F," published in SP-25, *Temperature and Concrete*.

1974 **Y. C. Yang** for his V. 69 paper, "Terminal Road Bridges for San Francisco International Airport."

1975 **Frank A. Randall, Jr**. for his V. 70 paper, "Historical Notes on Structural Safety."

1976 **Milton H. Wills, Jr.** for his V. 71 paper, "Lightweight Aggregate Particle Shape Effect on Structural Concrete."

1977 **Jose L. G. Marques** and **James O. Jirsa** for their V. 72 paper, "A Study of Hooked Bar Anchorages in Beam-Column Joints."

1978 **James R. Libby** for his V. 73 paper, "Segmental Box Girder Bridge Superstructure Design."

1979 **James M. Shilstone, Sr.** for his V. 74 paper, "Concrete Construction—Making the Process Work."

1980 **Robert E. Tobin** for his V. 75 paper, "Flow Cone Sand Tests."

1981 **Russell S. Fling** for his paper, "Using ACI 318 the Easy Way," published in *Concrete International*: *Design & Construction*, V. 1.

1982 **Rudolph C. Valore, Jr**. for his paper, "Calculation of U-Values of Hollow Concrete Masonry," published in *Concrete International*: *Design & Construction*, V. 2.

1983 **J. Stephen Ford, Donald C. Chang**, and **John E. Breen** for their V. 78 four-paper series on "Strength and Deformation Capacity of Columns and Multipanel Frames," published in *Concrete International: Design & Construction*, V. 3.

1984 **Ernest K. Schrader** for his paper, "The First Concrete Gravity Dam Designed and Built for Roller Compacted Construction Methods," published in *Concrete International: Design & Construction*, V. 4.

1985 **Robert B. Johnson** for his paper, "Seven-Story Concrete Brackets Support Office Tower," published in *Concrete International: Design & Construction*, V. 5.

1986 **Salvador Martinez, Arthur H. Nilson**, and **Floyd O. Slate** for their V. 81 paper, "Spirally Reinforced High-Strength Concrete Columns."

1987 **Arthur H. Nilson** for his paper, "Design Implications of Current Research on High-Strength Concrete," published in SP-87, *High-Strength Concrete*.

1988 **H. S. Lew** and **John L. Gross** for their paper, "Analysis of Shoring Loads and Slab Capacity for Multistory Concrete Construction" published in SP-90, *Forming Economical Concrete Buildings*.

1989 **Robert F. Ytterberg** for his three-part series "Shrinkage and Curling of Slabs on Grade" published in *Concrete International: Design & Construction*, V. 9.

1990 **William R. Anthony** for his paper, "Concrete Buildings—New Formwork Perspectives" published in SP-107, *Forming Economical Concrete Buildings*.

1991 **Shrinivas B. Bhide** and **Michael P. Collins** for their V. 86 paper, "Influence of Axial Tension on the Shear Capacity of Reinforced Concrete Members" Sept.-Oct. 1989, *ACI Structural Journal*.

1992 **John J. Roller** and **Henry G. Russell** for their V. 87 paper, "Shear Strength of High Strength Concrete Beams with Web Reinforcement," Mar.-Apr. 1990, *ACI Structural Journal*.

1993 **Vincent E. Sagan**, **Peter Gergely**, and **Richard N. White** for their V. 88 paper, "Behavior and Design of Noncontact Lap Splices Subjected to Repeated Inelastic Tensile Loading," July-Aug. 1991, *ACI Structural Journal*.

1994 **Terry J. Fricks** for his paper, "Cracking in Floor Slabs," published in *Concrete International*, V. 14.

1995 **George C. Hoff** for his paper, "High Strength Lightweight Aggregate Concrete for Arctic Applications—Part I," published in SP-136, *Structural Lightweight Aggregate Concrete Performance*.

1996 **Peter H. Emmons, Alexander M. Vaysburd**, and **James E. McDonald** for their paper, "Concrete Repair in the Future

Turn of the Century—Any Problems?" published in *Concrete International*, V. 16.

1997 **M. J.. Nigel Priestley** for his paper, "Myths and Fallacies in Earthquake Engineering—Conflicts Between Design and Reality" published in SP-157, *Recent Developments in Lateral Force Transfer in Buildings*.

1998 **Frederick R. Keith** and **Jerry A. Holland** for their paper, "And the Owner Said, 'Let There be Light…and No Floor Joints or Cracks" published in *Concrete International*, V. 18.

1999 **Hisham H. H. Ibrahim** and **James G. MacGregor** for their V. 94 paper, "Modification of the ACI Rectangular Stress Block for High-Strength Concrete" Jan.-Feb. 1997, *ACI Structural Journal*.

2000 **Stephen L. Amey, Dwayne A. Johnson, Matthew A. Miltenberger**, and **Hamid Farzam** for their V. 95 paper, "Predicting the Service Life of Concrete Marine Structures: An Environmental Methodology" Mar.-Apr. 1998 *ACI Structural Journal*.

2001 **Richard W. Burrows** for his paper, "The Visible and Invisible Cracking of Concrete," Jan. 1999 *ACI Monograph No. 11*.

2002 **Frédéric Légeron** and **Patrick Paultre** for their V. 97 paper, "Behavior of High-Strength Concrete Columns under Cyclic Flexure and Constant Axial Load," July-Aug. 2000, *ACI Structural Journal*.

2003 **Salah A. Altoubat** and **David A. Lange** for their V. 98 paper, "Creep, Shrinkage, and Cracking of Restrained Concrete at Early Age," July-Aug. 2001, *ACI Materials Journal*.

2004 **Norman L. Scott** for his paper, "In Construction, Who is Responsible for What?" published in *Concrete International*, V. 24.

WASON MEDAL FOR MATERIALS RESEARCH

The Wason Medal for Materials Research was founded in 1917 by Leonard C. Wason, past president, of the American Concrete Institute. It may be bestowed annually, but not necessarily in each year, on a member or members of the Institute reporting, in a peer-reviewed paper published by the Institute, original research work on concrete materials and their uses, or a discovery that advances the state of knowledge of materials used in the construction industry. This award is restricted to members of the Institute, although all authors are eligible if any author is an ACI member. Prior to the awards for 1971, this medal was awarded to research papers dealing with any phase of Institute interests.

Recipients, with year of award presentation and title of paper, are:

1929 **S.C. Hollister** for work reported in his V. 24 paper, "The Design and Construction of a Skew Arch."

1930 **Harrison F. Gonnerman** and **Paul M. Woodworth** for work reported in their V. 25 paper "Tests of Retempered Concrete."

1932 **Morton O. Withey** for work reported in his V. 27 paper, "Long Time Tests of Concrete."

1933 **Treval C. Powers** for work reported in his V. 28 paper, "Studies of Workability of Concrete."

1935 **A. G. Timms** and **N. H. Withey** for work reported in their V. 30 paper, "Temperature Effects on Compressive Strength of Concrete."

1936 **Ben Moreell, Douglas E. Parsons**, and **A. H. Stang** for work reported in their V. 31 papers, "Tests of Mesnager Hinges" and "Articulations for Concrete Structures—the Mesnager Hinge."

1937 **J. R. Shank** for work reported in his V. 32 paper, "The Mechanics of Plastic Flow of Concrete."

1938 **Frank E. Richart** and **R. A. Olson** for work reported in their V. 33 paper, "Rapid and Long-Time Tests on Reinforced Concrete Knee Frames."

1939 **Thomas E. Stanton** and **Lester C. Meder** for work reported in their V. 34 paper, "Resistance of Cement to Attack by Sea Water and by Alkali Soils."

1940 **Treval C. Powers** for work reported in his V. 35 paper, "The Bleeding of Portland Cement Paste, Mortar, and Concrete."

1941 **George W. Washa** for work reported in his V. 36 paper, "Comparison of the Physical and Mechanical Properties of Hand-Rodded and Vibrated Concrete Made with Different Cements."

1942 **Louis R. Forbrich** for work reported in his V. 37 paper, "The Effects of Various Reagents on the Heat Liberation Characteristics of Portland Cement."

1943 **Myron A. Swayze** for work reported in his V. 38 paper, "Early Concrete Volume Changes and Their Control."

1944 **Vernon P. Jensen** for work reported in his V. 39 paper, "The Plasticity Ratio of Concrete and Its Effect on the Ultimate Strength of Beams."

1945 **Harrison F. Gonnerman** for work reported in his V. 40 paper, "Tests of Concrete Containing Air Entraining Portland Cements—or Air Entraining Materials Added to Batch at Mixer."

1946 **Bartlett G. Long, Henry J. Kurtz,** and **Thomas A. Sandenaw** for work reported in their V. 41 paper, "An Instrument and a Technic for Field Determination of the Modulus of Elasticity and Flexural Strength of Concrete (Pavements)."

1947 **Charles E. Wuerpel** for work reported in his V. 42 paper, "Laboratory Studies of Concrete Containing Air-Entraining Admixtures."

1948 **Treval C. Powers** and **Theodore L. Brownyard** for work reported in their V. 43 paper, "Studies of the Physical Properties of Hardened Portland Cement Paste."

1949 **Richard C. Mielenz, Kenneth T. Greene**, and **Elton J. Benton** for work reported in their V. 44 paper, "Chemical Test of Reactivity of Aggregates with Cement Alkalies; Chemical Processes in Cement-Aggregate Reaction."

1950 **Thomas M. Kelly, Louis Schuman**, and **F. B. Hornibrook** for work reported in their V. 45 paper, "A Study of Alkali-Aggregate Reactivity by Means of Mortar Bar Expansions."

1951 **John R. Leslie** and **William J. Cheesman** for work reported in their V. 46 paper, "An Ultrasonic Method of Studying Deterioration and Cracking in Concrete Structures."

1952 **W. J. McCoy** and **A. G. Caldwell** for work reported in their V. 47 paper, "New Approach to Inhibiting Alkali-Aggregate Expansion."

1953 **Charles H. Scholer** and **Gerald M. Smith** for work reported in their V. 48 paper, "Use of Chicago Fly Ash in Reducing Cement-Aggregate Reaction."

1954 **Phil M. Ferguson** and **J. Neils Thompson** for work reported in their V. 49 paper, "Diagonal Tension in T-Beams Without Stirrups."

1955 **Thomas B. Kennedy** and **Katharine Mather** for work reported in their V. 50 paper, "Correlation Between Laboratory Accelerated Freezing and Thawing and Weathering at Treat Island, Maine."

1956 **Keith G. Moody, Ivan M. Viest, Richard C. Elstner** and **Eivind Hognestad** for work reported in their V. 51 paper, "Shear Strength of Reinforced Concrete Beams."

1957 **Kenneth R. Lauer** and **Floyd O. Slate** for work reported in their V. 52 paper, "Autogenous Healing of Cement Paste."

1958 **Phil M. Ferguson** for work reported in his V. 53 paper, "Some Implications of Recent Diagonal Tension Tests."

1959 **F. T. Mathis** and **M. J. Greaves** for work reported in their V. 54 paper, "Destructive Impulse Loading of Reinforced Concrete Beams."

1960 **Boris Bresler** and **K. S. Píster** for work reported in their V. 55 paper, "Strength of Concrete Under Combined Stresses."

1961 **Henry T. Toennies** for work reported in his V. 56 paper, "Artificial Carbonation of Concrete Masonry Units."

1963 **Elmo C. Higginson** for work reported in his V. 58 paper, "Effect of Steam Curing on the Important Properties of Concrete."

1964 **J. J. Hromadik** for work reported in his V. 59 paper, "Column Strength of Long Piles."

1965 **Thomas T. C. Hsu, Floyd O. Slate, Gerald M. Sturman, George Winter**, and **Stanley Olsefski** for work reported in their V. 60 series of four papers: "Microcracking of Plain Concrete and the Shape of the Stress-Strain Curve;" "Mathematical Analysis of Shrinkage in a Model of Hardened Concrete;" "Tensile Bond Strength Between Aggregate and Cement Paste or Mortar;" and "X-Rays for Study of Internal Structure and Microcracking of Concrete."

1966 **M. L. Jones, L. D. Lutes**, and **G. M. Smith** for work reported in their V. 61 paper, "Dynamic Properties of Reinforced and Prestressed Concrete Structural Elements."

1967 **D. N. Acharya** and **K. O. Kemp** for work reported in their V. 62 paper, "Significance of Dowel Forces on the Shear Failure of Rectangular Reinforced Concrete Beams Without Web Reinforcement."

1968 **Alan D. Buck** and **W. L. Dolch** for work reported in their V. 63 paper, "Investigation of a Reaction Involving Nondolomitic Limestone Aggregate in Concrete."

1969 **Larry E. Farmer, Phil M. Ferguson**, and **Ugur Ersoy** for work reported in their V. 64 paper, "T-Beams Under Combined Bending, Shear, and Torsion."

1970 **W. Gene Corley** and **Neil M. Hawkins** for work reported in their V. 65 paper, "Shearhead Reinforcement for Slabs."

1971 **J. T. Dikeon, L. E. Kukacka, J. E. Backstrom**, and **M. Steinberg** for work reported in their V. 66 paper, "Polymerization Makes Tougher Concrete."

