JUNE 2020 V. 42 No. 6

Concrete international

The Magazine of the Concrete Community

Formwork

American Concrete Institute

Concrete international

The Magazine of the Concrete Community

JUNE 2020 V. 42 No. 6

FORMWORK

ALSO FEATURING

June

Concrete international

PUBLISHER
John C. Glumb, CAE
john.glumb@concrete.org

EDITOR-IN-CHIEF
Rex C. Donahey, PE
rex.donahey@concrete.org

ENGINEERING EDITOR
W. Agata Pyc
agata.pyc@concrete.org

MANAGING EDITOR
Keith A. Tosolt
keith.tosolt@concrete.org

EDITOR
Rebecca Emanuelsen
rebecca.emanuelsen@concrete.org

ADVERTISING
Jeff Rhodes
MCI USA
jeff.rhodes@mci-group.com

PUBLISHING SERVICES

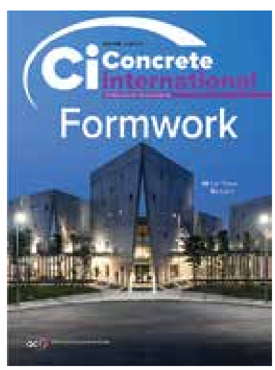
MANAGER
Barry M. Bergin

EDITORS
Kaitlyn J. Dobberteen,
Tiesha Elam, Hannah Genig,
Angela R. Matthews,
Kelli R. Slayden

GRAPHIC DESIGNERS
Susan K. Esper, Ryan M. Jay,
Gail L. Tatum

American Concrete Institute
Always advancing

AMERICAN CONCRETE INSTITUTE
http://www.concrete.org
Tel. +1.248.848.3700
Fax. +1.248.848.3150



Viettel Offsite Studio in Hanoi, Vietnam, is defined by six V-shaped structures that open like books to a lake and garden view. The raw, unfinished cast-in-place concrete emulates the rustic surroundings of the complex. For more details, see the article on p. 30 (*photo courtesy of Vo Trong Nghia Architects*).

departments

IN **Ci**

Additive Advancement

The *ACI Materials Journal* is soliciting original papers for a special issue on "Advances in Rheology and Additive Manufacturing in Construction" (see Call for Papers, p. 53), combining the science of deformation and flow of matter with the process of joining materials to make parts, usually layer upon layer, from 3-D model data. Based on the existing literature, I expect that much of the issue's content will focus on concrete mixtures that can be pumped and extruded through a nozzle. For successful additive manufacturing, such a mixture must also be capable of:

- Being deposited along a defined path, creating a layer while largely retaining its extruded shape;
- Bonding with the previously deposited layer; and
- Resisting significant deformation under the weight of subsequent layers.

Well over 100 years ago, workers using Van Guilder hollow-wall machines were essentially engaged in additive manufacturing, as they produced walls by joining concrete mixtures layer by layer (see p. 39). Granted, the necessary 3-D models were only envisioned by the workers, and much of the work was accomplished through their exertion. However, the Van Guilder system was successfully used to construct hundreds of buildings. Perhaps the success can be credited to the use of concrete mixtures that overcame the three listed rheological design challenges.

Interest in additive manufacturing is increasing. It may behoove us to look to the past and review previous practices to consider how old technology can be adapted for the future.

Rex C. Donahey

President's

Memo

A New Proposed Code Structure

Jeffrey W. Coleman
ACI President

The ACI Board of Direction and Technical Activities Committee (TAC) have been reviewing how codes are processed within the Institute. Over the past year, the Board has been discussing how ACI can change to accomplish our Vision to provide the knowledge needed to use concrete effectively for a changing world. At the same time, TAC has been discussing the basic structure of how committees work. These deliberations have resulted in a proposal for a new ACI code structure. While details for this structure will be worked out over the next several months, I think the timing is right to discuss the motivation for this activity.

People in the construction industry certainly know of ACI. But if concrete is not their focus, they may only be familiar with the ACI 318 Code. As we know, this only scratches the surface of our 285 unique technical documents, of which 19 are code documents (with another six code documents under development). This lack of industry recognition for the depth of ACI material that is available must change. ACI also needs to help champions of new technologies to understand how their information can be made visible and, if appropriate, eventually standardized.

A couple of years ago, the ACI Board charged a task group with determining whether ACI was doing enough to codify new technologies. The group's discussions made it clear that many proponents of new technologies set their sights on being accepted in ACI 318, even though the Institute may have more appropriate documents for eventually standardizing their product or method. This finding indicated that ACI's code structure is opaque to too many people—even those in the concrete industry—and it has highlighted the need for changing the ways ACI organizes, presents, and markets its code documents.

Recently, in part as a result of discussions with our industry partner PCI, three new code-writing committees have been approved by TAC. One of these committees, ACI/PCI 319, will focus on items unique to precast concrete structures. Another committee will focus on items unique to post-tensioned concrete structures, which recently voted to become joint with PTI. The third committee will write a durability code, based on work by ACI Committee 201, Durability of Concrete.

These committees were formed around the following core principles:

- ACI 318 contains the backbone information for reinforced concrete design;
- New code committees will cover focused topics or industries;
- Committee membership will be kept small—15 members or fewer;
- Committees will be placed on a schedule;
- Similar to ACI 318, committees will be discharged at the end of their schedule and repopulated for the next cycle; and
- Codes will be marketed as a suite of codes.

The structure of these new committees shows how ACI is advancing toward greater visibility of all the codes the Institute has to offer. By building off the name recognition of ACI 318, new codes would gain better visibility and recognition as part of ACI's suite of codes, covering not only the reinforced concrete buildings that ACI 318 is typically used for but also many other types of structures and specialized construction materials and techniques. The new concept allows for a more understandable structure. New industries can easily see themselves as the next code in the set. Existing ACI codes can be restructured for greater visibility, more efficient operations, and deadlines that meet industry needs.

Other technical committees that are currently writing codes need to be re-evaluated, including ACI Committees 350, Environmental Engineering Concrete Structures, and 440, Fiber-Reinforced Polymer Reinforcement. They both write codes along with specifications, guides, and reports. How these committees operate will be an ongoing discussion between TAC and the committees with a focus on efficiency in achieving ACI's goals.

TAC is also reviewing the relationship between code-writing committees and committees that write the bulk of the knowledge on a topic, known as our topic experts. It is from these committees that code-writing committees base their decisions on defining equations or limits of design. Better communication is needed between the committees that set the standard for the public and the committees that push the boundaries of a changing world.

This is a bold change evolving within ACI. I can see many variations of this concept as it starts to unfold. Do we have many sets of codes that fit distinctly different needs, such as new construction, repair, fire, or resiliency? How do we handle the overlap that will inevitably develop between different codes? Do our codes reference each other or are they adopted individually as the authorities in a locality see fit? These things will be hammered out over the next several months and years.

Jeffrey W. Coleman, American Concrete Institute

ACI SUSTAINING
The Foundation

Sustaining Members show true dedication to advancing concrete knowledge.

The continued support from these organizations has enhanced the progress of the concrete industry.

www.ashfordformula.com
+1.800.998.5664

With just one application, the Ashford Formula will permanently densify your floors, making it abrasion resistant, easy to clean and free of dust.

www.ascconline.org
+1.866.788.2722

ASCC is a nonprofit organization for cast-in-place concrete contractors, dedicated to enhancing the capabilities of those who build with concrete, and providing them a unified voice in the industry.

www.arcosalightweight.com
+1.678.777.6278

Arcosa Lightweight is America's largest producer of expanded shale and clay lightweight aggregate, with operations in California, Colorado, Texas, Louisiana, Alabama, Kentucky, Indiana, and Arkansas.

+ 1.603.953.5815

North S.Tarr Concrete Consulting, P.C., provides expert assistance with concrete issues (preventative and corrective) throughout the United States and internationally.

www.oztec.com
+1.800.533.9055

Oztec Industries' line of fully interchangeable steel heads and RubberHeads®, electric and gasoline motors, backpacks and flexible shafts are the most powerful, versatile, and reliable in the industry.

www.seretta.com
+1.407.290.9440

Seretta Construction, established in 1987, has offices in Orlando, Charlotte, and Austin. They are a full-service tiltwall contractor capable of any size project anywhere in the US.

Advanced Construction Technology Services
American Engineering Testing, Inc.
American Society of Concrete Contractors
Arcosa Lightweight
Ash Grove Cement Company
Baker Concrete Construction, Inc.
Barrier One, Inc.
BASF Admixtures, Inc.
Bentley Systems Inc.
Boral Resources
Cantera Concrete Company
Ceco Concrete Construction LLC
CHRYSO, Inc.
Concrete Reinforcing Steel Institute
Concrete Sealants, Inc.
Concrete Strategies LLC
CTLGroup
Curecrete Distribution, Inc.
Dayton Superior Corporation
Doka USA Ltd
Euclid Chemical
Full-Tilt Constructors, Inc.
Future Tech Consultants
GCP Applied Technologies
Keystone Structural Concrete LLC
Kryton International Inc.
LafargeHolcim (US) Inc.