1972 **G. L. Kalousek and E. J. Benton** for work reported in their V. 67 paper, "Mechanism of Seawater Attack on Cement Pastes."

1973 **Rajinder Paul Lohtia and K. W. Nasser** for work reported in their V. 68 papers, "Creep of Mass Concrete at High Temperatures" and "Mass Concrete Properties at High Temperatures."

1974 **Tony C. Y. Liu, Arthur H. Nilson**, and **Floyd O. Slate** for work reported in their V. 69 paper, "Stress-Strain Response and Fracture of Concrete in Uniaxial and Biaxial Compression."

1975 **Norbert K. Becker** and **Cameron MacInnis** for work reported in their V. 70 paper, "Theoretical Method for Predicting the Shrinkage of Concrete."

1976 **Colin D. Johnston** and **Ronald A. Coleman** for two papers published in SP-44, *Fiber Reinforced Concrete*: "Steel Fiber Reinforced Mortar and Concrete: A Review of Mechanical Properties," by Johnston; and "Strength and Deformation of Steel Fiber Reinforced Mortar in Uniaxial Tension," by Johnston and Coleman.

1977 **George W. Washa** and **Kurt F. Wendt** for work reported in their V. 72 paper, "Fifty Year Properties of Concrete."

1978 **V. M. Malhotra** for his ACI monograph, *Testing Hardened Concrete: Nondestructive Methods*.

1979 **Phillip B. Bamforth** and **Roger D. Browne** for their V. 74 paper, "Tests to Establish Concrete Pumpability."

1980 **H. S. Lew** and **T. W. Reichard** for their paper, "Prediction of Strength of Concrete from Maturity," published in SP-56, *Accelerated Strength Testing*.

1981 **L. M. Meyer** and **W. F. Perenchio** for their paper, "Theory of Concrete Slump Loss as Related to the Use of Chemical Admixtures," published in *Concrete International: Design & Construction*, V. 1.

1982 **J. Floyd Best** and **Ralph O. Lane** for their paper, "Testing for Optimum Pumpability of Concrete," published in *Concrete International: Design & Construction*, V. 2.

1983 **Tony C. Liu** for his V. 78 paper, "Abrasion Resistance of Concrete."

1984 **Yasuhiko Yamamoto** and **Masaki Kobayashi** for their paper, "Use of Mineral Fines in High Strength Concrete—Water Requirements and Strength," published in *Concrete International: Design & Construction*, V. 4.

1985 **George C. Hoff** and **Alan D. Buck** for their V. 80 paper, "Considerations in the Prevention of Damage to Concrete Frozen at Early Ages."

1986 **Nicholas J. Carino** for his paper, "Laboratory Study of Flaw Detection by the Pulse-Echo Method," published in SP-82, *In Situ/Nondestructive Testing of Concrete*.

1987 **Bruce J. Giza** and **William C. Stone** for their paper, "The Effect of Geometry and Aggregate on the Reliability of the Pullout Test," published in *Concrete International: Design & Construction*, V. 7.

1988 **P. Kumar Mehta** for his V. 83 paper, "Effect of Fly Ash Composition on Sulfate Resistance of Cement."

1989 **T. Carmichael, R. Douglas Hooton, Prenab K. Mukherjee**, and **Val R. Sturrup** for their paper, "Evaluation and Prediction of Concrete Durability—Ontario Hydro's Experience," published in SP-100, *Concrete Durability*.

1990 **Grant T. Halvorsen** for his paper, "Code Requirements for Crack Control," published in SP-104, *Concrete and Concrete Construction*.

1991 **Mary J. Sansalone** and **Nicholas J. Carino** for their V. 86 paper, "Detecting Delaminations in Concrete Slabs With and Without Overlays Using the Impact-Echo Method," Mar.-Apr. 1989, *ACI Materials Journal*.

1992 **Francois Saucier, Michel Pigeon,** and **Patrick Plante** for their V. 87 paper, "Air-Void Stability Part III: Field Tests of Superplasticized Concretes," Jan.-Feb. 1990, *ACI Materials Journal*.

1993 **Vagelis G. Papadakis, Costas G. Vayenas**, and **Michael N. Fardis** for their V. 88 paper, "Fundamental Modeling and Experimental Investigation of Concrete Carbonation," July-Aug. 1991, *ACI Materials Journal*.

1994 **Nicholas J. Carino** and **Rajesh C. Tank** for their V. 89 paper, "Maturity Functions for Concretes Made with Various Cements and Admixtures," Mar.-Apr. 1992, *ACI Materials Journal*.

1995 **Emmanuel K. Attiogbe** for his V. 90 paper, "Mean Spacing of Air Voids in Hardened Concrete," Mar.-Apr. 1993, *ACI Materials Journal*.

1996 **Josée Duchesne** and **Marc-André Berubé** for their V. 91 paper, "Available Alkalies from Supplementary Cementing Materials," May-June 1994, *ACI Materials Journal*.

1997 **Nemkumar Banthia** and **Jean-Francois Trottier** for their V. 92 papers, "Test Methods for Flexural Toughness Characterization of Fiber Reinforced Concrete: Some Concerns and a Proposition (Part I)," Jan.-Feb. 1995, *ACI Materials Journal*; and "Concrete Reinforced with Deformed Steel Fibers—Part II: Toughness Characterization," Mar.-Apr. 1995, *ACI Materials Journal*.

1998 **Michael D. A. Thomas** and **John D. Matthews** for their paper, "Chloride Penetration and Reinforcement Corrosion in Fly Ash Concrete Exposed to a Marine Environment," published in SP-163, *Concrete in Marine Environment*.

1999 **Ping Gu, Sandra Elliot, Roumianna Hristova, James J. Beaudoin, Réjean Brousseau,** and **Bruce Baldock** for their V. 94 paper,, "Study of Corrosion Inhibitor Performance in Chloride Contaminated Concrete by Electrochemical Impedance Spectroscopy," Sept.-Oct. 1997, *ACI Materials Journal*.

2000 **Thomas D. Bush, Jr.** for his V. 95 paper, "Laboratory Test Procedures for Evaluating Concrete Treated with Sealers," July-Aug. 1998, *ACI Materials Journal*.

2001 **Ronald G. Burg, Michael A. Caldarone, Guy Detwiler, Daniel C. Jansen,** and **Terry J. Willems** for their paper, "Compression Testing of HSC: Latest Technology," published in *Concrete International*, V. 21.

2002 **Ulla H. Jakobsen, Peter Laugesen,** and **Niels Thaulow** for their paper, "Determination of Water-Cement Ratio in Hardenend Concrete by Optical Flourescence Microscopy" published in SP-191, *Water-Cement Ratio and Other Durability Parameters—Techniques for Determination*.

2003 **Paulo J. M. Monteiro, Kome Shomglin, H. R. Wenk,** and **Nicole P. Hasparyk** for their V. 98 paper, "Effect of Aggregate Deformation on Alkali-Silica Reaction," Mar-Apr. 2001, *ACI Materials Journal*.

2004 **Long T. Phan** and **Nicholas J. Carino** for their V. 99 paper, "Effects of Test Conditions and Mixture Proportions on Behavior of High-Strength Concrete Exposed to High Temperatures," Jan.-Feb. 2002, *ACI Materials Journal*.

ACI STRUCTURAL RESEARCH AWARD

The ACI Structural Research Award is given to the author or authors of a peer-reviewed paper published by the Institute that describes a notable achievement in experimental or analytical research related to structural engineering and, most importantly, recommends how the research can be applied to design. At least one of the recipients must be a member of the Institute. The award need not be presented each year.

Prior to 1991, this award was named the Raymond C. Reese Structural Research Award. Through 1997, the award was given for a paper published by the Institute describing a notable achievement in research related to structural engineering and indicating how the research could be used.

Recipients, given with year of award presentation, are:

1972 **James G. MacGregor, John E. Breen**, and **Edward O. Pfrang** for their V. 67 paper, "Design of Slender Concrete Columns."

1973 **Alexander Placas** and **Paul E. Regan** for their V. 68 paper, "Shear Failure of Reinforced Concrete Beams."

1974 **Phil M. Ferguson** and **K. S. Rajagopalan** for their V. 69 paper, "Distributed Loads Creating Combined Torsion, Bending, and Shear on L-Beams with Stirrups."

1975 **B. Vijaya Rangan** and **A. S. Hall** for their V. 70 paper, "Strength of Rectangular Prestressed Concrete Beams in Combined Torsion, Bending, and Shear."

1976 **Denis Mitchell** and **Michael P. Collins** for their V. 71 paper, "Diagonal Compression Field Theory—A Rational Model for Structural Concrete in Pure Torsion."

1977 **John Minor** and **James O. Jirsa** for their V. 72 paper, "Behavior of Bent Bar Anchorages."

1978 **Neil M. Hawkins** for his V. 73 paper, "Fatigue Design Considerations for Reinforcement in Concrete Bridge Decks."

1979 **John E. Breen, James O. Jirsa,** and **C. O. Orangun** for their V. 74 paper, "A Re-Evaluation of Test Data on Development Length and Splices."

1980 **Anders Losberg** for his V. 75 paper, "Pavements and Slabs on Grade with Structurally Active Reinforcement."

1981 **Neil M. Hawkins** and **Denis Mitchell** for their V. 76 paper, "Progressive Collapse of Flat Plate Structures."

1982 **Thomas Paulay** for his paper, "Deterministic Design Procedure for Ductile Frames in Seismic Areas," published in *Concrete International: Design & Construction*, V. 2.

1983 **Thomas Paulay** and **Roy G. Taylor** for their V. 78 paper, "Slab Coupling of Earthquake-Resisting Shearwalls."

1984 **Robert Park, M. J. Nigel Priestley**, and **Brian D. Scott** for their V. 79 paper, "Stress-Strain Behavior of Concrete Confined by Overlapping Hoops at Low and High Strain Rates."

1985 **Frank J. Heger** and **Mehdi S. Zarghamee** for their V. 80 paper, "Buckling of Thin Concrete Domes."

1986 **W. Gene Corley, J. D. Aristizabal-Ochoa, Kwok-Nam Shiu**, and **R. G. Oesterle** for their V. 81 paper, "Web Crushing of Reinforced Concrete Structural Walls."

1987 **Ahmet E. Aktan, Vitelmo V. Bertero, Finley A. Charney**, and **Richard Sause** for their paper, "Earthquake Simulator Tests and Associated Experimental, Analytical and Correlation Studies of One-Fifth Scale Model," published in SP-84, *Earthquake Effects on Reinforced Concrete Structures*.

1988 **James G. MacGregor** and **David M. Rogowsky** for their paper, "Design of Reinforced Concrete Deep Beams," published in *Concrete International: Design & Construction*, V. 8.

1989 **Robert Park** and **M. J. Nigel Priestley** for their V. 84 paper, "Strength and Ductility of Concrete Bridge Columns Under Seismic Loading," Jan.-Feb. 1987, *ACI Structural Journal*.

1990 **Sher Ali Mirza, Richard W. Furlong**, and **John S. Ma** for their V. 85 paper, "Flexural Shear and Ledge Reinforced Concrete Inverted T-Girders," July-Aug. 1988, *ACI Structural Journal*.

1991 **Neil M. Hawkins, Aibin Bao**, and **Jun Yamazaki** for their V. 86 paper, "Moment Transfer from Concrete Slabs to Columns," Nov.-Dec. 1989, *ACI Structural Journal*.

1992 **Sung-Woo Shin, Mahmoud Kamara**, and **Satyendra K. Ghosh** for their paper, "Flexural Ductility, Strength Prediction, and Hysteretic Behavior of Ultra-High-Strength Concrete Members," published in SP-121, *High Strength Concrete—Second International Symposium*.

1993 **Kent A. Paulson, Arthur H. Nilson**, and **Kenneth C. Hover** for their V. 88 paper, "Long-Term Deflection of High Strength Concrete Beams," Mar.-Apr. 1991, *ACI Materials Journal*.

1994 **Nader Panahshahi, Richard N. White**, and **Peter Gergely** for their V. 89 paper, "Reinforced Concrete Compression Lap Splices under Inelastic Cyclic Loading," Mar.-Apr. 1992, *ACI Structural Journal*.

1995 **Bilal S. Hamad** and **James O. Jirsa** for their V. 90 paper, "Strength of Epoxy-Coated Reinforcing Bar Splices Confined with Transverse Reinforcement," Jan.-Feb. 1993, *ACI Structural Journal*.

1996 **Hossain Hadje-Ghaffari, Oan Chul Choi, David Darwin**, and **Steven L. McCabe** for their V. 91 paper, "Bond of Epoxy-Coated Reinforcement: Cover, Casting Position, Slump, and Consolidation," Jan.-Feb. 1994, *ACI Structural Journal*.

1997 **William C. Stone, Geraldine S. Cheok**, and **John F. Stanton** for their V. 92 paper, "Performance of Hybrid Moment-Resisting Precast Beam-Column Concrete Connections Subjected to Cyclic Loading," Mar.-Apr. 1995, *ACI Structural Journal*.

1998 **Michael P. Collins, Denis Mitchell, Perry Adebar,** and **Frank J. Vecchio** for their V. 93 paper, "General Shear Design Method," Jan.-Feb. 1996, *ACI Structural Journal*.

1999 **Shamim A. Sheikh** and **Shafik S. Khoury** for their V. 94 paper, "Performance-Based Approach for the Design of Confining Steel in Tied Columns," July-Aug. 1997, *ACI Structural Journal*.

2000 **Robert K. Dowell, Frieder Seible,** and **Edward L. Wilson** for their V. 95 paper, "Pivot Hysteresis Model for Reinforced Concrete Members," Sept.-Oct. 1998 *ACI Structural Journal*.

2001 **Ashraf El-Bahy, Sashi Kunnath, William Stone,** and **Andrew Taylor** for their V. 96 paper, "Cumulative Seismic Damage of Circular Bridge Columns: Variable Amplitude Tests," Sept.-Oct. 1999, *ACI Structural Journal*.

2002 **Mervyn J. Kowalsky, M.J. Nigel Priestley,** and **Frieder Seible** for their V. 97 paper, "Dynamic Behavior of Lightweight Concrete Bridges," July-Aug. 2000, *ACI Structural Journal*.

2003 **Carlos G. Quintero-Febres** and **James K. Wight** for their V. 98 paper, "Experimental Study of Reinforced Concrete Interior Wide Beam-Column Connections Subjected to Lateral Loading," July-Aug. 2001, *ACI Structural Journal*.

2004 **James G. MacGregor** for his paper, "Derivation of Strut-and-Tie Models for the 2002 ACI Code," published in SP-208, *Examples for the Design of Structural Concrete with Strut-and-Tie Models*.

ACI CONSTRUCTION PRACTICE AWARD

Founded in 1944 by the Institute, the ACI Construction Practice Award is intended to enrich the literature in construction practices and to honor the workers whose resourcefulness produces a completed structure from drawings and specifications. It may be awarded annually, but not necessarily in each year, to the author or coauthors of any paper of outstanding merit on concrete construction practice published by ACI. It is not restricted to members of the Institute.

Recipients, given with year of award presented, are:

1946 **Lewis H. Tuthill** for his V. 41 paper, "Concrete Operations in the Concrete Ship Program."

1947 **J. W. Kelly** and **B. D. Keatts** for their V. 42 paper, "Two Special Methods for Restoring and Strengthening Masonry Structures."

1948 **Richard J. Wilson** for his V. 43 paper, "Lining of the Alva B. Adams Tunnel."

1949 **Raymond E. Davis, E. Clinton Jansen,** and **William T. Neelands** for their V. 44 paper, "Restoration of Barker Dam."

1950 **S. O. Asplund** for his V. 45 paper, "Strengthening Bridge Slabs with Grouted Reinforcement."

1951 **W. S. Colby** for his V. 46 paper, "Design and Construction of a Circulative Water Intake."

1952 **Otto Safir** for his V. 47 paper, "Precast Concrete Construction in Canada."

1953 **F. Thomas Collins** for his V. 48 paper, "Tilt-Up Construction in Western U.S."

1954 **Alden M. Klein** and **J. H. A. Crockett** for their V. 49 paper, "Design and Construction a Fully Vibration-Controlled Forging Hammer Foundation."

1957 **Roy R. Clark** for his V. 52 paper, "Bonneville Stilling Basin Repaired After 17 Years of Service."

1958 **James S. Minges** and **Donald S. Wild** for their V. 53 paper, "Six Stories of Prestressed Slabs Erected by Lift-Slab Methods."

1959 **Jack E. Rosenlund** for his V. 54 paper, "Construction of the Dallas Memorial Auditorium."

1960 **J. F. Camellerie** for his V. 55 paper, "Slip Form Details and Techniques."

1962 **Andre Paduart** and **J. Van Doosselaere** for their V. 57 paper, "Design and Construction of the Civil Engineering 'Arrow' at the Brussels International Exhibition."

1963 **Arthur R. Anderson** and **A. T. Waidelich** for their V. 58 paper, “Prestressed and Precast Concrete Building at Boeing Plant.”

1964 **Joseph R. Proctor, Jr.** for his V. 59 paper, “Economics of Formwork Planning.”

1965 **James B. Lyttle** for his V. 60 paper, “Unique Roof Construction at Dulles Airport.”

1966 **Andrew R. Nasser** for his V. 61 paper, “Construction of Buttressed Dome Segment.”

1967 **E. R. Cancio** and **A. F. Munoz** for their V. 62 paper, “Small Precast Concrete Pieces Make Up a Medium Span Prestressed Bridge.”

1968 **Everette W. Osgood** and **James M. Keith** for their V. 63 paper, “Construction of the Accelerator Housing at the Stanford Linear Accelerator Center.”

1969 **Lin Y. Huang, N. P. Angeles, Howard R. May, Keith C. Thornton,** and **Jack L. Korb** for their V. 64 paper, “Design and Construction of North Terminal Building at the Detroit Metropolitan Airport.”

1970 **David J. Fitzgerald** for his V. 65 paper, “Construction of Habitat ‘67.”

1971 **John J. White** for his paper, “The Anchorage of Engineered Structures of Concrete and Other Foundations,” published in SP-22, *Mechanical Fasteners for Concrete*.

1974 **Charles Novacek** for his V. 69 paper, “Construction of the Walter P. Chrysler Building, Highland Park, Michigan.”

1975 **Kenneth G. Jessop** for his V. 70 paper, “Philosophy of Formwork in Civil Engineering.”

1976 **William Rohde, Kenneth D. Wheeler, Jesse Schwartz, Raymond D. Heun, Charles Shimel,** and **Joseph R. Wolf** for their V. 71 paper, “Responsibility in Concrete Inspection.”

1977 **Arvid Grant** for his V. 72 paper, “Incremental Launching of Concrete Structures.”

1978 **Frank A. Randall, Jr.** and **Peter D. Courtois** for their V. 73 paper, “Side Form Spacers.”

1979 **David Brown** for his V. 74 paper, “Bridge Deck Deterioration: Some Solutions.”

1980 **H. W. Chung** for his V. 75 paper, “How Good is Good Enough—A Dilemma in Acceptance Testing of Concrete.”

1981 **John A. Bickley** for his paper, “Mass Production of Highly Toleranced Precast Concrete Tunnel Segments,” published in *Concrete International: Design & Construction*, V. 1.

1982 **Mary K. Hurd** for her paper, “Denny Creek Bridge: A Concrete Answer to Environmental Challenges,” published in *Concrete International: Design & Construction*, V. 2.

1983 **Raymond C. Heun** for his paper, “Specifications—Are They Adequate?” published in *Concrete International: Design & Construction*, V. 3.

1984 **Richard C. Meininger** for his paper, “Ordering Quality Concrete for Residential or Commercial Jobs,” published in *Concrete International: Design & Construction*, V. 4.

1985 **Cameron Kemp** and **Gerry Weiler** for their paper, “Tilt-Up Construction of a Shopping Center” published in *Concrete International: Design & Construction*, V. 5.

1986 **Donald F. Meinheit** and **Jack F. Monson** for their paper, “Parking Garage Repaired Using Thin Polymer Concrete Overlay,” published in *Concrete International: Design & Construction*, V. 6.

1987 **James M. Shilstone, Sr.** for his paper, “Architectural Concrete Contract Documents,” published in *Concrete International: Design & Construction*, V. 7.

1988 **Mary K. Hurd** for her paper, “Segmental Box-Girder Bridge Construction,” published in *Concrete International: Design & Construction*, V. 8.

1989 **Ernest K. Schrader** for his paper, “Compaction of Roller Compacted Concrete,” published in SP-96, *Consolidation of Concrete*.

1990 **Paul Gilbride, Dudley R. Morgan,** and **Theodore W. Bremner** for their paper, “Deterioration and Rehabilitation of Berth Faces in Tidal Zones at the Port of Saint John,” published in SP-109, *Concrete in Marine Environment*.

1991 **Terence C. Holland** for his paper, “Working with Silica Fume in Ready Mixed Concrete—U.S.A. Experience,” published in SP-114, V. 2, *Fly Ash, Silica Fume, Slag, Natural Pozzolans in Concrete*.

1992 **M. P. Virlogeux** for his paper, “External Prestressing: From Construction History to Modern Technique and Technology,” published in SP-120, *External Prestressing in Bridges*.

1994 **Edward B. Finkel** for his paper, “The (Un)Common Industrial Concrete Floor Slab on Grade,” published in *Concrete International*, V. 14.

1995 **John S. Beebe** and **Robert R. McGlohn** for their paper, “Installing and Testing Large Adhesive Anchors,” published in *Concrete International*, V. 15.

1996 **Phillip S. Dunston**, **David W. Johnston**, and **Paul P. McCain** for their paper, “Formwork Pressures in Tall Walls with Extended Set Concrete,” published in *Concrete International*, V. 16.

1997 **Jerome H. Ford** for his paper, “Vertical Forming in Congested Areas,” published in *Concrete International*, V. 17.

1998 **Keith Kesner** and **Randall W. Poston** for their paper, “Unbonded Post-Tensioned Concrete Corrosion: Myths, Misconceptions, and Truths,” published in *Concrete International*, V. 18.

1999 **P. Kumar Mehta** for his paper, “Durability—Critical Issues for the Future,” published in *Concrete International*, V. 19.

2000 **Peter H. Emmons, Alexander M. Vaysburd,** and **Jay Thomas** for their paper, “Strengthening Concrete Structures, Part I,” and “Strengthening Concrete Structures, Part II,” both published in *Concrete International*, V. 20.

2001 **Kevin M. Cail, Jack J. Holley, Donald S. Hopkins, Marie-Christine Lanctôt,** and **Michael D. A. Thomas** for their paper “Custom HPC Mixtures for Challenging Bridge Design,” published in *Concrete International*, V. 21.

2002 **G. R. Shashaani, Jim Vahman, and Ed D. Valdez** for their paper, “24 Steps to Successful Floor Slabs” published in *Concrete International*, V. 22

2003 **Donald A. Bailey, Edward J. Barbour, Scott W. Cupp, Jerry A. Holland,** and **David W. Knight** for their paper, “Gatorade Floor: Quenching Thirst, Joints, Cracks, and Cure” published in *Concrete International*, V. 23.

2004 **Richard Morin, Gilbert Haddad,** and **Pierre-Claude Aitcin** for their paper, “Crack Free, High-Performance Concrete Structures,” published in *Concrete International*, V. 24.

ACI DESIGN PRACTICE AWARD

This award recognizes advanced concepts and techniques applied to a specific design practice or project. Awards are given to the author or coauthors of the paper and to the engineer or engineering firm responsible for design. Institute membership is not required, peer review is not required, and the award may be given annually, but not necessarily.

From 1997-2000, the award was named the Structural Engineering Award and was given for advanced concepts and techniques related to structural engineering. Up until 1997, the award was named the Maurice P. van Buren Structural Engineering Award and was given for a completed outstanding concrete building project incorporating advanced structural design concepts, advanced structural design techniques, or both, described in a paper published by the Institute.

Recipients, given with year of award presented, are:

1983 **Joseph P. Colaco, Jay B. Ames,** and **Eli R. Dubinsky** for their paper, "Concrete Shear Walls and Spandrel Beam Moment Frame Brace New York Office Tower," published in *Concrete International: Design & Construction*, V. 3.

1986 **Irwin Cantor** and **Ysrael A. Seinuk** for their paper, "Trump Tower: Concrete Satisfies Architectural, Design, and Construction Demands," published in *Concrete International: Design & Construction*, V. 6.

1987 **Jacob S. Grossman** for his paper, "780 Third Avenue—The First High-Rise Diagonally Braced Concrete Structure," published in *Concrete International: Design & Construction*, V. 7.

1988 **Harald G. Greve** for his paper, "Precast for Terra Cotta," published in *Concrete International: Design & Construction*, V. 8.

1989 **Mohammad Abul Mansur, Seng-Lip Lee**, and **P. Paramasivam** for their paper, "Ferrocement Sunscreens on High Rise Buildings," published in *Concrete International: Design & Construction*, V. 9.

1990 **Bijan O. Aalami** and **David T. Swanson** for their paper, "Innovative Rehabilitation of a Parking Structure," published in *Concrete International*, V. 10

1991 **Bill L. Gunnin** for his paper, "Market Tower—Indianapolis, Ind.," published in *Concrete International*, V. 11.

1992 **M. A. Mansur** for his paper, "Design and Construction of an Elevated Ferrocement Water Tank," published in *Concrete International*, V. 12.

1995 **Javier F. Horvilleur** for his paper, "The Nations Bank Tower," published in *Concrete International*, V. 15.

1996 **Richard Smart** for his paper, "Edmonds Centre for B. C. Hydro," published in *Concrete International*, V. 16.

1997 **Arthur J. O'Leary** for his paper, "Multi-Story Precast Concrete Framed Buildings," published in SP-157, *Recent Developments in Lateral Force Transfer in Buildings*.