MEMBERS of Our Success

aci Sustaining Member

To learn more about Sustaining Members, visit www.concrete.org/sustainingmembers.

Read more about this month's featured Sustaining Members in the profiles below!

www.chrysoinc.com
+1.800.936.7553

CHRYSO offers the industry's most innovative and complete line of concrete admixtures and cement additives, coupled with expert technical services focused on customer success.

www.daytonsuperior.com
+1.888.977.9600

For over 90 years, Dayton Superior Corporation has been a leading provider of accessories, chemicals, forming, shoring, and paving product solutions within the nonresidential concrete construction industry.

www.doka.com
+1.201.641.6500

Doka is a world leader in developing, manufacturing and distributing formwork technology for use in all fields of the construction sector, utilizing more than 160 sales and logistics facilities in over 70 countries.

www.spggogreen.com
+1.877.957.4626

SPG, Specialty Products Group®, is an organization formed specifically for the purpose of supplying engineered sustainable solutions to the construction environment and the world.

www.twc-cs.com
+1.517.771.8192

TWC Concrete Services, LLC, offers unmatched expertise as a subcontractor providing their clients the total concrete package, specializing in Tilt Ups, Flatwork and Footings to Walls, Reinforced Steel and Concrete Pumping.

www.xypex.com
+1.800.961.4477

XYPEX Chemical Corporation is the leading manufacturer of crystalline concrete waterproofing technology with a network of distributors in more than 80 countries around the world.

Lehigh Hanson
Meadow Burke Products Inc.
W.R. Meadows, Inc.
Metromont Corporation
Municipal Testing Group
North S.Tarr Concrete Consulting PC
Oztec Industries, Inc.
Parrent Concrete LLC
Penetron International Ltd
Phoenix Industrial
Precast/Prestressed Concrete Institute
Saudi Building Code National Committee
Seretta Construction Inc.
Sika Corporation
Specialty Products Group, Inc.
STRUCTURAL
Structural Services, Inc.
Superior Construction Services
Tekna Chem SPA
TWC Concrete Services, LLC
Twining Concrete Insight
Xypex Chemical Corp.

News

ACI Foundation Funds Research Projects

The ACI Foundation's Concrete Research Council (CRC) selected eight research projects to receive grants this year. The ACI Foundation is committed to progress in the industry by contributing financially to necessary and worthy research. The following research projects will receive funding:

- "Calibration of Simplified Creep and Shrinkage Models Developed Using Solidification Theory," Brock Hedegaard, University of Minnesota Duluth, Principal Investigator, and Mija Hubler, University of Colorado Boulder, Co-Principal Investigator; endorsed by ACI Committee 209, Creep and Shrinkage in Concrete;
- "Validation of Service Life Prediction for a 28-Year-Old Parking Garage Constructed of Low-Permeability Concrete," Amanda Bordelon, Utah Valley University, Principal Investigator, and W. Spencer Guthrie, Brigham Young University, Co-Principal Investigator; endorsed by ACI Committees 234, Silica Fume in Concrete, and 365, Service Life Prediction;
- "Determination of the Curing Efficiency of Externally and Internally Cured Concrete Using Neutron Radiography," Mehdi Khanzadeh Moradllo, Temple University, Principal Investigator, and W. Jason Weiss, Oregon State University, Co-Principal Investigator; endorsed by ACI Committees 213, Lightweight Aggregate and Concrete, and 308, Curing Concrete;
- "Full-Scale Testing of a New Double-Beam Coupling Beam (DBCB) with a Simplistic Reinforcing Layout," Shih-Ho Chao, University of Texas at Arlington, Principal Investigator; endorsed by ACI Subcommittee 318-H, Seismic Provisions;
- "Assessing ACI 318 Using Data from the 2015 and 2019 E-Defense 10-Story, Full-Scale Building Tests," John Wallace, University of California, Los Angeles, Principal Investigator; endorsed by ACI Subcommittee 318-H, Seismic Provisions, and ACI Committee 369, Seismic Repair and Rehabilitation;
- "Behavior and Design of Concrete Structures Under Natural Fires," Thomas Gernay, Johns Hopkins University, Principal Investigator, and Patrick Bamonte, Politecnico di Milano, Co-Principal Investigator; endorsed by Joint ACI-TMS Committee 216, Fire Resistance and Fire Protection of Structures;
- "Reliability Evaluation of ACI 318 Strength Reduction Factor for One-Way Shear," Robert Barnes, Auburn University, Principal Investigator, and Andrzej Nowak, Auburn University, Co-Principal Investigator; endorsed by ACI Subcommittee 318-E, Section and Member Strength; and
- "Durability of Anchorage Pour-Backs: Evaluating the Link Between Surface Preparation and Bond," Natassia Brenkus, The Ohio State University, Principal Investigator; endorsed by ACI Subcommittee 301-I, Post-Tensioned Concrete – Section 9.

CRC recommended these eight projects for funding based on impact to the industry, ACI committee engagement, and collaboration with other funders and organizations. Further information about each of this year's awarded projects—including additional funding partners, research team, ACI committee involvement, project details, and more—is available at **www.ACIFoundation.org**.

2020 Professors' Workshop to Be Held Online

Due to social distancing recommendations resulting from the coronavirus pandemic, ACI will host the Professors' Workshop as a virtual meeting on July 27-29, 2020.

The Professors' Workshop is designed to provide instructors in civil engineering, architecture, architectural engineering, materials science, and construction management programs the latest tools and teaching techniques to effectively engage students in courses that cover structural concrete design, construction, materials, and pavements.

Prominent faculty and industry representatives will present information on proven teaching methods and instructional resources, as well as updates on the latest industry technical information and trends. The focus of the workshop is on the development and improvement of teaching resources and techniques for undergraduate courses in structural concrete design, concrete materials, and pavements—with a specific emphasis on online learning.

Details for the virtual event will be available soon. Visit **www.concrete.org/events** for more information. The event is cosponsored by the PCA Education Foundation and the ACI Foundation.

U.S. Nuclear Regulatory Commission Endorses Two ACI Codes

ACI announced that the U.S. Nuclear Regulatory Commission (NRC) has updated its Regulatory Guide 1.199, "Anchoring Components and Structural Supports in Concrete," to endorse two ACI codes. The codes endorsed include "Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary (ACI 349-13)" and "Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary (ACI 355.2-07)." An additional ASTM International standard test method for strength of anchors has been endorsed.

The NRC licenses and regulates civilian use of nuclear energy to protect public health and safety and the environment. Endorsement of these two ACI codes in the NRC Regulatory Guide series aligns with ACI's mission to advocate for the adoption of its consensus-based knowledge.

For more information on ACI advocacy, visit **www.concrete.org/advocacy**.

NEHRP Future Provisions and Research Needs: Request for Input

As part of its efforts to regularly update the National Earthquake Hazards Reduction Program (NEHRP) Recommended Seismic Provisions for New Buildings and Other Structures, the Building Seismic Safety Council (BSSC) is charged by the Federal Emergency Management Agency (FEMA) to identify and recommend issues to be addressed and research needed to advance the state of the art of earthquake-resistant design and to serve as the basis for future refinement of the provisions.

During the project to generate the 2020 edition of the provisions, the various issue teams and study groups that assisted with the development of proposals for the Provisions Update Committee (PUC) and Member Organization ballots identified specific items that were beyond the scope of the 2020 provisions update. These were assembled and edited by an oversight committee led by PUC members Kelly Cobeen and S.K. Ghosh.

BSSC is seeking input, particularly regarding the following questions:

- What topics are missing from the document?
- Are there topics with which you disagree?
- What topics are high priority?

Visit **www.nibs.org/page/bssc_pubs** to download the report. Provide responses in writing by June 15, 2020, to Jiqiu Yuan at jyuan@nibs.org.

ASTM International Cancels June In-Person Standards Meetings

In light of COVID-19 and ongoing safety concerns for members and staff, ASTM International announced that all previously scheduled in-person June standards development meetings (including independent meetings) have been canceled. Previously, ASTM International announced the cancellation of all May in-person meetings.

These decisions were based on several factors, including, but not limited to:

- Continued review of information and recommendations from the U.S. Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), and other governmental bodies;
- Input from ASTM International members whose organizations are increasingly concerned with travel; and
- Specific information on the projected city restrictions in Boston, MA, and Washington, DC, with input from the hotels.

ASTM International staff will be contacting committee leaders to plan alternatives for conducting committee business. Visit **www.astm.org** or **www.astm.org/MEETINGS/** for updated information.

In May, ASTM International also announced it is providing no-cost public access to a suite of more than two dozen standards used in the production and testing of personal protective equipment to combat the coronavirus public health emergency. For more information, visit **www.astm.org/COVID-19**.