1998 **Jeffery T. Miller** and **Lawrence D. Reaveley** for their paper, "Hotel Utah Remodel and Seismic Upgrade," published in SP-160, *Seismic Rehabilitation of Concrete Structures*.

1999 **Michael P. Collins, Frank J. Vecchio, Robert G. Selby,** and **Pawan R. Gupta** for their paper, "The Failure of an Offshore Platform," published in *Concrete International*, V. 19.

2000 **Amin Ghali** and **Walter H. Dilger** for their paper, "Anchoring with Double-Head Studs," published in *Concrete International*, V. 20.

2001 **Sameh S. Badie, Mantu C. Baishya,** and **Maher K. Tadros** for their paper, "Innovative Bridge Panel Systems a Success," published in *Concrete International*, V. 21.

2002 **Sarah L. Billington, Stephen B. Ratchye, John E. Breen,** and **D. Andrew Vernooy** for their paper, "Example Applications of Aesthetics and Efficiency Guidelines" published in *Concrete International*, V. 22.

2003 **Edward G. Nawy** for his paper, "Design for Crack Control in Reinforced and Prestressed Concrete Beams, Two-Way Slabs and Circular Tanks—A State of the Art" published in SP-204, *Design and Construction Practices to Mitigate Cracking*.

2004 **Tjen Nung Tjhin** and **Daniel Kuchma** for their paper, "Example 1b: Alternative Design for the Non-Slender Beam (Deep Beam)," published in SP-208, *Examples for the Design of Structural Concrete with Strut-and-Tie Models*.

HENRY C. TURNER MEDAL

The Henry C. Turner Medal was founded in 1927 by Henry C. Turner, past president, American Concrete Institute. It is awarded for notable achievements in, or service to, the concrete industry. In making selections for the Turner Medal, the committee is not restricted to members of the Institute nor to the achievements of any particular period. It may be awarded once in any year, but not necessarily in each year.

Recipients, given with year of award presented, are:

1928 **Arthur N. Talbott**
1929 **William K. Hatt**
1930 **Frederick E. Turneaure**
1932 **Duff A. Abrams**
1934 **John J. Earley**
1939 **Phaon H. Bates**
1943 **Ben Moreell**
1946 **John Lucian Savage**
1947 **Morton O. Withey**
1952 **Raymond E. Davis**
1955 **Roderick B. Young**
1956 **Franklin R. McMillan**
1957 **Albert T. Goldbeck**
1958 **Herbert J. Gilkey**
1959 **Douglas E. Parsons**
1960 **Harrison F. Gonnerman**
1961 **Stanton Walker**
1962 **Karl P. Billner**
1963 **Charles H. Scholer**
1964 **Chester P. Siess**
1965 **Douglas McHenry**
1966 **Lewis H. Tuthill**
1967 **Roy W. Carlson**
1968 **Milo S. Ketchum**
1969 **Roger H. Corbetta**
1970 **Harry B. Zackrison, Sr.**
1971 **George E. Warren**
1972 **George Winter**
1973 **Bryant Mather**
1974 **Ben C. Gerwick**
1975 **William A. Maples**
1976 **Phil M. Ferguson**
1977 **Raymond C. Reese**
1978 **Arthur R. Anderson**
1979 **Solomon Cady Hollister**
1980 **William M. Avery**
1981 **Walter H. Price**
1982 **Edward A. Abdun-Nur**
1983 **V. Mohan Malhotra**
1984 **Robert E. Philleo**
1985 **Material Service Corp**
1986 **Robert E. Englekirk**
1987 **I. Leon Glassgold**
1988 **Anton Tedesko**
1989 **W. Gene Corley**
1990 **Charles J. Pankow**

1991	Daniel P. Jenny
1992	Clifford L. Freyermuth
1993	Norman L. Scott
1994	James S. Pierce
1995	Mary K. Hurd
1996	Emery Farkas
1997	Anthony E. Fiorato
1998	Samuel J. Henry
1999	H. S. Lew
2000	George F. Leyh
2001	Adam M. Neville
2002	Thomas B. Battles
2003	Michel Virlogeux
2004	L. Michael Shydlowski

ALFRED E. LINDAU AWARD

The Alfred E. Lindau Award was founded in 1947 by the Concrete Reinforcing Steel Institute to honor the memory of Alfred E. Lindau, past president of the American Concrete Institute. The award shall be given only for outstanding contributions to reinforced concrete design practice and is not mandatory each year. Any and all persons, firms, or corporations are eligible to compete for and receive the award.

Recipients, given with year of award presented, are:

1950	Frank E. Richart
1951	Charles S. Whitney
1952	Douglas E. Parsons
1953	Franklin R. McMillan
1956	John I. Parcel
1957	Raymond C. Reese
1958	A. Amirikian
1960	Arthur R. Lord
1961	Anton Tedesko
1962	Pier Luigi Nervi
1963	Carl A. Menzel
1964	Alfred L. Parme
1965	Felix Candela
1966	Richard R. Bradshaw
1967	Nicolas Esquillan
1968	Arthur R. Anderson
1969	E. E. Rippstein J. F. Seifreid
1970	Alan H. Mattock
1971	Clyde E. Kesler
1972	Phil M. Ferguson
1973	Fazlur R. Khan
1974	Max Zar
1975	Roger Nicolet
1976	Hubert Rüsch
1977	Eivind Hognestad
1978	Mark Fintel
1979	Maurice P. van Buren
1981	Armand H. Gustaferro
1982	Paul F. Rice
1983	Richard M. Gensert
1984	Robert E. Englekirk
1985	John A. Martin
1986	James O. Jirsa
1987	James R. Clifton Robert G. Mathey
1988	Arvid Grant
1989	Jacob S. Grossman
1990	James R. Libby
1991	Edward S. Hoffman
1992	Walter P. Moore, Jr.
1993	Mete A. Sozen
1994	John E. Breen
1995	Hiroyuki Aoyama
1996	Ignacio Martín
1997	Bruno Thürlimann
1998	Jack P. Moehle
1999	Loring A. Wyllie, Jr.
2000	W. Gene Corley
2001	James G. MacGregor
2002	James R. Cagley
2003	Luis E. García
2004	S. K. Ghosh

HENRY L. KENNEDY AWARD

The Henry L. Kennedy Award was established in 1958 by the Institute to honor the late Henry L. Kennedy, an extremely active Institute member who was a past president and, at the time of his death, chairman of the Institute's Building Committee.

The award is given only for outstanding technical or administrative service to the Institute and is not mandatory each year. The basis for selection of awardees is outstanding activity or service that has enhanced the Institute's prestige, marked leadership in technical, administrative, or special committee work, or other distinguished service to the Institute. Except under unusual circumstances, honorary members, past presidents, and current officers and directors are not considered for this award.

Recipients, given with year of award presented, are:

1959	Joseph DiStasio, Sr.
1960	Harry C. Delzell
1961	A. Allan Bates
1962	Robert C. Johnson
1963	Ivan L. Tyler
1964	Raymond C. Reese
1965	Walter H. Price
1966	Stephen J. Chamberlin
1967	John P. Thompson
1968	Samuel Hobbs
1969	Bruce E. Foster
1970	Walter J. McCoy
1971	Eivind Hognestad
1972	Edward G. Nawy
1973	Richard C. Mielenz
1974	Emil Schmid
1975	John Arvid "Bob" Hanson
1976	Thomas J. Reading
1977	Bertold E. Weinberg
1978	V. M. Malhotra
1979	Francis J. Principe
1980	Samuel J. Henry
1981	Emery Farkas
1982	James R. Libby
1983	George C. Hoff
1984	Gerald B. Neville
1985	Loring A. Wyllie, Jr.
1986	Clarkson W. Pinkham
1987	Joseph A. Dobrowolski
1988	Peter D. Courtois
1989	Thomas J. Pasko
1990	H. S. Lew
1991	William R. Tolley
1992	Dean E. Stephan
1993	Kenneth H. Murray
1994	Richard D. Gaynor
1995	William J. Wilhelm
1996	Douglas W. Deno
1997	Merlyn Isaak
1998	Charles Pankow Builders, Ltd.
1999	Daniel L. Baker James R. Cagley Norman L. Scott
2000	James R. Cagley
2001	Howard R. May
2002	Anthony E. Fiorato
2003	George B. Barney
2004	Catherine E. French

CHARLES S. WHITNEY MEDAL

The Charles S. Whitney Medal for Engineering Development was founded in 1961 by Ammann and Whitney, to honor the memory of Charles S. Whitney. It may be bestowed once in any year, but not necessarily in each year, for noteworthy engineering development work in concrete design or construction. The recognition may be extended to a firm or agency alone, or to an individual.

Any outstanding engineering development work contributing importantly, through development of general engineering practice or through application in specific noteworthy projects, to the advancement of the sciences or arts of concrete design or construction is eligible.

Recipients, given with year of award presented, are:

1966	**The Engineering Experiment Station, University of Illinois**
1967	**Ulrich Finsterwalder** and the engineering firm of **Dykerhoff and Widmann**
1968	**Eero Saarinen** and associates **Kevin Roche, John Dinkeloo,** and **Joseph Lacy**
1969	**Eric L. Erickson** and the **Bridge Division, U.S. Bureau of Public Roads**
1970	**Ammann and Whitney**

1971 Engineering Materials Laboratory, University of California, Berkeley
1972 The Research and Development Laboratories of the **Portland Cement Association**
1973 The Bureau of Reclamation, Engineering Laboratory
1974 Concrete Laboratory, Waterways Experiment Station, Corps of Engineers
1975 Concrete Technology Corporation, Tacoma, Washington
1976 The Research and Development Division of the **Cement and Concrete Association**
1977 Wiss, Janney, Elstner and Associates, Inc.
1978 Bechtel Power Corporation
1979 The Center for Building Technology, National Bureau of Standards
1980 The Phil M. Ferguson Structural Engineering Laboratory of the **University of Texas, Austin**
1981 T.Y. Lin International
1983 Figg and Muller Engineering, Inc.
1984 U.S. Naval Engineering Laboratory
1986 Sargent & Lundy
1987 Stewart C. Watson
1988 The Laboratories at the **Department of Structural Engineering, Cornell University**
1989 The Structural Research Laboratories, Department of Civil Engineering, University of Toronto
1990 Canada Centre for Mineral and Energy Technology (CANMET)
1992 Berger/ABAM Engineers, Inc.
1993 Concrete Reinforcing Steel Institute
1994 Structural Engineering Laboratory, Canterbury University, Christchurch, New Zealand
1995 Figg Engineering Group
1996 The Charles Lee Powell Structural Research Laboratories at **University of California, San Diego**
1997 Hibernia Management and Development Company
1998 Strait Crossing, Inc.
1999 Construction Technology Laboratories, Inc.
2001 Walter P. Moore & Associates, Inc.
2002 The Thornton-Tomasetti Group, Inc.
2003 Morley Construction Company
2004 Charles Pankow Builders, Ltd.

ARTHUR R. ANDERSON AWARD

The Arthur R. Anderson Award was established in 1972 by the Institute in recognition of Arthur R. Anderson, past president of the Institute, for his imaginative and outstanding leadership and insistence on excellence of concrete quality for engineering works.

The award is given for outstanding contributions to the advancement of knowledge of concrete as a construction material and need not be presented each year. All persons, firms, corporations, or organizations are eligible to receive the award.

Recipients, given with year of award presented, are:

1973 Adam M. Neville
1974 George J. Verbeck
1975 Milos Polivka
1976 T. C. Powers
1977 Levi S. Brown
1978 Richard D. Gaynor
1979 Joseph J. Waddell
1980 Paul Klieger
1981 Robert E. Philleo
1982 Katharine Mather
1983 Floyd O. Slate
1984 Robert E. Tobin
1985 William L. Dolch
1986 Boris Bresler
1987 John E. Breen
1988 David C. Stark
1989 Surendra P. Shah
1990 Vitelmo V. Bertero
1991 Thomas T. C. Hsu
1992 David Darwin
1993 Sidney Diamond
1994 Henry G. Russell
1995 Pierre-Claude Aïtcin
1996 John M. Scanlon
1997 M. J. Nigel Priestley
1998 National Aggregates Association and the National Ready Mixed Concrete Association
1999 Advanced Cement-Based Materials at Northwestern University
2000 Peter H. Emmons
2001 Bryant Mather
2002 Per Fidjestøl
2003 Robert F. Mast
2004 Clifford L. Freyermuth

ROGER H. CORBETTA CONCRETE CONSTRUCTOR AWARD

The Roger H. Corbetta Concrete Constructor Award was established in 1972 in recognition of Roger H. Corbetta, past president of the Institute, for his creative leadership and his many outstanding contributions to the use of concrete for construction.

The award is given to an individual or an organization who, or which, as a constructor, has made significant contributions to progress in methods of concrete construction. The award need not be presented each year.

Recipients, given with year of award presented, are:

1973 Arthur R. Anderson
1974 Charles J. Pankow
1975 Knut Tovshus
1976 Phillip R. Jackson
1977 Michael A. Lombard
1978 Charles J. Prokop
1980 Gerald M. Miller
1981 Ben C. Gerwick, Jr.
1983 Ontario Hydro-Electric Power Commission
1984 Cecil V. Wellborn
1985 Richard E. "Jeff" Kasler
1986 E. Robert Jean
1987 Paul H. Sommers
1988 Eugene H. Boeke
1989 Norwegian Contractors
1991 Sam Kurtz
1992 Jaime Moreno
1993 Daniel L. Baker
1994 William R. Phillips
1995 James E. Cook
1997 C. Raymond Hays
1998 C. Terry Dooley
1999 Thomas D. Verti
2000 Robert A. Epifano
2001 Dean E. Stephan
2002 Myles A. Murray
2003 Brad D. Inman
2004 Alphonse E. Engelman

JOE W. KELLY AWARD

The Joe W. Kelly Award was established in 1974 in recognition of the contributions of Joe W. Kelly, past president of the Institute, to concrete technology, his devotion to teaching, the advancement of his profession, and the use of concrete in construction. The award is given only for outstanding contributions to education in the broad field of concrete and need not be given each year.

Awardees given with the year of of award presented, are:

1975 William A. Cordon
1976 Mete A. Sozen

1977 **Phil M. Ferguson**
1978 **Boris Bresler**
1979 **George Winter**
1980 **Edward L. Kawala**
1981 **John E. Breen**
1982 **Cutberto Diaz-Gomez**
1983 **Charles G. Salmon**
1984 **Noel J. Everard**
1985 **Paul Zia**
1986 **James G. MacGregor**
1987 **William J. Wilhelm**
1988 **Boyd C. Ringo**
1989 **Ronald H. Hall**
1990 **Ned H. Burns**
1991 **Alan H. Mattock**
1992 **Richard N. White**
1993 **Roger E. Wilson**
1994 **Michael P. Collins**
1995 **Luke M. Snell**
1996 **Neil M. Hawkins**
1997 **James O. Jirsa**
1998 **Teodoro E. Harmsen**
1999 **James K. Wight**
2000 **Luis E. Garcia**
2001 **Kenneth C. Hover**
2002 **Sharon L. Wood**
2003 **Portland Cement Association**
2004 **Sher Ali Mirza**

DELMAR L. BLOEM DISTINGUISHED SERVICE AWARD

The Institute established a Distinguished Service Award in 1969 to recognize noteworthy work on ACI technical committees. The name of the award was changed to the Delmar L. Bloem Distinguished Service Award in 1972 in honor of the late Delmar L. Bloem because he had demonstrated, over a period of many years, the characteristics and dedication required for the award. The award is given to a current (or recent) chairman of a technical committee, or under special circumstances, to deserving individuals other than committee chairmen, in recognition of outstanding performance. One award may be given each year; however, there may be none or more than one recipient in any particular year.

Recipients, given with year of award presented, are:

1970 **Russell S. Fling**
J.A. Hanson
Paul Klieger
W. H. Kuenning
George H. Nelson
Joseph R. Proctor, Jr.
Thomas J. Reading
Lewis H. Tuthill
1971 **Noel J. Everard**
Ernest C. Fortier
Shut'ien Li
1972 **Hector L. King**
Albyn Mackintosh
Robert E. Price
Peter Smith
1973 **Edward Cohen**
George F. Leyh
M. Daniel Vanderbilt
1974 **Calvin C. Oleson**
W. Gordon Plewes
1975 **Fritz Kramrisch**
James G. MacGregor
1976 **Joseph A. Dobrowolski**
John M. Hanson
T. E. Northrup
1977 **Richard C. Mielenz**
Howard Newlon, Jr.
1978 **W. Gene Corley**
Eugene P. Holland
1979 **Peter D. Courtois**
I. Leon Glassgold
Eric C. Smith
1980 **James T. Dikeou**
J. R. Dise
Eivind Hognestad
1981 **Peter Gergely**
Donald L. Houghton
Byron I. Zolin
1982 **William C. Black**
A. Ernest Fisher, III
Richard S. Orr
1983 **V. Mohan Malhotra**
1984 **Theodore R. Crom**
Charles G. Salmon
Harry Stavrides
Stewart C. Watson
1985 **Ralph L. Duncan**
David W. Fowler
Timothy J. Fowler
Mete A. Sozen
1986 **David Darwin**
Charles H. Henager
Henry G. Russell
1987 **James L. Cope**
David G. Manning
1988 **Jal N. Birdy**
Geoffrey Frohnsdorff
Robert W. Gaul
1989 **Richard O. Albright**
John E. Breen
David P. Gustafson
Gary R. Mass
1990 **Mario J. Catani**
Mary K. Hurd
James O. Jirsa
1991 **Bryant Mather**
James K. Wight
1992 **James P. Allen, III**
John E. Sadler
John M. Scanlon
Dean E. Stephan
1993 **Nicholas J. Carino**
Grant T. Halvorsen
Douglas D. Lee
Paul R. Stodola
1994 **Harry A. Chambers**
T. D. Lin
John F. McDermott
1995 **Daniel P. Jenny**
D. Gerry Walters
1996 **James Colville**
Timothy L. Moore
Arthur J. Mullkoff
1997 **Terence C. Holland**
Basile G. Rabbat
Harold R. Sandberg
1998 **John A. Bickley**
W. Barry Butler
Charles A. Zalesiak
1999 **Michael J. Boyle**
Charles W. Dolan
Peter Mendis
Antonio Nanni
2000 **James R. Cagley**
Julio A. Ramirez
2001 **Jack P. Moehle**
Charles S. Hanskat
Richard E. Wollmershauser
2002 **Claude E. Jaycox**
Nicholas A. Legatos
Jan Olek
2003 **Robert C. O'Neill**
David W. Johnston
Richard S. Orr
2004 **Stephen B. Tatro**
James E. Cook
Sami H. Rizkalla
Tony C. Liu

CEDRIC WILLSON AWARD

The Cedric Willson Award was established by the Northeast Texas Chapter and approved by the ACI Board of Direction in 1976 in recognition of Cedric Willson's many contributions in the field of lightweight aggregate, lightweight concrete, and lightweight concrete masonry. The award is given for outstanding contributions to one or more of these fields. A person, firm, or organization is eligible for the award. The award need not be given annually.

Recipients, given with the year of award presented, are:

1977 **J. A. "Bob" Hanson**
1978 **Frank G. Erskine**
1979 **Robert E. Tobin**
1980 **Truman R. Jones, Jr.**
1982 **Joseph J. Shideler**
1984 **Thomas A. Holm**
1986 **John W. Roberts**
1988 **Theodore W. Bremner**
1992 **Leonard S. Hobbs**
1995 **George C. Hoff**
1997 **V. Mohan Malhotra**
1999 **Richard W. Kriner**
2000 **Alexander M. Vaysburd**
2002 **David A. Crocker**

CHAPTER ACTIVITIES AWARD

The Chapter Activities Award was founded in 1975 to recognize outstanding service in the promotion and development of a chapter or chapters by a member of ACI International. Nominations are made by the Chapter Activities Committee, and recommendations are approved by the Board. As of 2003, CAC recognizes both a domestic and international awardee. The award need not be presented each year.

Recipients, given with the year of award presented, are:

1976	**Gajanan M. Sabnis**	**1991**	**James S. Lai**
1977	**V. M. Malhotra**	**1992**	**T. Z. Chastain**
1978	**Edward G. Nawy**	**1993**	**Ronald E. Vaughn**
1979	**Joseph A. Dobrowolski**	**1995**	**H. S. Lew**
1980	**Everette W. Osgood**	**1996**	**Robert E. Tobin**
1981	**Robert D. Babine**	**1997**	**Luke M. Snell**
1982	**Jairo Uribe Escamilla**	**1998**	**James A. Kolakowski**
1983	**Ramesh N. Raikar**	**1999**	**Lorenzo Flores-Castro**
1984	**C. Taylor Test**	**2000**	**William L. Barringer**
1985	**Kenneth D. Cummins**	**2001**	**LaGrit F. "Sam" Morris**
1986	**Robert G. Lee**	**2002**	**Dianne Johnston**
1987	**George C. Hoff**	**2003**	**William E. Rushing, Jr.**
1988	**Claude B. Trusty, Jr.**		**S. K. Manjrekar**
1989	**I. Leon Glassgold**	**2004**	**Robert H. Kuhlman**
1990	**Ramon F. Gutierrez**		**Naji Al Mutairi**

ACI YOUNG MEMBER AWARD FOR PROFESSIONAL ACHIEVEMENT

The ACI Young Member Award for Professional Achievement was established in 1997 by ACI's Board of Direction to recognize the significant contributions made by ACI's younger members. Nominees must be 35 years of age or less at the time the completed nomination form is recieved at headquarters. Nominations can be made by an ACI member or chapter; self-nominations are not considered. No more than three recipients will be named in any year. The award need not be given annually.

Recipients, given with year of award presented, are:

1999	**David B. McDonald**	**2002**	**Robert J. Frosch**
	Kelly M. Page		**Kevin J. Folliard**
	Chetan R. Raikar	**2003**	**Moncef L. Nehdi**
2000	**Debrethann R. Orsak**	**2004**	**Alejandro Durán-Herrera**
	Jean-Francois Trottier		**Andrea J. Schokker**
2001	**Kevin A. MacDonald**		
	Rajalingam Valluvan		

WALTER P. MOORE, JR. FACULTY ACHIEVEMENT AWARD

The Walter P. Moore, Jr. Faculty Achievement Award recognizes new faculty members for excellence and innovation in the teaching of concrete design, materials, or construction. The award honors the late Walter P. Moore, Jr., ACI Fellow, former ACI Board member, and a structural engineer and educator in Texas. The award recipient shall have taught an undergraduate level course related to concrete structural design, concrete materials, or concrete construction; total time served in all faculty positions shall not exceed seven calendar years; the individual shall be an ACI member; evidence of technical competence, high character, and integrity; and other evidence of merit, which, in the judgment of the award committee, shall have advanced ACI's and awards purposes. An ACI member or student chapter can submit nominations to ACI headquarters.

Recipients are:

2002 F. Michael Bartlett
2003 Norbert J. Delatte, Jr.
2004 W. Jason Weiss

LECTURE SERIES

ACI Commemorative Lecture Series

The ACI Commemorative Lecture Series, beginning in the fall of 1998, replaced the expired Phil M. Ferguson Lecture Series. A new series was established on a multi-year cycle to commemorate prominent deceased members. Each year, a speaker is selected by a board committee appointed by ACI's president, with the lecture being presented at the following fall convention. The first Commemorative Lecture Series (1998-2000) was in honor of George Winter. The second Commemorative Lecture Series (2001-2005) will be in honor of Lewis H. Tuthill. The lecture subjects are chosen by the speaker and can relate to the entire range of Institute interest. The only qualification requirement for a speaker is that he or she is outstanding in the concrete field.

Previous lecturers in the R. E. Davis Lecture Series were:

1972	**Roy W. Carlson**	**1980**	**Roy Rowe**
1973	**Howard H. Newlon, Jr.**	**1981**	**W. Burr Bennett**
1974	**Richard C. Mielenz**	**1982**	**Boris Bresler**
1975	**Peter Smith**	**1983**	**Gunnar M. Idorn**
1976	**Lewis H. Tuthill**	**1984**	**Ben C. Gerwick, Jr.**
1977	**Halvard H. Birkeland**	**1985**	**Elvind Hognestad**
1978	**John E. Breen**	**1986**	**Charles J. Pankow**
1979	**Paul Klieger**	**1987**	**Robert E. Philleo**

Previous lecturers in the Phil M. Ferguson Lecture Series were:

1988	**James G. MacGregor**	**1993**	**Russell S. Fling**
1989	**Alan H. Mattock**	**1994**	**Jörg Schlaich**
1990	**Bruno Thurlimann**	**1995**	**Mete A. Sozen**
1991	**W. Gene Corley**	**1996**	**Hajime Okamura**
1992	**Anton Tedesko**	**1997**	**Michael P. Collins**

Previous lecturers in the ACI Commemorative Lecture Series honoring George Winter were:

1998 Richard N. White
1999 Hiroyuki Aoyama
2000 James O. Jirsa

The lecturers in the ACI Commemorative Lecture Series honoring Lewis H. Tuthill are:

2001	**P. Kumar Mehta**	**2004**	**V. Mohan Malhotra**
2002	**Bryant Mather**		
2003	**James S. Pierce**		

ROBERT E. PHILLEO AWARD (CONCRETE RESEARCH COUNCIL)

The Robert E. Philleo Award of the Concrete Research Council, American Concrete Institute, established in 1992, is given in recognition of a person, persons, or an organization for outstanding research in the concrete materials field, or for outstanding contributions to the advancement of concrete technology through application of the results of concrete materials research. It is given in memory of an Institute past president and Honorary Member who was also chair of the Concrete Materials Research Council, now the Concrete Research Council.