CIM Program Annual Report

The Concrete Industry Management (CIM) program announced the release of the 2018-2019 annual report. Compiled by the National Steering Committee (NSC), the report was distributed at World of Concrete.

Highlights of this year's CIM annual report include:

- Committee reports (Education, Marketing, Recruitment, Auction, and Finance);
- Institutional reports from all CIM programs;
- MBA program update; and
- Profiles of CIM students, graduates, and faculty.

"The CIM annual report is a testament to the dedication and effort of the CIM program leaders, faculty, and students," said Brian Gallagher, Chairman of the CIM Marketing Committee. "The quality and amount of activity completed by the CIM faculty and students is very impressive." View the annual report at **www.concretedegree.com**.

Over $1 Billion in Grants to 439 Airports in 50 States

U.S. Secretary of Transportation Elaine L. Chao announced that the Department of Transportation's Federal Aviation Administration (FAA) will award over $1.18 billion in airport safety and infrastructure grants. The total includes $731 million in Airport Improvement Program (AIP) grants and $455 million in Supplemental Discretionary grants. The money will be available for 100% of the eligible costs under the Coronavirus Aid, Relief, and Economic Security (CARES) Act.

The combined AIP and Supplemental Discretionary grants will fund a wide variety of projects. Some of these projects will include purchasing aircraft rescue and firefighting equipment, constructing runways and taxiways, repairing runways and taxiways, installing aircraft lighting and signage, conducting airport master plan studies.

"The 439 grants will ensure that airport sponsors can make the necessary improvements so their airports can operate in a safe and efficient manner for years to come," said FAA Administrator Stephen M. Dickson.

A complete list of grants and an interactive map of airports receiving funding is available at **www.faa.gov/airports**.

ESCSI John Ries Scholarship for Academic Year 2020-2021

The Expanded Shale, Clay, and Slate Institute (ESCSI) is accepting applications for the John Ries Scholarship for the academic year 2020-2021 for undergraduate and graduate students in civil engineering or closely related majors.

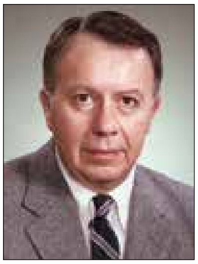
The ESCSI is the international trade association for manufacturers of rotary kiln-produced expanded shale, clay, and slate (ESCS) lightweight aggregate. ESCSI promotes the use of rotary kiln-produced lightweight aggregate in the lightweight concrete masonry and structural lightweight concrete markets, as well as for use in asphalt, geotechnical, and other applications. The association works closely with other technical organizations, including ACI, to maintain product quality, life safety, and professional integrity throughout the construction industry and related building code bodies.

Applications are accepted as self-nominations by undergraduate or graduate students in civil engineering or closely related majors who are enrolled in fall 2020 and will return to school for spring 2021. All applications shall be postmarked no later than October 1, 2020. Applications should include the following:

- The application form signed by the applicant (electronic signature is acceptable); this form is also available as a Google Form at **https://forms.gle/xU9ykvsEbJZ4pbcx9**;
- A one-page statement of qualifications by the student describing motivation in ESCS materials, academic and career goals related to ESCS applications, planned research-based or practice-based projects involving ESCS materials, and/or the value of this scholarship to achieve goals or complete projects (one-page doc or pdf);
- Unofficial transcripts indicating current GPA of 2.75 or higher (pdf); and
- A confidential letter of recommendation by a faculty member signed, dated, and sealed; or sent directly via e-mail to ESCSI by the faculty member with the subject "John Ries Scholarship."

Send completed application and attachments to Expanded Shale, Clay, and Slate Institute, 35 East Wacker Dr., Suite 850, Chicago, IL 60601; info@escsi.org.

In Remembrance


Raths

Charles (Chuck) H. Raths passed away on April 19, 2020, in Nashville, TN, at the age of 85. Professionally, Raths was known as a forensic engineering pioneer. Following his early experience as a designer and researcher, at the age of 32 in 1966, he opened a one-man engineering firm called Chas. H. Raths & Associates. This company was the seed that in 1969 became Raths, Raths & Johnson, Inc., with offices in Chicago and Willowbrook, IL.

Raths received his BS and MS in civil engineering from Michigan State University, East Lansing, MI, in 1959 and 1960, respectively. He began his career as a design engineer with Finkbeiner, Pettis & Strout in Toledo, OH, before joining PCA Structural Laboratories, where, as a development engineer, he performed research and structural testing on precast concrete members and connections. The approach he developed for corbel design won him the Precast/Prestressed Concrete Institute's (PCI) Martin P. Korn Award, and that approach is still used today. He then applied the knowledge he gained at PCA as the Chief Engineer for precast concrete fabricator Crest/Schokbeton.

As a long-standing PCI member, he served on the committee that developed design standards for the first edition of the PCI Design Handbook (1971) and received the PCI Medallion Award for outstanding engineering contributions to his profession. In addition to PCI, he was also an active member of ACI, ASTM International, Structural Engineers Association of Illinois, and the American Society of Civil Engineers (ASCE). Throughout his career, he published numerous technical papers and received many recognitions and honors for his contributions to the engineering and construction industries.

CALL FOR PAPERS

Advances in Rheology and Additive Manufacturing in Construction

Special Issue: *ACI Materials Journal*

Guest Editors: Kamal H. Khayat and Shiho Kawashima

Solicited: Original papers are invited for a special issue of the *ACI Materials Journal* on Advances in Rheology and Additive Manufacturing in Construction. Topics of interest include but are not limited to advanced rheological characterization of fresh cement-based systems; thixotropy, shear thickening, shear-induced migration, and other complex rheological behavior; analytical and computational flow models; rheometry and workability measurements for extrusion-based 3-D printing, particle-bed printing, and other additive manufacturing (AM) techniques; novel AM techniques; mixture design and use of chemical and mineral admixtures to control rheology for successful AM; use of alternative binders and solidification methods for AM; adjusting rheology and print parameters for printability, buildability, reinforcement, interlayer bonding, and other key features of AM.

For consideration, please submit: 1) Paper title; 2) Author name(s), title, affiliation, contact information, and corresponding author; and 3) Abstract with a maximum length of 300 words.

Submit abstracts to s-kawashima@columbia.edu by **June 15, 2020**
Notification of acceptance to submit full paper: **June 30, 2020**
Full paper deadline for peer review: **October 31, 2020**

On the Move

Homa Ghaemi was named Chief Executive Officer of Klein & Hoffman, a structural engineering and architecture firm based in Chicago, IL. Ghaemi, previously COO and Senior Principal, has been with the firm for 19 years. She is a licensed structural engineer with over 35 years of domestic and international experience. She received her bachelor's and master's degrees in civil engineering from The Ohio State University, Columbus, OH, and her MBA from Kellogg School of Management at Northwestern University, Evanston, IL.

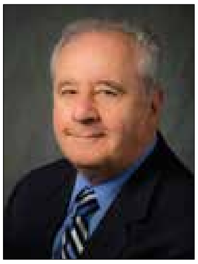
FORTA Corporation announced the retirement of ACI member **Daniel Biddle**, Vice President of Sales. Biddle started his career as the first salesman of synthetic fiber for concrete not only for FORTA but for the Unites States. In 1979, he was hired by Rodger Lindh, FORTA Founder. Biddle's involvement in dozens of organizations, associations, and committees over the years introduced fiber reinforcement to standard-setting industry members. He is a member of ACI Committees 302, Construction of Concrete Floors; 325, Concrete Pavements; 330, Concrete Parking Lots and Site Paving; 360, Design of Slabs on Ground; and 522, Pervious Concrete.

ACI member **Doug Nagel** joined the ownership group at VAA this year. The multidiscipline engineering firm of 150 employees is now privately held by 12 partners. A Senior Structural Engineer, Nagel manages work within VAA's agribusiness and industrial sectors across North America, including the design of grain storage silos, evaluations of process enhancements, and retrofit services for owners, fabricators, and design-build contractors. He started his career at VAA as an intern. He received his undergraduate and graduate degrees in civil engineering from the University of Minnesota Twin Cities, Minneapolis, MN, and his structural experience includes steel, concrete, and slipform design. Nagel is Vice President of the Minnesota Concrete Council and a member of ACI Committee 313, Concrete Bins and Silos.

Honors and Awards

Harvey W. Parker was awarded the Lifetime Achievement Award from the International Tunnelling Association and Underground Space Association (ITA). Parker served as President of the ITA from 2004 to 2007 and as ITA's official representative and spokesperson for sustainable development to the United Nations. The award was given in honor of his significant contributions to signature tunneling projects through innovation, leadership, and expertise. Parker pioneered the development of steel fiber shotcrete in 1972. He has worked on notable projects such as

Nagel



Frangopol

the Mount Baker Ridge Tunnel in Seattle, WA. In addition, he has held adjunct or visiting teaching positions at the University of Illinois and Columbia University. He received his BS in civil engineering from Auburn Polytechnic Institute (now Auburn University), Auburn, AL; his master's degree in civil engineering from Harvard University, Cambridge, MA; and his PhD in civil engineering with a minor in geology from the University of Illinois at Urbana-Champaign, Urbana, IL. He continues his work as a geotechnical and tunnel engineer with Harvey Parker & Associates.