Recipients, given with the year of award presented, are:

1992 **Bryant Mather**
1993 **David C. Stark**
1994 **Richard C. Mielenz**
1995 **Paul Klieger**
1996 **V. Mohan Malhotra**
1997 **John M. Scanlon**
1998 **R. Narayan Swamy**
1999 **Richard D. Gaynor**
2000 **Venkataswamy Ramakrishnan**
2001 **Edward G. Nawy**
2003 **David W. Fowler**
2004 **Nicholas J. Carino**

CRC AWARD
Arthur J. Boase Award

To recognize and honor a person, persons, or organization for outstanding activities and achievements in the reinforced concrete field, the Arthur J. Boase Award was established by ASCE, and is now presented by the Concrete Research Council of ConREF.

Recipients, given with the year of award presented, are:

1971 **Leo H. Corning**
1972 **Eric L. Erickson**
1973 **Douglas McHenry**
1974 **Ernest Gruenwald**
1975 **Chester P. Siess**
1976 **Dugald J. Cameron**
1977 **Maurice van Buren**
1978 **Anton Tedesko**
1979 **Arthur R. Anderson**
1980 **Alfred L. Parme**
1981 **Elvind Hognestad**
1982 **Phil M. Ferguson**
1983 **W. Burr Bennett**
1984 **Paul F. Rice**
1985 **James G. MacGregor**
1986 **W. Gene Corley**
1987 **John E. Breen**
1988 **Mete A. Sozen**
1989 **Boris Bresler**
1990 **Morris Schupack**
1991 **Daniel P. Jenny**
1992 **Paul Zia**
1993 **James O. Jirsa**
1994 **Alan H. Mattock**
1995 **John M. Hanson**
1996 **John F. McDermott**
1997 **Robert F. Mast**
1998 **Sharon L. Wood**
1999 **Anthony E. Fiorato**
2000 **Catherine E. French**
2001 **LeRoy A. Lutz**
2002 **James K. Wight**
2004 **Michael P. Collins**

HONORARY MEMBERS

The Institute recognizes persons of eminence in its field, and those who perform extraordinary meritorious service to the Institute, by conferring on them Honorary Membership (see Bylaws, Article II, Section 2). The following individuals have been so recognized:

1926 **Richard L. Humphrey**
1927 **Adolph Buhler**
1932 **Edward D. Boyer**
Fritz Emperger
William K. Hatt
Robert W. Lesley
Arthur N. Talbot
Sanford E. Thompson
Frederick E. Turneaure
Henry C. Turner
Leonard C. Wason
1935 **Alfred E. Lindau**
1940 **Benjamin F. Affleck**
1943 **John J. Earley**
Franklin R. McMillan
1951 **Harrison F. Gonnerman**
Frank E. Richart
1953 **Roderick B. Young**
1954 **Raymond E. Davis**
1955 **Frank H. Jackson**
Thomas E. Stanton
1956 **Morton O. Withey**
1957 **Arthur R. Lord**
1958 **Eugene Freyssinet**
Douglas E. Parsons
Stanton Walker
1959 **Hardy Cross**
Herbert J. Gilkey
Eduardo Torroja
1960 **Charles H. Scholer**
William Lerch
1961 **Treval C. Powers**
1962 **A. T. Goldbeck**
Inge Lyse
1963 **S. C. Hollister**
Maxwell M. Upson
1964 **Ulrich Finsterwalder**
Kiyoshi Muto
Bryam W. Steele
1965 **Franco Levi**
Douglas McHenry
1966 **P. H. Bates**
William Glanville
Joe W. Kelly
1967 **Frederick M. Lea**
Nathan M. Newmark
Lewis H. Tuthill
1968 **Phil M. Ferguson**
Hubert Rusch
1969 **Roy W. Carlson**
Bryant Mather
Pier Luigi Nervi
Raymond C. Reese
Chester P. Siess
1970 **Roger H. Corbetta**
Carl A. Menzel
Walter H. Price
1971 **A. Allan Bates**
Philip H. Gooding
Ben Moreell
Georg Wastlund
1972 **Arthur R. Anderson**
Fritz Leonhardt
1973 **Anton Tedesko**
Clyde E. Kesler
1974 **Graydon E. Burnett**
Samuel Hobbs
Masatane Kokubu
Telemaco van Langendonck
1975 **Miles N. Clair**
William F. H. Schmidt
Joseph J. Shideler
Branko Zezelj
1976 **Paul W. Abeles**
Samuel Burks
Eivind Hognestad
W. Gordon Plewes
Emilio Rosenblueth
John P. Thompson
1977 **Julio Ferry-Borges**
Michael A. Lombard
Walter J. McCoy
George Winter
Hubert Woods
1978 **William A. Cordon**
T. Y. Lin
Robert E. Philleo
R. E. Rowe
A. A. Yee
1979 **Edward A. Abdun-Nur**
Francisco de Assis Basilio
John A. Blume
Felix Candela
Ben C. Gerwick
1980 **Edward Cohen**
W. C. Hansen
Robert G. L'Hermite
1981 **Gunnar M. Idorn**
1982 **Russell S. Fling**
Guido Oberti
1983 **William M. Avery**
Richard C. Mielenz
Bruno Thurlimann
1984 **Alexander Major**
John F. McLaughlin
1985 **Paul Klieger**
Shu-T'ien Li
Katharine Mather
Alfred L. Parme
1986 **Milo S. Ketchum**
V. Mohan Malhotra
Adam M. Neville
Thomas J. Reading
1987 **Bertrand Goldberg**
Jean M. Muller

	Thomas Paulay
1988	Boris Bresler
	Milos Polivka
	Paul F. Rice
	Jorg Schlaich
1989	T. Z. Chastain
	Robert G. Lee
	Stewart C. Watson
	Robert E. Wilde
1990	Carl E. Ekberg, Jr.
	Noel J. Everard
	George W. Washa
1991	Bengt F. Friberg
	Charles J. Pankow
1992	John E. Breen
	Ignacio Martín
	Floyd O. Slate
1993	Peter D. Courtois
	Emery Farkas
	Yves Saillard
1994	James R. Libby
	Alan H. Mattock
	Norman L. Scott
	Peter Smith
1995	Eugene H. Boeke, Jr.
	Teodoro E. Harmsen
	Ivar Holand
	Walter E. Kunze
	René Walther
1996	T. E. "Gene" Northup
	W. G. J. "Mick" Ryan
	Joseph H. Walker
1997	W. Burr Bennett
	Richard D. Gaynor
	Robert Park
1998	Mary K. Hurd
	George Somerville
	Paul Zia
1999	John M. Hanson
	Daniel P. Jenny
	Raymundo Rivera-Villarreal
	James E. Roberts
	Mete A. Sozen
2000	I. Leon Glassgold
	Charles G. Salmon
	John M. Scanlon, Jr.
	Loring A. Wyllie, Jr.
2001	Hiroyuki Aoyama
	Joseph A. Dobrowolski
	James G. MacGregor
	Alexander C. Scordelis
2002	Vitelmo V. Bertero
	George C. Hoff
	George F. Leyh
	Bertold E. Weinberg
2003	David P. Billington
	W. Gene Corley
	Francis J. Principe
	Dean E. Stephan
	Augusto Carlos de Vasconcelos
2004	Robert F. Mast
	Roberto Meli
	Edward G. Nawy
	Ramesh N. Raiker
	James M. Shilstone, Sr.

ACI FELLOWS

The Bylaws provide that Fellows are nominated by a Fellows Nomination Committee and elected by the Board of Direction. Potential candidates may be presented to the Fellows Nomination Committee for its consideration by a member of the Committee, by a local chapter, by the International Committee, or by petition by five current ACI members. The potential candidate shall be a member or representative of an Organizational or Sustaining Member of the Institute for at least 10 years, including 3 of the last 5 years at the time of nomination, and has made outstanding contributions to the production or use of concrete materials, products, and structures in the areas of education, research, development, design, construction, or management. In addition, a Fellow shall have made significant contributions through committees and/or the local chapter. A Fellow shall retain that rank provided membership in the Institute is maintained or until elected an Honorary Member. The final selection takes into account both service to ACI and significant contributions to the field of concrete.

The Fellows are listed by year of nomination:

1974

Abdun-Nur, Edward A.
Abeles, Paul W.
Adams, Robert F.
Amirikian, Arsham
Anderson, Boyd G.
Appleton, Joseph H.
Avery, William M.
Bennett, W. Burr, Jr.
Billington, David P.
Birkeland, Halvard W.
Branson, Dan E.
Breen, John E.
Bresler, Boris
Burks, Samuel D.
Candela, Felix
Cannon, Robert W.
Chastain, T. Z.
Cohen, Edward
Collins, A. R.
Cook, Herbert K.
Cordon, William A.
Corley, W. Gene
Degenkolb, H. J.
DeSerio, James N.
Diaz de Cossio, Roger
Elstner, Richard C.
Ernst, George C.
Erskine, Frank G.
Everard, Noel J.
Farkas, Emery
Feld, Jacob
Fentress, L. Blake
Fintel, Mark
Fisher, Gordon P.
Fling, Russell S.
Foster, Bruce E.
Friberg, Bengt F.
Gaynor, Richard D.
Geer, Elihu
Gesund, Hans
Gibbons, Ashby T.
Goetz, John L.
Gruenwald, Ernst
Guralnick, Sidney A.
Hansen, W. C.
Hanson, J. A.
Helms, Samuel B.
Henry, Samuel J.
Hersey, A. T.
Higginson, Elmo C.
Hognestad, Eivind
Holley, Myle J.
Houghton, Donald L.
Hulsbos, Cornie L.
Hurd, Mary K.
Janney, Jack R.
Jenny, Daniel P.
Jorgensen, Ib Falk
Kalousek, George L.
Kemp, Emory L.
Ketchum, Milo S.
Klieger, Paul
Kluge, Ralph W.
Kokubu, Masatane
Kramrisch, Fritz
Kuenning, William H.
Lauer, K. R.
Leabu, Victor F.
LeMessurier, W. J.
Lewis, Donald W.
Li, Shu-T'ien
Lin, T.Y.
Litvin, Albert
Lount, A. Murray
MacGregor, James G.
Mackintosh, Albyn
Malhotra, V. Mohan
Maples, William A.
Martin, Ignacio
Mather, Katharine
Mathey, Robert G.
Mattock, Alan H.
McCarthy, James A.
McCoy, Walter J.
McLaughlin, John F.
McLean, Harry H.
Meyers, Bernard L.
Michalos, James
Mielenz, Richard C.
Molke, Eric
Mustard, J. Neil
Nawy, Edward G.
Nelson, George H.
Neville, Adam M.
Newlon, Howard H., Jr.
Oleson, Calvin C.
Paris, George H.
Parme, Alfred L.
Pauw, Adrian
Penzien, Joseph
Petersen, Perry H.
Pfrang, Edward O.
Philleo, Robert E.
Piper, James D.
Pletta, Dan H.
Plewes, W. Gordon
Polivka, Milos
Popovics, Sandor
Praeger, Emil H.
Pregnoff, Michael V.
Principe, Francis J.
Prior, Melville E.
Protze, Herman G., Sr.
Raphael, Jerome M.
Reading, Thomas J.

Rice, Paul F.
Rogers, Paul
Roll, Frederic
Rollins, Carl M.
Rosenblueth, Emilio
Rowe, Robert E.
Salvadori, Mario G.
Sawyer, Herbert A.
Schmid, Emil
Schmidt, William
Schousboe, Ingvar
Schupack, Morris
Scordelis, Alexander C.
Serafim, J.Laginha
Shideler, Joseph J.
Slate, Floyd O.
Smith, Gerald
Smith, Peter
Sozen, Mete A.
Sphar, Leland L.
Stanners, James E.
Stingley, W. M.
Thompson, J. Neils
Thompson, John P.
Tobin, Robert E.
Toennies, Henry
Troxell, George E.
Valore, Rudolph C., Jr.
Van Buren, Maurice P.
Vellines, R. P.
Verbeck, George J.
Vieser, Ellis S.
Viest, Ivan M.
Waddell, Joseph J.
Walker, Joseph H.
Washa, George W.
Waugh, William R.
Wiedyke, Robert G.
Wilde, Robert E.
Willson, Cedric
Winter, George
Wycoff, John C.
Yee, Alfred A.
Zar, Max
Zia, Paul
Zoldners, N. G.