The American Concrete Pavement Association (ACPA) recast its honorary life membership and named it in honor of **Leet "Ed" Denton**, noting his more than 50 years of commitment and service to the association. Denton is the retired President of Denton Enterprises, St. Clair Shores, MI. He became the first recipient of the namesake membership category. Denton was presented the award during a special ceremony at the closing banquet during ACPA's 56th annual meeting.

ACI member **Dan M. Frangopol**, the inaugural Fazlur R. Khan Endowed Chair of Structural Engineering and Architecture at Lehigh University, Bethlehem, PA, and his former postdoc **Yan Liu**, Associate Professor, School of Naval Architecture and Ocean Engineering, Wuhan, Hubei, China, are the recipients of the 2020 Raymond C. Reese Research Prize awarded by the American Society of Civil Engineers (ASCE). According to ASCE, the prize is "awarded to the author or authors of a paper in a print issue of an ASCE journal…that describes a notable achievement in research related to structural engineering and which indicates how the research can be used." The awardees' research was shared with the academic and professional community through the article "Utility and Information Analysis for Optimum Inspection of Fatigue-Sensitive Structures," which appeared in the ASCE *Journal of Structural Engineering*, V. 145, No. 2, Feb. 2019. Frangopol is a member of ACI Committee 348, Structural Reliability and Safety, and Joint ACI-ASCE Committee 343, Concrete Bridge Design.

Chapter Reports

Nandha Engineering College Student Chapter – ACI Visits Plant

The Nandha Engineering College Student Chapter – ACI in Perundurai, Erode, India, organized an industrial visit on the topic of concrete technology for civil engineering students. The trip to RPP Ready Mix Plant, Erode, took place on March 10, 2020. E.K. Mohanraj, Professor and Student Chapter Mentor, organized the site visit technical session.

The attendees learned about ready mixed concrete production and its batching process. Technical experts at RPP discussed admixture use and mixture design formulation to meet concrete specifications. Students experienced real-time production of different grades of ready mixed concrete, including material handling, batching processes, and initial concrete tests. The industrial visit was valuable in that it enhanced the students' understanding of the theoretical topics that comprise concrete technology.

Members of the Nandha Engineering College Student Chapter – ACI visited the RPP Ready Mix Plant in Erode, India

Georgia Chapter – ACI 2020 Dan R. Brown Project Awards

The Georgia Chapter – ACI held its annual Dan R. Brown Awards Banquet on February 28, 2020. More than 180 chapter members and guests gathered for this year's networking social and celebration of Georgia concrete projects for 2019. The keynote speaker for the event was Jeffery W. Coleman, who is now ACI President. He opened the program with some notes on ACI's goals and objectives for 2020.

Kelly Roberts, 2020 Georgia Chapter – ACI President, followed with presentations of the $5000 Robert K. Kuhlman and the $2500 LaGrit "Sam" Morris Memorial Scholarships. This year's awardees were Luna Al Hassani and Daniel Benkeser, respectively.

Al Hassani is currently a second-year PhD student at Georgia Institute of Technology in the civil engineering program. Before pursuing her PhD, she received her bachelor's degree in civil engineering in Jordan and master's degree at the University of Sheffield. Al Hassani is extremely interested in concrete material technologies and making use of readily available materials in novel ways to enhance sustainability and resilience in modern infrastructure. She plans to pursue a career in academia and research with a focus on the durability and sustainability of concrete materials.

Benkeser is currently a third-year PhD student at Georgia Tech in the civil engineering program. Prior to that, he received a bachelor's degree in civil engineering at the University of Illinois, where he studied self-consolidating concrete. He is currently working on research with the Georgia Department of Transportation to find possible reuse options for sediment dredged from the Savannah River. He is continuing to pursue research work on geomaterials and geotechnology.

Georgia Chapter Awards Program Committee members Steven Maloof, Derek Brown, and Wayne Wilson concluded the evening with the presentation of eight first-place awards, 10 awards of excellence, and seven outstanding achievement awards in eight different project categories. This year's first-place award winners included:

- High-Rise—725 Ponce, New City Properties;
- Low-Rise—SAFStor, SAFStor Bishop, LLC;
- Public Works Education—Kendeda Building for Innovative Sustainable Design, Georgia Tech;
- Public Works—Bellwood Quarry Pump Station and Hemphill Tunnel Station, City of Atlanta;
- Parking Deck—Dalney Building, Georgia Tech;
- Restoration—Emory University Convocation Hall, Emory University;
- Hardscape/Special—Hemma Dragon & Brilliant Blue Swirls, Atlanta Botanical Gardens; and

- Industrial—Delta Jet Engine Test Facility, Delta Air Lines, Inc.

—submitted by Wayne Wilson, Executive Director, Georgia Chapter – ACI

ACI Concrete Field Testing Technician – Grade I Certification Exam in Jakarta

The Singapore Chapter – ACI (SC-ACI) successfully conducted its first ACI Concrete Field Testing Technician – Grade I certification examination in Jakarta, Indonesia, on June 8, 2019. The exam was conducted for the technical staff of PT Pionirbeton Industri (PBI), one of the leading ready mixed concrete suppliers in Indonesia. PBI is a subsidiary of Indocement Tunggal Prakarsa (ITP), and ITP's parent company is HeidelbergCement, Germany, the second largest producer of cement in the world.

Ten examinees took the certification examination in the central laboratory of PBI at Pulogadung, Jakarta. Lu Jin Ping, SC-ACI President, and Joseph Lim, SC-ACI Director, were in Jakarta to conduct the exam. The event was coordinated by Arvind Suryavanshi, General Manager, Technical, of PBI, who is also a past Director and Head of the SC-ACI Education Committee.

SC-ACI examiners Joseph Lim and Lu Jin Ping (eighth and ninth from left), with Arvind Suryavanshi (seventh from left) and Kuky Permana (10th from left) of PBI, and the certification examinees and support staff

Kongu Engineering College Participates in ASCE Canoe Competition

The Kongu Engineering College team finished in third place in the 2020 American Society of Civil Engineers (ASCE) Indian Region Concrete Canoe Competition. Team MADRASAPATTINAM was guided by L. Suresh Kumar, Assistant Engineer, Central Public Works Department, Chennai, and G.S. Rampradheep, Associate Professor, Kongu Engineering College. Team members included S.K. Jeeva, V. Gowtham, N. Balaji, J. Karpagavarsini, A.S. Madhan, T. Shimar Ahamed, K. Vignesh Kumar, C.N. Vinish Nandan, J. Omprakash, K. Rakesh, S. Prasath, J. Rahul, V. Ranjani, G. Varrsini, S. Arshiya, G. Gowthaman, P. Kavin, L. Kaven Krishna, R. Aparna, T. Deepika, and Y. Rethanya.

Team MADRASAPATTINAM of Kongu Engineering College

The team approached the project with an integrated plan to rely on the expertise of every individual and encourage them to understand the complete process. The objectives and goals were explained clearly to the team members, which helped them work more effectively.

Research was undertaken to fabricate an economical, eco-friendly canoe by reducing its size. Initially, the hull design was done using AutoCAD and the three-dimensional model was rendered using SOLIDWORKS®. The length of the canoe was optimized to 4.75 m (15 ft 7 in.). A model with a 1:3 scale ratio was constructed for testing drag and studying the dynamic behavior of the canoe. From the knowledge gained regarding the model canoe behavior and material study, a practice canoe was constructed.

The positive mold for the canoe was prepared using medium-density fiber boards, cut into sections with CNC machines to obtain the shape of the hull. These sections were covered with cement mortar to obtain the shape of the canoe. After sanding, cement mortar paste was coated over the mold. After the paste cured, the sanding process was repeated to obtain a smooth surface. For the purpose of easy demolding, an enamel coating was applied over the mold. To impart sustainability to the project, glazed iso balls (GIB), a recycled waste glass product, were used as an aggregate. The baseline materials used for canoe construction were ordinary portland cement 53 Grade (53 MPa [7690 psi]), glass fiber mesh, GIB, and admixtures.

The completed concrete canoe weighed about 114 lb (52 kg).

aci Foundation Awards Student Fellowships and Scholarships for 2020-2021

Twenty students receive financial aid from the ACI Foundation

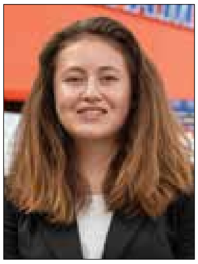
The ACI Foundation has announced its 2020-2021 Fellowship and Scholarship recipients. The ACI Foundation is a nonprofit subsidiary of ACI that promotes progress, innovation, and collaboration in the concrete industry through strategic investments in research, scholarships, and ideas. With the help of generous donors, the ACI Foundation strongly supports students joining the field of concrete and becoming our future designers, engineers, construction managers, and contractors. The ACI Foundation has provided financial support, mentorship, and internship opportunities in the concrete industry to 175 students in the last decade.

ACI Foundation Student Fellowships

The ACI Foundation Student Fellowships are offered to high-potential undergraduate and graduate students in engineering, construction management, and other appropriate curricula who are endorsed by an ACI member. The purpose of the Student Fellowship Program is to identify, attract, and develop outstanding professionals for productive careers in the concrete field. During the academic year, each student will receive a $10,000 to $15,000 educational stipend, paid travel expenses and attendance fees to attend two ACI Conventions, and assistance in finding an industry mentor. The recipients include:

ACI Foundation Concrete Materials Fellowship

Madeleine Murphree is pursuing her bachelor's degree in civil engineering with a focus on materials at the University of Florida, Gainesville, FL. She became interested in concrete after attending a batching-and-mixing session for the concrete canoe team during her first year at the university. "After a recommendation from one of the captains, I started doing personal reading into the microstructure of concrete and quickly became fascinated with all the possibilities for concrete production and use," she said. Murphree was recently chosen to be a mixture design captain for the University of Florida concrete canoe team. She is an active member of the new ACI student chapter at the University of Florida and attended the ACI Concrete Convention – Fall 2019 in Cincinnati, OH, where she participated in the ACI Fiber-Reinforced Polymer (FRP) Composites competition. Murphree's long-term goal is to obtain her PhD and work in academia.

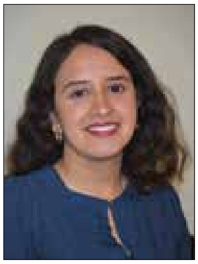


Murphree

Al Shanti

ACI Middle East Fellowship

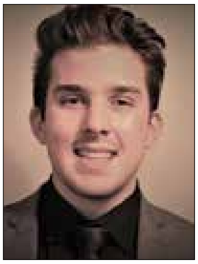
Siham Al Shanti is a graduate student at the United Arab Emirates University, Al Ain, United Arab Emirates (UAE), where she also completed her undergraduate studies. She is currently working on her MSc thesis, "Reuse of Sewage Sludge Ash in Producing Self-Compacted Concrete." The main goal of this research is to mitigate the negative impacts of sewage sludge ash by implementing it in the production of a sustainable self-compacting concrete. Recently, she coauthored a research paper titled "Characterization of Sewage Sludge Ash as Affected by Different Temperature and Time," which she also presented at the International Conference of Sustainable Construction Materials and Technologies at Kingston University, London, UK. She attended her first ACI Concrete Convention in Québec City, QC, Canada, in Spring 2019. "This experience motivated me to enhance my civil engineering background and spread knowledge among students in my country," she said.

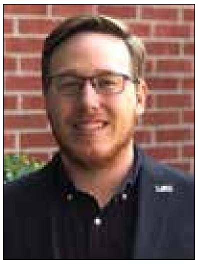

Hernandez-Bassal


Cottongim


Thangjitham


Witte


Coleman


Upshaw

ACI Presidents' Fellowship

Laura Hernandez-Bassal is a doctoral student at the University of California, Davis, Davis, CA. After graduating with her master's degree, she started her career as a Structural Engineer at Gilsanz Murray Steficek (GMS), a structural design firm. During her time at GMS, she became certified as an ACI Concrete Field Testing Technician – Grade I. For her doctoral research, she plans to analyze several instrumented concrete buildings in California and assess their performance based on the provisions in ASCE/SEI 41-17, "Seismic Evaluation and Retrofit of Existing Buildings," as well as other more recent approaches. "I have continuously been fascinated by reinforced concrete as a building material through my structural design experience and research activities. Now, as a doctoral student, understanding the behavior and response of concrete buildings to earthquakes has become a major portion of my research objectives," Hernandez-Bassal said.

Baker Student Fellowship

Maya Cottongim is an undergraduate student at Northwestern University, Evanston, IL. During the summer of 2019, she worked as an intern at Flood Testing Laboratories, where she immersed herself in the world of construction and developed a new perspective on how cities are built. "Applying knowledge that was learned in a classroom setting into real-life construction has drastically changed my perspective of how I view my studies," Cottongim said. She is the Treasurer of the student chapter of the American Society of Civil Engineers (ASCE) at Northwestern. Previously, she was involved in the construction process for the ASCE National Concrete Canoe Competition. Of her career goals, Cottongim said, "I hope to construct skyscrapers around the world that push limits and utilize materials in the most efficient way possible."

Barbara S. and W. Calvin McCall Carolinas Fellowship

Jessica Thangjitham is a PhD student at North Carolina State University, Raleigh, NC. Her research deals with reimagining how reinforced concrete is used to withstand unpredictable seismic loads. Her interest in concrete was originally sparked through her involvement with her university's concrete canoe team. Her passion and curiosity grew through internships on concrete bridge construction sites. Following her undergraduate studies, she transitioned to a career as a structural engineer at a multidisciplinary firm. "I had the opportunity to work on a diverse array of concrete design projects where I excelled at developing designs that met building codes while fostering constructability. I was the lead designer on a repair of the hurricane-damaged Miami Airport Control Tower, using complex wind tunnel test data to design a unique concrete repair," she said. Thangjitham hopes to pursue a career as a professor, which will allow her to bring state-of-the-art research into classroom courses.

Charles Pankow Foundation Student Fellowship

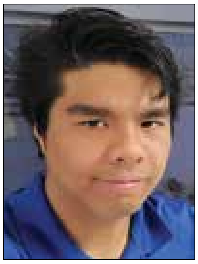
Andrew Witte is a student at Valparaiso University, Valparaiso, IN. In the summer of 2019, he interned with Smith Ready Mix, where he worked in quality control. "My firsthand experience at the plant helped me understand more fully the process of how concrete is carefully formed and mixed," Witte said. During his internship, he learned the proper disposal procedures that truck drivers must follow, and he is very interested in sustainability. Witte believes that engineering codes of ethics need to make sustainability a priority. "As a residential life employee, I am planning a sustainability program in my dorm to educate anyone concerned with the environment about proposed actions to change various engineering codes of ethics," he said.

Daniel W. Falconer Memorial Fellowship

Zachary Coleman is pursuing his PhD at Auburn University, Auburn, AL. His career aspirations include becoming a university professor with the aim of researching ways to make reinforced concrete structures more sustainable and resilient against natural disasters. "My passion for concrete structures and materials was kindled during my sophomore year of undergraduate study at Lafayette College when Dr. David Mante offered me a position on his research team," he said. The goal of the research team's experiment was to develop a sacrificial sensor capable of measuring the in-place elastic modulus of a concrete specimen. "Currently, Dr. Mante and I are in the process of publishing the results of our sensor testing inside small- and large-scale concrete specimens," Coleman said.

Darrell F. Elliott Louisiana Fellowship

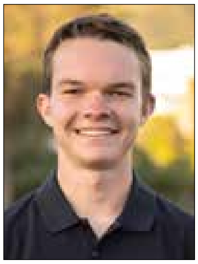
Matthew Upshaw is a doctoral student at Louisiana State University, Baton Rouge, LA. "I first became intrigued by the



Orense

Carper

Bailey



Slavin

idea of a career in the concrete industry during my third year of undergraduate studies in my reinforced concrete design class," Upshaw said. Prior to this, he had considered focusing his career on environmental engineering. After a summer spent working in his local Department of Transportation construction office, he began preparing for graduate school with a focus on structural engineering programs. Upon completing his doctoral studies, he plans to continue researching novel ideas about concrete and how it can be modified as a green building material. "I am convinced that geopolymer concrete and recycled-aggregate concrete represent the next step in the evolution of concrete," he said.

Don Marks Memorial Fellowship

David Orense is finishing his bachelor's in civil engineering at the University of Florida (UF), Gainesville, FL, and will pursue graduate studies at the Pennsylvania State University, State College, PA. During his summers as an undergraduate, he interned at Vector Corrosion Services and Argos Ready-Mix and was able to explore different aspects of the concrete industry. "I am actively seeking internships with concrete design companies to complete a full 'cradle-to-grave' knowledge of the typical concrete structure life cycle," he said. In the past, he has served as the mixture design lead of his school's concrete canoe design team. During his final undergraduate year, he served as the President of the UF Student Chapter – ACI and will join the newly formed student chapter at the ACI Concrete Convention – Fall 2020 to compete in the FRP Composites Competition.

Elmer Baker Fellowship

Samuel Carper is a civil engineering student at the University of Cincinnati, Cincinnati, OH. He credits his grandfather—an ironworker and concrete finisher—with instilling an early passion in him for concrete work and encouraging him to enroll in college. "It is an art and trade that most people take for granted," he said. His first co-op position, with Baker Concrete, was an enriching experience. "I have had the opportunity to travel across the country building some of the most innovative and creative structures of this generation," Carper said. "There has never been a dull moment, and I knew from my first day on site that I was where I was meant to be," he continued. Carper is an ACI student member and has been a member of a National Concrete Canoe Competition team.