1975

Amrhein, James E.
Aoyama, Hiroyuki
Arni, Howard T.
Arup, Ove
Baker, A. L.
Benjamin, Jack R.
Bernaert, Stephane
Berwanger, Carl
Burmeister, Robert A.
Camellerie, Joseph F.
Chartraud, Jean
Chinn, James
Christiansen, John V.
Clendenning, T. T.
Craven, M. A.
Creskoff, Jacob J.
Cromartie, William D.
Cummins, Kenneth D.
Dise, J. R.
DiStasio, J.
Ekberg, Carl E., Jr.
FitzSimons, Neal
Furlong, Richard W.
Gergely, Peter
Gerwick, Ben C., Jr.
Glover, Robert E.
Gustaferro, Armand H.
Hanson, Norman W.
Hanson, John M.
Hawkins, Neil M.
Heslop, W.
Holland, Eugene Paul
Houk, Ivan E., Jr.
Huggins, Mark W.
Kaar, Paul H.
Keeton, John R.
L'Hermite, Robert
Libby, James R.
Lorman, William R.
Lovewell, C. E.
Mast, Robert F.
Mirsky, Aron L.
Nasser, George D.
Nilson, Arthur H.
O'Brien, Dixon E., Jr.
O'Donnell, Keith O.
O'Sullivan, Marcus L.
Pankow, Charles J.
Pasko, Thomas J., Jr.
Price, Robert E.
Robles, Francisco
Sabnis, Gajanan M.
Saenz, Luis P.
Salmon, Charles G.
Sbarounis, John A.
Scholer, Charles F.
Schutz, Raymond J.
Scott, Norman L.
Shilstone, James M., Sr.
Southworth, George B.
Szilard, Rudolph
Test, C. Taylor
Thurlimann, Bruno
Vanderbilt, M. Daniel
White, John J.
White, Richard N.
Wilson, Charles W.
Woods, Hubert
Zweig, Alfred

1976

Aas-Jacobsen, A.
Alsmeyer, William C.
Anderson, Herbert G.
Anderson, Tom W.
Bertero, Vitelmo
Black,W. C.
Blume, John A.
Bradshaw, Richard R.
Brielmaier, A. A.
Brown, J. D.
Cain, Craig John
Covington, James F.
Crom, Theodore R.
DeSimone, Vincent J.
Dobrowolski, Joseph A.
Dunham, Clarence W.
Finney, E. A.
Fleming, David E.
Florey, James Robert
Fruchtbaum, Jacob
Galezewski, Steven
Gensert, Richard M.
Glantz, O.
Gottheil, Louis A.
Idorn, Gunnar M.
Jacques, Francis J.
Jirsa, James O.
Knight, Charles H., Jr.
Kunze, Walter
Lauer, L. Robert
Layne, Henry M.
Leyh, George F.
Lombard, Michael A.
Moulton, Wilbur E.
Nerenst, Poul
Parker, William E.
Paterson, John D.
Pei, I. M.
Peyton, R. L.
Randall, Frank A., Jr.
Reichard, Thomas W.
Ruhling, John A.
Saillard, Yves
Shah, Surendra P.
Shalon, Rahel
Simmonds, Sidney H.
Skipper, Virgil D.
Thorson, Edward W.
Tynes, W. O.
Weinberg, Bertold E.
Wilder, Carl R.
Zaldastani, Othar
Zollman, Charles C.

1977

Cameron, Dugald
Cormack, H. W.
Courtois, Peter D.
DeSimone, S. Vince
Furr, Howard L.
Grant, Arvid R.
Halsted, Leroy E.
Harboe, Edward M.
Hedstrom, Edwin G.
Heun, Raymond C.
Hoff, George C.
Hoffman, Edward S.
Houde, Jules
Keifer, Oswin, Jr.
Legatski, Leo M.
Nasser, Karim
Nicolet, Roger R.
Paduart, A. L.
Park, Robert
Philips, Orley D.
Ringo, Boyd C.
Rivkind, Leo E.
Ryan, W. G. "Mick"
Safarian, Sargis S.
Smith, Eugene
Sollenberger, Norman J.
Spellman, Donald L.
Sprouse, J. H.
Switzer, L. Glenn
Thompson, Sophus N.
Untrauer, Ray E.
Ward, Michael A.
Wilhelm, William J.
Willetts, Cecil H.
Wilson, Arnold
Wilson, John R.

1978

Barton, Stanley G.
Bathe, George R.
Bisaillon, Andre
Blaha, William J.
Burns, Ned H.
Dikeou, James T.
Frey, George J.
Gamble, William L.
Heger, Frank J.
Henning, Norman E.
Hsu, Thomas T. C.
Johnson, Carl B.
Jones, Truman R., Jr.
Khan, Fazlur
King, John
Livingood, A. T.
Livingston, Stanley
MacInnis, Cameron
Malinowski, Roman
Oberti, Guido
Paulay, Thomas
Purandare, N. N.

1979

Ballinger, Craig A.

Barnes, Stephenson B.
Burgess, Woodrow L.
Jackson, Phillip R.
Meininger, Richard C.
Popov, Egor Paul
Redmond, Thomas B.
Rivera-Villarreal, Raymundo
Smith, Dennis T.
Watson, Stewart C.
Wood, Robert H.

1980

Burnett, Eric F. P.
Crist, Jr., Robert Andrew
Haddad, Gilbert J.
Huang, Ti
Jurkovich, William J.
Mirza, M. Saeed
Palmer, Kenneth E.
Parmelee, Richard A.
Paulet, E. G.
Thornley, Bertrand K., Jr.
Wagner, William V., Jr.

1981

Austin, David E.
Ba™ant, Zdenek P.
Bickley, John A.
Bishara, Alfred G.
Brondum-Nielsen, Troels
Carpenter, James E.
Collins, Michael P.
Cranston, William B.
Fiorato, Anthony E.
Grossman, Jacob S.
Gustafson, David P.
Hernandez, Cesar
Isberner, Albert W., Jr.
Kordina, Karl
Lefter, James
Moran, Charles F.
Nicholson, Leo P.
Prebis, Walter J.
Pyle, Don T.
Russell, Henry G.
Sommerville, George
Stavrides, Harry
Venuti, William J.
Warwaruk, Joseph

1982

Ahn, Kyung-Mo
Battey, George E.
Bovay, Harry E., Jr.
Brauner, Herbert A.
Burres, Warren G.
Cady, Philip D.
Cantor, Irwin G.
Carter, Alan C.
Chacon-Toral, Jose F.
Darwin, David
Decker, Edwin A.
Delyannis, Leonidas T.
Derecho, Arnaldo T.
Dickey, Walter L.
Fowler, Timothy J.
Glassgold, I. Leon
Hansen, Carl C.
Hansen, Torben C.
Harris, Harry G.
Hays, C. Raymond
Hedstrom, Richard O.
Hendrickson, John G., Jr.
Hill, Eugene D., Jr.
Hollon, George W.
Holm, Thomas A.
Hotaling, William W., Jr.
Hunter, David A., Jr.
Jerome, Joseph J.
Jobse, Harold J.
Keelen, Charles A.
Kriner, Richard W.
LaFraugh, Robert W.
Losberg, Anders
May, Howard R.
McCalla, W. T.
McElroy, Joseph A.
Medwadowski, Stefan J.
Mitchell, Denis
Naaman, Antoine E.
Pare, Robert Lee
Platt, Doran S., Jr.
Podolny, Walter, Jr.
Popoff, Alexander, Jr.
Ramsey, Richard A.
Robinson, Harry C.
Sandberg, Harold R.
Scanlon, John M., Jr.
Speyer, Irwin J.
Strand, Donald R.
Swartz, Stuart E.
Udani, P. J.
Uribe, E. Jairo
Wyllie, Loring A., Jr.
Yang, Yue-Chyou

1983

Albright, Richard O.
Anderson, Harry G., Jr.
Bondre, Narayan G.
Brown, Ted M.
Buettner, Donald R.
Cagley, James R.
Calavera, Jose
Caldera, Dante J.
Colaco, Joseph P.
Danforth, Richard H.
Davis, Raymond E., Jr.
Desai, Raj T.
Diaz-Gomez, Cutberto
Feeser, Larry J.
Ferguson, Brian J.
Ferry-Borges, Julio
Fordyce, Homer E.
Freyermuth, Clifford L.
Hay, Richard E.
Heinen, Richard
Housner, George W.
Howe, Warner
Hunt, Theodore W.
Imper, Richard R.
Johnston, David W.
Juuse, Gunnar
Kahn, Lawrence F.
Klein, Frank
Lamond, Joseph F.
Lancaster, Rex I.
Lane, Ralph O.
Lee, Stanley H.
Lutz, LeRoy A.
McDermott, John F.
Meinheit, Donald F.
Meisel, Donald D.
Moreadith, Frederick L.
Moretto, Oreste
Neville, Gerald B.
Northup, T. E. "Gene"
Pinkham, Clarkson W.
Preston, H. Kent
Randall, Robert W.
Rosenwasser, Robert
Schnobrich, William C.
Schwartz, Jesse
Seinuk, Ysrael A.
Shewmaker, Robert E.
Shoolbred, Robert A.
Stein, Leon
Taylor, Michael A.
Uzumeri, S. M.
Van Epps, Robert J.
Weisz, Philip C.
Williams, Joe V., Jr.
Winter, Michael
Witta, Eduard
Wyatt, Jesse R.

1984

Abrams, Melvin S.
Allen, James P., III
Anderson, Karl J.
Ardahl, Jon B.
Ashar, Hansraj G.
Ballou, Charles L.
Brecher, E. Fred
Brewer, William E.
Brown, G. Cabell
Burgener, Maurice L.
Cartelli, Vincent R.
Crawford, Edgar G.
Cronin, Randall C.
Dailey, Lawrence C.
Deno, Douglas W.
Dewdney, Harold S.
Doermann, Richard J.
Douma, Atze
Downes, Arthur M.
Finfrock, Robert D., Jr.
Fowler, David W.
Fredericks, John C.
Gordon, Raymond S.
Griffin, Philip G.
Gutierrez, Ramon F.
Gutt, Tadius J.
Harger, Herbert L.
Hilsdorf, Hubert K.
Holbek, Kai
Hyland, Edward J.
Isaak, Merlyn
Johnston Roy G.
Kelly, John B.
Kerpel, Enrique K.
Kerstetter, Michael J.
King, Rolla D.
Kulka, Felix
Lai, James S.
Liljestrom, William P.
Liu, Tony C.
Martin, Leslie D.
McCann, Ray A.
Mehta, Povindar Kumar
Nagami, Mas
Nicoletti, Joseph P.
Robledo, Villegas Gabriel
Roy, Della M.
Tang, Man-Chung
Trusty, Claude B.
Walser, Adolf
Wheeler, William T.
Whitaker, Robert Lee
Wight, James K.
Wilson, Brian G. E.
Zsutty, Theodore C.

1985

Casad, Donald D.
Chin, Ark G.
Clark, John H.
Cook, Clyde E.
Dale, Eugene J.
Fehnel, Charles D.
Golden, Francis P.
Gouwens, Albert J.

Graf, Edward D.
Halstead, Philip E.
Hodson Richard C.
Jacobson, Norman G., Jr.
Kaminetzky, Dov
Kelly, Albert A.
Krell, William C.
Little, Robert W.
Mann, Jack I.
McLaughlin, John M.
Moore, Jerome A.
Nielsen, Harald
Nielsen, Norby N.
Osgood, Everette W.
Plaehn, Juergen L.
Rubin, Edward H.
Smith, Robert G.
Van Deurzen, John T.
Willard, Harry G.
Zaidi, S. Tauguir H.

1986

Bell, Leonard W.
Boeke, Eugene H., Jr.
Buck, Alan D.
Comann, David H.
Dixon, Donald E.
Doar, David
Dolch, William L.
Dubin, Eugene A.
Flores, Alvarez Rodrigo
Gogate, Anand B.
Hall, Arthur S.
Hope, Brian B.
Hourigan, Edward V.
Johnson, Robert B.
Lee, Robert G.
Lew, H. S.
Martin, John A.
Mass, Gary R.
May, Charles C.
Nagataki, Shigeyoshi
Nene, Ramchandra L.
Okamura, Hajime
Pasch, James H.
Patel, Shirish B.
Peterson, Carl A.
Seeger, John C., Jr.
Warner, James
Weber, Jack W.
Williams, Richard W.

1987

Burg, George R. U.
Carreira, Domingo J.
Chacos, Gregory P.
Chojnacki, Boguslaw
Cohn, M. Z.
Dorton, Roger Anthony
Frohnsdorff, Geoffrey
Klaiber, F. Wayne
Kupfer, Herbert K.
Lamberson, Eugene A.
McDonald, James E.
Phelan, William S.
Pierce, James S.
Rangan, B. Vijaya
Rosenlund, Jack E.
Sahlin, Sven
Schrader, Ernest K.
Tam, Chat Tim
Tassios, Theodossius P.
Williams, J. Craig

1988

Aïtcin, Pierre-Claude
Best, Cecil H.
Campbell-Allen, Denison
Carino, Nicholas J.
Coke, Jo C.
Cope, James L.
Creegan, Patrick J.
Duncan, Ralph L.
Erlin, Bernard, E.
Gebler, Steven H.
Ghosh, Satyendra K.
Grouni, Hidayat N.
Halvorsen, Grant T.
Hansen, Kenneth D.
Henry, Robert L.
Johnston, Colin D.
Lee, Douglas D.
Lenschow, Rolf Johan
Malisch, Ward R.
Nassaux, Frederic A.
Perenchio, William F.
Pomeroy, Charles D.
Rabbat, Basile G.
Ramakrishnan, Venkataswamy
Sommers, Paul H.
Stephan, Dean E.
Walker, H. Carl, Jr.