Richard D. Stehly Memorial Fellowship

Peyton Bailey is a civil engineering student at the University of Louisiana at Lafayette, Lafayette, LA. As a research apprentice, he has worked on projects such as increasing the lifespans of roadways and experimenting with the conductivity of cement-based piezoelectric composite mixtures. He is a member of his school's American Society of Civil Engineers (ASCE) student chapter and was elected by his peers to be captain of the 2020 concrete canoe team. Bailey has also been elected President of the University of Louisiana at Lafayette Student Chapter – ACI. "As president, one of my goals is to encourage sustainability in all competitions and projects," he said. As such, he joined a team to compete in ASCE's first Sustainable Solutions Competition, which challenged teams to design and construct a sustainable doghouse. "Our team placed second place in the regional competition and third place in the national competition," Bailey said. "I was able to learn about sustainability and its importance to the future of industry."

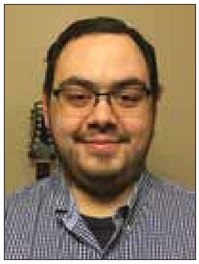
Tribute to the Founders Fellowship

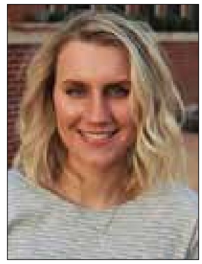
Nicholas Slavin, a student at California Polytechnic State University, San Luis Obispo, CA, previously conducted an 8-week research internship at the University of Auckland, Auckland, New Zealand. The primary project during this internship involved developing retrofit techniques for unreinforced masonry cavity walls subjected to out-of-plane loading. "Through papers for the Australian and New Zealand earthquake engineering societies, I hope to affect seismic code and provide industry with efficient retrofit techniques," he said. At California Polytechnic State University, he conducts research on the 2017 Puebla, Mexico, earthquake. Slavin has also held an internship with KNA Structural Engineers and is the design lead of his school's Earthquake Engineering Research Institute (EERI) student chapter. Going forward, he wants to research practical retrofit solutions that will be directly applicable to engineers and organizations like ACI. Of his career aspirations, Slavin said, "I hope to improve seismic performance of concrete structures and affect code development and public safety."

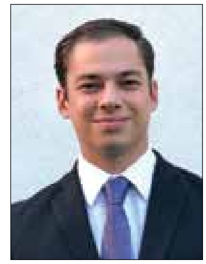
ACI Foundation Graduate and Undergraduate Scholarships

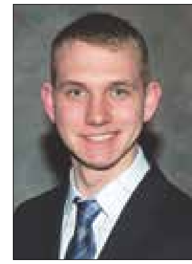
Funded primarily through donations, the ACI Foundation administers these scholarships, which are offered to high-


Haney


O'campo


McArtor


Ibarra Davila


Steger

potential, full-time, first- or second-year (after bachelor's degree) graduate students. During the academic year, each student will receive a $5000 educational stipend for tuition, residence, books, and materials, as well as appropriate certificates, recognition, and publicity. The Richard D. Stehly Memorial Scholarship is awarded to an undergraduate student.

Recipients of the 2020-2021 ACI Foundation Graduate and Undergraduate Scholarships are:

ACI Scholarship

Zachary Haney is studying civil engineering at the Illinois Institute of Technology (IIT), Chicago, IL. While a high school student, a summer internship in the field of concrete testing led Haney to obtain his ACI Concrete Field Testing Technician – Grade I certification. He has been an active member in the IIT American Society of Civil Engineers (ASCE) chapter and is the current President. Haney works part-time at Thornton Tomasetti in Chicago, IL, where he is gaining knowledge about ACI codes and specifications for resilient design, especially in foundations and shear walls. He plans to stay with the firm to gain more experience. "Overall, I hope to impact the structural engineering community with my knowledge of concrete due in part to ACI," Haney said. "With my whole career ahead of me, I am excited to develop our cities and infrastructure in a positive manner for many years to come."

Joseph O'campo attends the University of North Carolina (UNC) at Charlotte, Charlotte, NC. After the freshmen-level course "Construction Materials" taught by Tara Cavalline, he was inspired by her to join both ACI and the UNC Charlotte Student Chapter – ACI team that competed in the Concrete Construction competition. For the past 2 years, O'campo has been a member of a research team headed by Cavalline and Brett Tempest, working on projects for the North Carolina Department of Transportation. He has enrolled in the early entry program for UNC Charlotte's MS in construction and facilities management. The research project for his thesis will evaluate the effectiveness of the Super Air Meter and implement a new performance specification based on it for North Carolina. "Like the beginning of my journey into the material known as concrete, I would like the end to be in a classroom; however, this time I want to be the one who inspires the next generation," O'campo said.

Bertold E. Weinberg Scholarship

Erinn McArtor is pursuing her MS at Oklahoma State University, Stillwater, OK. She is a graduate research assistant focused on concrete shrinkage and cracking. She is working with another student and professor Tyler Ley to create a specification for the Oklahoma Department of Transportation to reduce cracking in bridge decks. McArtor attended her first ACI Convention in Fall 2019 in Cincinnati, OH, and described it as a very eye-opening experience. "Being surrounded by thousands of industry professionals and academic leaders made me realize how many people work together to inspire innovation in the concrete industry," she said. She looks forward to becoming a contributing ACI member. McArtor's career goal is to obtain her professional engineering license and work as a structural engineer designing bridges and structures or as a materials engineer researching and testing concrete.

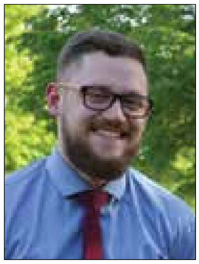
Katharine & Bryant Mather Scholarship

Daniel Ibarra Davila is finishing his undergraduate studies at the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) – Mexico, Monterrey, Mexico. He will be pursuing his master's degree in construction management at the University of Illinois at Urbana-Champaign, Urbana, IL. Through internships, Ibarra Davila has visited project jobsites and gained appreciation for how workers build formwork for slabs and columns and place concrete for these structural elements. He has also had training on the factors that can affect concrete strength and how to take an adequate sample for strength testing. Ibarra Davila plans to further his knowledge by taking courses about construction optimization and decision risk analysis. "I believe that my internships and academic courses regarding the concrete industry, together with some construction management courses, will open more opportunities for me," he said. His goal is to become a construction supervisor delivering the best quality possible for each project.

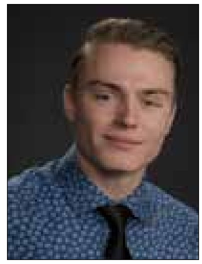
Richard D. Stehly Memorial Scholarship

Benjamin Steger is attending the University of Missouri – Columbia, Columbia, MO, for his BS focusing on concrete and reinforced concrete design. He is a member of the University of Missouri concrete canoe team and works part-time for Aaron Saucier in the Department of Civil and Environmental Engineering. While taking a civil materials

Peabody



Choma



Vachon

course, Steger earned his ACI Concrete Field Testing Technician – Grade I certification to prepare for future employment involving the use of concrete and cementitious materials. Steger's work with Saucier is leading to future research opportunities in designing blast-resistant structures to mitigate the loss of life that occurs during blast events. He intends to serve as an engineering officer in the U.S. Army after graduation. "Reinforced concrete is the fundamental building block of the defensive structures and key infrastructure that protects coalition soldiers and the civilian populations they defend," Steger said.

Schwing America Scholarship

Daniel Peabody is enrolled in the Concrete Industry Management (CIM) MBA program at Middle Tennessee State University, Murfreesboro, TN. He is currently working for a ready mixed concrete supplier. "There are few industries that allow you to spend a morning in a 40-foot hole in a contentious but professional argument and an afternoon in the boardroom participating in multimillion-dollar negotiations," Peabody said. When offered an opportunity to further his education through the CIM MBA program, he jumped at the chance. He believes that increased knowledge will improve his ability to make decisions about the product he sells. "It is fulfilling to know that our cities and infrastructure cannot be built without people like me," Peabody said. "In addition to maintaining the profitability of my current company, I feel that it is my mission to further concrete's status as the world's most important product," he added.

Stewart C. Watson Memorial Scholarship

Michael Choma is a graduate student at Cleveland State University, Cleveland, OH. He was first introduced to the concrete industry when taking a reinforced concrete class taught by Srinivas Allena at Washington State University, Pullman, WA. He then worked with Allena as an undergraduate research assistant to help several graduate students in their work on ultra-high-performance cementitious composites and their use as an encapsulation grout for nuclear waste. Starting in the fall of 2019, Choma decided to focus his civil engineering career on concrete as a structural building material. He followed Allena to Cleveland State University to continue his education through its master's research program. Choma hopes to start an ACI student chapter at Cleveland State University. "I am confident that the students at Cleveland State will be able to benefit from the student chapter in ways that will also help guide them in their career goals in the concrete industry," he said.

W. Gene Corley Scholarship

Thomas Vachon is pursuing his MS at the University of Saskatchewan, Saskatoon, SK, Canada. When he was 10 years old, he helped construct his family's new house by building forms and placing concrete for the strip footings. Vachon chose to study masonry because of the complexity of the structural assemblage composed of four elements: blocks, grout, mortar, and reinforcement. His research addresses a gap related to the design of masonry subject to flexure by reevaluating the compressive stress reduction factor included in CSA S304 code equations. In the future, Vachon would like to contribute to ACI Subcommittee 440-M, FRP-Repair of Masonry Structures. He aspires to work for an international structural engineering consulting firm while obtaining his professional engineering designation. After getting work experience, Vachon hopes to pursue a PhD to further his specialization in the repair of masonry structures and enjoy a consulting career solving complex structural problems.

Submissions Are Encouraged

ACI Foundation Graduate and Undergraduate Fellowships and Scholarships are available to applicants whose studies relate to concrete and who are endorsed by at least one ACI member. The online application for the 2021-2022 academic year will be available July 1, 2020. Visit **www.acifoundation.org/scholarships** for submission instructions.

If you are an ACI member and know of a student who is deserving of a scholarship or fellowship, please encourage them to apply. Your inspiration may be the vital impetus toward a lifetime of discovery.

ACI Technical Committee Chairs Appointed

Before the virtual ACI Concrete Convention – Spring 2020, the ACI Technical Activities Committee (TAC) selected Chairs for 31 ACI technical committees. These actions became effective after the Convention.

New Appointments

Technical Activities Committee: Michael C. Brown, WSP USA, Herndon, VA; replaced Lawrence F. Kahn, Georgia Institute of Technology, Lilburn, GA.

133, Disaster Reconnaissance: Santiago Pujol, University of Canterbury, Christchurch, New Zealand; replaced Michael E. Kreger, University of Alabama, Tuscaloosa, AL.

211, Proportioning Concrete Mixtures: Ezgi Wilson, Transport for NSW, Sydney, Australia; replaced Timothy S. Folks, Hawaiian Cement, Aiea, HI.

231, Properties of Concrete at Early Ages: Kyle Austin Riding, University of Florida, Gainesville, FL; replaced W. Jason Weiss, Oregon State University, Corvallis, OR.

313, Concrete Bins and Silos: David C. Mattes, Hoffmann Inc., Muscatine, IA; replaced Timothy A. Harvey, Columbus, OH.

315, Details of Concrete Reinforcement (Joint ACI-CRSI): Christopher James Perry, Perry Associates LLC, Chicago, IL; replaced Richard H. Birley, Langley, BC, Canada.

369, Seismic Repair and Rehabilitation: Adolfo B. Matamoros, University of Texas at San Antonio, San Antonio, TX; replaced Wassim M. Ghannoum, University of Texas at San Antonio, San Antonio, TX.

376, Concrete Structures for Refrigerated Liquefied Gas Containment: Rolf P. Pawski, Landmark Structures, Wheaton, IL; replaced Kare Hjorteset, WSP, Seattle, WA.

435, Deflection of Concrete Building Structures: Dylan Freytag, Pivot Engineers, Austin, TX; replaced Eric S. Musselman, Villanova University, Villanova, PA.

437, Strength Evaluation of Existing Concrete Structures: Aaron K. Larosche, Pivot Engineers, Austin, TX; replaced Paul H. Ziehl, University of South Carolina, Columbia, SC.

506, Shotcreting: Simon Reny, Sika Canada, Boisbriand, QC, Canada; replaced Marc Jolin, Laval University, Québec City, QC, Canada.

524, Plastering: Mark R. Lukkarila, Beton Consulting Engineers, Mendota Heights, MN; replaced Larry Rowland, Lehigh White Cement Company, West Palm Beach, FL.

533, Precast Panels: Karen Polanco, Metromont Corporation, Brandon, FL; replaced David Wan, Oldcastle Infrastructure, Selkirk, NY.

543, Concrete Piles: David L. Hartmann, Frank W. Neal & Associates, Inc., Fort Worth, TX; replaced Domenic D'Argenzio, Mueser Rutledge Consulting Engineers, New York, NY.

Reappointments

121, Quality Assurance Systems for Concrete: Michelle E. Walters, Hatch, Mississauga, ON, Canada.

221, Aggregates: Anol Kanti Mukhopadhyay, Texas A&M Transportation Institute, College Station, TX.

222, Corrosion of Metals in Concrete: O. Burkan Isgor, Oregon State University, Corvallis, OR.

239, Ultra-High-Performance Concrete: Benjamin Graybeal, Federal Highway Administration, McLean, VA.

307, Concrete Chimneys: Denis J. Radecki, Terre Haute, IN.

314, Simplified Design of Concrete Buildings: Esteban Anzola, WSP, Coral Gables, FL.

325, Concrete Pavements: Kurt D. Smith, Applied Pavement Technology, Inc., Urbana, IL.

343, Concrete Bridge Design (Joint ACI-ASCE): Michael C. Brown, WSP USA, Herndon, VA.

349, Concrete Nuclear Structures: Adeola K. Adediran, Savannah River Remediation, Aiken, SC.

360, Design of Slabs on Ground: Scott M. Tarr, North S.Tarr Concrete Consulting, Dover, NH.

365, Service Life Prediction: Kyle D. Stanish, Tourney Consulting Group, Kalamazoo, MI.

377, Performance-Based Structural Integrity & Resilience of Concrete Structures: Mehrdad Sasani, Northeastern University, Boston, MA.

378, Concrete Wind Turbine Towers: Daniel A. Kuchma, Tufts University, Medford, MA.

421, Design of Reinforced Concrete Slabs (Joint ACI-ASCE): Mustafa A. Mahamid, University of Illinois at Chicago, Chicago, IL.

441, Reinforced Concrete Columns (Joint ACI-ASCE): Mohamed A. ElGawady, Missouri S&T, Rolla, MO.

445, Shear and Torsion (Joint ACI-ASCE): Abdeldjelil Belarbi, University of Houston, Houston, TX.

546, Repair of Concrete: Peter Barlow, Contech Services Inc., Seattle, WA.

ACI Board Committee Members Thanked

These ACI members have ended terms on Standing Board Committees as of the virtual ACI Concrete Convention – Spring 2020. Their service to the Institute is appreciated.

Certification Programs Committee: Joe Hug (past Chair), The Monarch Cement Company, Olathe, KS; and Augusto H. Holmberg, Instituto del Cemento y del Hormigón de Chile, Santiago, Chile.

Chapter Activities Committee: Alejandro Duran-Herrera, Universidad Autónoma de Nuevo León, San Nicolás de los Garza, NL, Mexico.

Committee on Codes and Standards Advocacy and Outreach: Ki Yong Ann, Hanyang University, Ansan, The Republic of Korea; Jeffrey W. Coleman, The Coleman Law Firm, LLC, Minneapolis, MN; Lawrence C. Novak, International Code Council, Country Club Hills, IL; Constandino Sirakis, NYC Department of Buildings, New York, NY; and Charles A. Zalesiak, Dominion Energy, Glen Allen, VA.

Construction Liaison Committee: Larry G. Karlson (past Chair), PCL Constructors, Inc., Bellevue, WA; James N. Cornell Jr., JN Cornell Associates, LLC, Mansfield, TX; and Alma L. Reyes, AURAC Consultoría y Construcción SA de CV, Mexico City, DF, Mexico.

Financial Advisory Committee: Jeffrey W. Coleman, The Coleman Law Firm, LLC, Minneapolis, MN; and Debrethann R. Orsak, Cagley Associates, Inc., Rockville, MD.

Honors and Awards Committee: Sharon L. Wood (past Chair), University of Austin at Texas, Austin, TX; and Neven Krstulovic-Opara, ExxonMobil Production, Spring, TX.

International Advisory Committee: Neven Krstulovic-Opara (past Chair), ExxonMobil Production, Spring, TX.

International Project Awards Committee: Anne M. Ellis (past Chair), Charles Pankow Foundation, McLean, VA; Alain Belanger, Mississauga, ON, Canada; Rita Madison, ARMCA, Little Rock, AR; and Quinn McGuire, The Euclid Chemical Company, Las Vegas, NV.

Standards Board: Sharon L. Wood (past Chair), University of Texas at Austin, Austin, TX.

Student and Young Professional Activities Committee: Megan M. Huberty, American Engineering Testing, Inc., St. Paul, MN.

Technical Activities Committee: Lawrence F. Kahn (past Chair), Georgia Institute of Technology, Lilburn, GA; Neven Krstulovic-Opara, ExxonMobil Production, Spring, TX; Kimberly E. Kurtis, Georgia Institute of Technology, Atlanta, GA; and Michael S. Stenko, Transpo Industries, Inc., New Rochelle, NY.