1989

Albinger, John Martin
Ayers, Charles M.
Clear, Kenneth C.
Diamond, Sidney
Galer, Richard E.
Gjorv, Odd E.
Gordon, Clifford
Holland, Terence C.
Hooton, R. Douglas
Ikeda, Shoji
Mittelacher, Martin B.
Moore, William C.
Moreno. Jaime
Mullarky, Jon I.
Mullkoff, Arthur J.
Naik, Tarun R.
Pearce, Ira W.
Phillips, William R.
Ramsdell, Sara Deming
Richards, John A.
Richards, Owen
Saucier, Kenneth L.
Schlegel, Donald L.
Snell, Luke M.
Stark, David Charles
Stodola, Paul R.
Young, J. Francis

1990

Anderson, Gerald H.
Aswad, Alex
Barker, James M.
Bihr, James E.
Bruce, Robert N., Jr.
Butler, W. Barry
Catani, Mario J.
Chambers, Harry A.
Dolan, Charles W.
Ghali, Amin
Graham, James R.
Hall, Ronald H.
Hanna, Amir N.
Harmsen, Teodoro E.
Henager, Charles H.
Hollrah, Ronald L.
King, Loyd H.
Klingner, Richard E.
Kuhlman, Robert H.
Langley, Wilbert Spencer
Lopez, Alejandro Graf
Marin, Joaquin
Moore, Timothy L.
Murray, Kenneth H.
Musser, Donald W.
Nagy, Henry
Pavon, Victor M.
Priestley, M. J. Nigel
Riley, Orrin
Roy, Hedley E. H.
Sargious, Michel A.
Snow, Peter G.
Snyder, Julian
Terpening, Robert Lee
Veltrop, Jan Adrianus
Wilson, Roger E.
Yost, H. Allen
Ytterberg, Robert F.

1991

Anderson, Robert R.
Avril, Arthur C.
Baker, Daniel L.
Batson, Gordon B.
Burns, Muriel
Cook, James E.
Crocker, David A.
Day, Kenneth W.
Fontana, Jack J.
Garcia, Luis E.
Gilley, Harold W. "Bud"
Gutierrez, Joe
Hegle, Richard L.
Hime, William G.
Hobbs, Leonard S.
Inman, Brad D.
Kaden, Richard A.
Lankard, David R.
Miller, Chester W.
Mirza, S. Ali
Moehle, Jack P.
Murray, Myles A.
Patzias, Terry
Rad, Franz N.
Raikar, R. N.
Sawyer, James L.
Suprenant, Bruce A.
Werner, Orville R., II

1992

Akers, David James
Ashby, John Bernard
Baker, Claude V.
Beeby, Andrew W.
Call, Bayard M.
Colville, James
Cook, Geoffrey R.
DePuy, Glenn W.
Dilger, Walter H.
Englekirk, Robert E.
Epifano, Robert A.
Essex, Richard B.
Flibotte, Leo P.
Gaul, Robert W.
Gerstle, Kurt H.
Gulyas, Robert J.
Hillerborg. Arne R.
Hindo, Kal R.
Hover, Kenneth C.
Jenkins, Robert S.
Kittridge, David Grant
Kozeliski, Frank A.
Marusin, Stella Lucie
Mindess, Sidney
Morgan, Dudley R.
Nepper-Christensen, Palle
Panarese, William C.
Rewerts, Thomas L.
Senbetta, Ephraim
Vincent, Lionel W.
Zetlin, Lev

1993

Abrams, Daniel P.
Bondy, Kenneth B.
Bremner, Theodore W.
Carrasquillo, Ramon L.
Clifton, James R.

DiPasquale, Raymond A.
Fidjestol, Per
Graber, Dennis Wayne
Hale, Herbert C., Jr.
Kosmatka, Steven H.
Manning, David Gary
McCall, W. Calvin
Muller, Asher
Ozyildirim, H. Celik
Pigeon, Michel
Ragan, Steven A.
Rizkalla, Sami H.
Rumman, Wadi S.
Sadler, John E.
Scott, Billy M.
Seabrook, Philip T.
Smith, Robert J.

1994

Archibald, James P.
Boyle, Michael J.
Buyukozturk, Oral
Cohen, Menashi D.
Dixit, Om P.
Finkel, Edward B.
Flynn, Russell T.
Freedman, Sidney
Gibbe, K. Fred
Gregorian, Zareh B.
Harris, James R.
Keck, Roy H.
Kluball, Jerome G.
Lathrup, Donald E.
Libby, Donald R.
Mujumdar, Vilas S.
Naus, Dan J.
Porter, Max L.
Shroff, Avanti C.
Spannenberg, Ralph H.
Swamy, R. Narayan
Tanner, John L., III
Tolley, William R.
Vaughn, Ronald Edward
Verti, Thomas D.
Weyers, Richard Edwin
Whiting, David A.
Wintz, Joseph Anthony, III
Wood, Sharon L.

1995

Balaguru, Perumalsamy N.
Barnett, Robert P.
Bimel, Carl
French, Catherine E.
Gardner, N. John
Hsu, Cheng-Tzu Thomas
Mansur, Mohammad Abul
Milks, Donald E.
Moore, Walter P., Jr.
Murphy, Gerald R.
Phong, Bart C. L.
Popovic, Predrag L.
Poston, Randall W.
Rear, Kenneth B.
Sherman, Terry W.
Smith, Philip A.
Tatro, Stephan B.
Tokar, Valery
Vaysburd, Alexander M.
Wakeley, Lillian D.

1996

Ahmad, Shuaib H.
Allred, J. Howard
Bentur, Arnon
Braestrup, Mikael W.
Breeze, Paul C.
Burg, Ronald G.
Chrest, Anthony P.
Emmons, Peter H.
Godfrey, Dwaine Aubrey
Gopalaratnam, Vellore S.
Guerra, Antonio Jose
Herrera, Angel E.
Kazakavich, Vincent
Kreger, Michael E.
Lancelot, Harry B., III
Leming, Michael L.
Miller, Richard E.
Parmasivam, Palaniappa
Pielert, James H.
Shaikh, A. Fattah
Sprinkel, Michael M.
Walters, D. Gerald

1997

Al-Manaseer, Akthem
Barringer, William L.
Barth, Florian G.
Casabonne, Carlos R.
Close, Steven R.
Daye, Marwan A.
Ehsani, Mohammad R.
Face, Allen, III
Fagundo, Fernando E.
Frost, Richard J.
Haney, James T.
Hightower, Fred E.
Krauthammer, Theodor
Larson, Erick N.
Lee, James A.
Long, Adrian E.
Nowak, Andrzej S.
Piggott, Robert W.
Pointer, B. Duke
Rice, Edward K.
Richardson, Robert C.
Saatcioglu, Murat
Sexsmith, Robert G.
Speck, Jeffrey F.
Stafford, David G.
Stanton, John F.
Tikalsky, Paul J.
Zollo, Ronald F.

1998

Baker, Clyde N., Jr.
Chern, Jenn-Chuan
Dooley, C. Terry
Forster, Stephen W.
Fouad, Fouad H.
Frangopol, Dan M.
Galinat, Melvyn A.
Haavik, Douglas
Holland, Jerry A.
Huffman, Morris “Skip”
Izquierdo, Jose M.
McCabe, Steven L.
Ramirez, Julio A.
Ravina, Dan
Teodoru, George V. M.
Vogt, Woodward L.
Zoltanetzky, Paul, Jr.

1999

Best, J. Floyd
Bonacci, John F.
Daniel, D. Gene
Eligenhausen, Rolf
Gale, E. A. “Jack”
Halczak, William
Haynes, Harvey H.
Hulshizer, Allen J.
Kaufman, Alfred L.
Kopczynski, Cary S.
Leon, Roberto T.
Nanni, Antonio
Ohama, Yoshihiko
Pergalsky, Aimee
Rushing, William E., Jr.
Sabouni, Abdul-Rahim R.
Saiidi, Mehdi S.
Sansalone, Mary J.
Scanlon, Andrew
Segura, Jorge I.
Shilstone, James M. “Jay,” Jr.
Soroushian, Parviz
Tatnall, Peter C.
Vecchio, Frank J.
Wollmershauser, Richard E.
Wood, Roger D.

2000

Barney, George B.
Belarbi, Abdeldjelil “D. J.”
Elliot, Darrell F.
Ford, Jerome H.
Geiker, Mette
Gill, Hershell
Hansen, M. R.
Issa, Mohsen A.
Klein, Gary J.
Maloney, Peter M.
Manjrekar, Surendra “S. K.”
Morris, LaGrit F. “Sam”
Nmai, Charles K.
Ohlwiler, Clifford R.
Pashina, Brian J.
Sanders, David H.
Schemmel, John J.
Shahrooz, Bahram M.
Sheikh, Shamim A.
Smoak, William Glenn
Stehly, Richard D.
Tipping, Eldon G.
Wallace, John W.

2001

Alcocer, Sergio M.
Awad, Khaled W.
Detwiler, Rachel J.
Eberhard, Marc O.
Filippou, Filip C.
Freeman, Sigmund A.
Glassgold, Jill E.
Khan, Mohammad S.
Love, John R.
Luther, Mark D.
Marianos, Ward N., Jr.
Rodriguez, Mario E.
Seible, Frieder
Stark, Roberto
Taerwe, Luc R.
Yankelevsky, David Z.

2002

Aboutaha, Riyad S.
Bada, Nick Paul
Bartlett, F. Michael
Baseheart, T. Michael
Carter, Paul D.
Coleman, Jeffrey W.
Cook, Ronald A.
Dorfmueller, Daniel P.
Downs, Thomas J.
Face, Samuel A., Jr.
Falconer, Daniel W.
Farzam, Hamid
Gaudette, Paul E.
Gerstle, Walter H.
Heitzmann, Richard F.
Jaycox, Claude E.

Lange, David A.
Lee, Li-Hyung
McMican, Donald G.
Olek, Jan
O'Neill, Robert C.
Orsak, Debrethann R.
Page, Kelly M.
Pincheira, Jose A.
Pistilli, Michael F.
Schaeffer, Thomas C.
Shiu, Kwok-Nam
Solomon, Joseph R.
Steiner, Peter J.
Tadros, Maher K.
Thaulow, Niels
Weil, Thomas G.

2003
Baloh, Diane L.
Banthia, Nemkumar
Becker, Roger J.
Bognacki, Casimir J.
Bury, Mark A.
Cleland, Ned M.
Crouch, Christopher R.
Cumming, Neil A.
D'Arcy, Thomas J.
Diulus, Dale H.
Engelman, Alphonse E.
Ferraris, Chiara F.
Fricks, Terry J.
Frosch, Robert J.
Hayes, John R., Jr.
Janssen, Donald J.
Legatos, Nicholas A.
Lobo, Colin L.
MacDonald, Clifford N.
Malerk, Thomas O.
Maloof, Nicholas B.
Mehta, Anand S.
Meyer, Christian
Oglesby, Rita K.
Oh, Byung Hwan
Paultre, Patrick
Reineck, Karl-Heinz
Russell, Bruce W.
Sen, Rajan
Tayabji, Shiraz D.

2004
Adaska, Wayne S.
Anderson, Robert B.
Babakhanian, Vartan
Bader, Maher A. M.
Bhide, Shrinivas B.
Burdette, Edwin G.
Chen, Tsung-Li T.
Darwish, Mohamed Nasser A. N.
Dragunsky, Boris Z.
Folliard, Kevin J.
Gallegos, Hector
Green, Daniel J.
Green, Roger
Hamad, Bilal S.
Hamilton, H. R. "Trey," III
Hanskat, Charles S.
Harris, G. Terry, Sr.
Johal, L. S. "Paul"
Khaloo, Ali R.
Kolodziej, Jeri A.
Kuchma, Daniel
Lozen, Kenneth M.
MacDonald, Kevin A.
Martin, Ross S.
Massicotte, Bruno
Mo, Yi-Lung
Orr, Richard S.
Paul, Jay H.
Pessiki, Stephen P.
Rossi, William F.
Roumain, Jean-Claude M.
Seguirant, Stephen J.
Talukdar, Barendra K.
Wafa, Faisal Fouad
Watson, Ronald J.
Zhang, Min-Hong

From its meager beginning with three men concerned about the quality of the concrete block being produced in 1904 to more than 16,000 members today, ACI has built a worldwide reputation as the premier source for information on concrete construction. Because of the hard-working dedication of its members and the evolution of a time-tested, unbiased, consensus process, ACI documents are widely acknowledged as the “standard of practice” for nearly everything that is done with concrete.

Not many organizations can say they have been around 100 years. The fact that ACI has is a testament to the efforts of its members and the volunteer committees and officers. The members are why we exist and are the reason ACI is entering its second century with the stature it has in the concrete industry.

It is an honor and a privilege to be part of this milestone. ACI has come a long way, and it is blessed with the opportunity to go even further. We have a chance to expand our role internationally and develop stronger relationships with our counterparts around the world. Our history is impressive, and our future is bright.

“Progress Through Knowledge” is on strong ground to continue for a second 100 years.

—William R. Tolley

Executive Vice President