Code
Advocacy

Position Statements Facilitate Advocacy

ACI's nine declarations support code development and industry cooperation

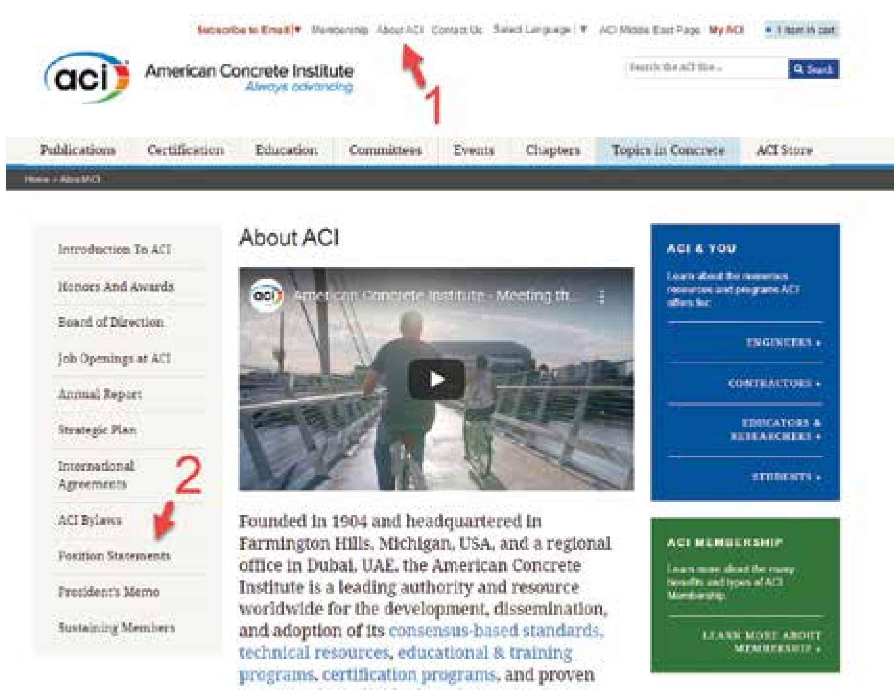
by Robert J. Frosch and Stephen S. Szoke

During the Spring and Fall 2019 ACI Concrete Conventions, the Institute's Board of Direction approved six position statements to facilitate advocacy and outreach efforts related to the development of codes and standards. Success in codes and standards development often relies on building relationships and fostering support from like-minded groups. While position statements are instrumental for these activities, the statements may also be used to communicate ACI programs and activities to a multitude of audiences. During the Spring 2020 Board of Direction meeting, three additional position statements were approved. These statements emphasize ACI's role in influencing programs, policies, rules, and regulations related to concrete and concrete technology.

Because many other organizations communicate their positions and policies via statements, ACI's position statements can allow the Institute to more easily align its efforts with like-minded organizations. The statements are valuable in venues at all levels: local, state, national, and international—anywhere ACI may benefit from influencing programs, rules, regulations, legislation, and related endeavors. Where ACI position statements are in alignment with those of other organizations, they may be used to enhance relationships and encourage collaboration.

Policies and Procedures

A position statement is initiated by the ACI Committee on Codes and Standards Advocacy and Outreach (CSAO), which identifies an issue and ballots a draft statement as a recommendation to the ACI Executive Committee. If approved by the Executive Committee, a statement is advanced to the ACI Board of Direction for approval. Successful statements are classified as either position statements (PS)



The approved position statements are posted for public viewing on the ACI website on the "About ACI" page

or standing position statements (SPS).

Statements assigned to the former class must be reviewed every 3 years to ensure continuing alignment with ACI's mission and the goals and objectives of ACI's strategic plan. These position statements may be reapproved, revised, or terminated. Statements assigned to the latter class have been determined to be fundamental to the core activities, mission, and goals of ACI. Standing position statements are reviewed for revision or termination only when a member of CSAO, the Executive Committee, or the Board requests a review.

Benefits

Among many associations, adoption of position statements is a common technique for establishing guidelines and providing direction for representatives influencing relevant standards and regulations developed by other entities. While ACI has previously had only limited efforts toward pursuing or influencing national and international programs, policies, and standards, inaction is not compatible with the objectives of the outreach strategic goal in the ACI strategic plan: "actively seek opportunities to advance national and global outreach" and "establish relationships with regulatory authorities to advance adoption."

Advocacy efforts involve commitments to support activities that influence local, state, national, and global policies, positions, and program initiatives that are aligned with ACI's vision, mission, and strategic plan. Effective outreach requires that sanctioned ACI representatives attend and actively participate in meetings and hearings. Because simultaneous balloting of appropriate ACI members or committees is not feasible, the adopted position statements serve as a mechanism allowing representatives to make timely responses, thus establishing ACI as an entity capable of being engaged in development of policy positions. Position statements are thus valuable instruments that provide ACI the opportunity to benefit in local, state, national, and international policy and program initiatives that are consistent with ACI's mission, vision, and strategic plan.

Current Statements

ACI now has nine position statements on advocacy efforts related to code development and adoption. The three most recently approved statements encourage the development and use of ACI programs, services, and standards. The statements are listed herein, with position statements designated as SPS or PS in the title:

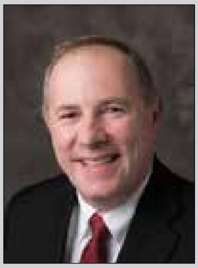
- **Current Code and Standard Adoption (SPS)**. Encourage the adoption and/or use of current building codes and standards;
- **Adoption of ACI Documents without Modifications (SPS)**. Encourage the adoption and use of ACI products including, but not limited to, codes and standards, without modification;
- **Acceptance of ACI Certification Programs (SPS)**. Support the use of certifications as requirements for acceptance of sampling, testing, inspection, and installation of concrete and related products and materials; encourage the use of certification programs developed and administered by professional societies in lieu of programs developed and administered by other entities; and support mandates or other preferences on accreditation of individuals and entities engaged in providing services related to concrete and concrete products;
- **Concrete Knowledge (SPS)**. Support research, technological advancements, and dissemination of concrete technology; and encourage such programs, where applicable, be channeled through, directed to, or otherwise engaged with ACI and/or the ACI Foundation;
- **Enhanced Resilience (PS)**. Encourage or establish criteria related to enhancing the resilience of the built environment; and, where appropriate, engage ACI and/or the ACI Foundation to facilitate programs and activities related to the role of concrete technology in achieving enhanced resilience;
- **Sustainability (PS)**. Encourage or establish criteria related to enhancing the sustainability of the built environment; and, where appropriate, engage ACI and/or the ACI Foundation to facilitate programs and activities related to the role of concrete technology in achieving enhanced sustainability;
- **Professional Societies (SPS)**. Encourage and place preference on programs and services developed by professional societies and encourage the use of ACI programs and services where related to the advancement of concrete technology;
- **New Standards (SPS)**. Encourage new standards related to concrete technology be developed through ACI, or otherwise involve ACI in the development process; and
- **ACI Chapters (SPS)**. Encourage the dissemination of concrete technology and acceptance and adoption of ACI codes and related materials through ACI chapters.

Advocacy and Outreach

ACI's position statements have already been useful in better communicating ACI positions in codes and standards development and in setting public policy. The statements have facilitated ACI collaboration and activities with the Alliance for National and Community Resilience, Building Owners and Managers Association, Green Building Institute, International Code Council, National Fire Protection Association, National Institute of Building Sciences, Resilience Building Coalition (hosted by the American Institute of Architects), and U.S. Green Building Council.

Continued collaboration based on the Institute's position statements will help ACI align efforts with other organizations to better influence programs, policies, rules, and regulations related to concrete and concrete technology.

Selected for reader interest by the editors.



Robert J. Frosch, FACI, is a Professor of civil engineering and Senior Associate Dean of Facilities and Operations in the College of Engineering at Purdue University, West Lafayette, IN. A past member of the ACI Board of Direction, he is currently Chair of the Committee on Codes and Standards Advocacy and Outreach and a member of the ACI Technical Activities Committee and ACI Committee 318, Structural Concrete Building Code. He is also Chair of ACI Subcommittee 318-D, Members, and is Editor-in-Chief of the *ACI Structural Journal*. He is the recipient of the ACI 318 Distinguished Service Award, the 2014 ACI Foundation Arthur J. Boase Award for outstanding structural research, and the 2020 ACI Joe W. Kelly Award. He received his BSE from Tulane University, New Orleans, LA, and his MSE and PhD from The University of Texas at Austin, Austin, TX.

Stephen S. Szoke, FACI, is an ACI Code Advocacy Engineer. He is a Staff Liaison for the Committee on Codes and Standards Advocacy and Outreach, ACI Board Committee Chairs, and ACI Committee 130, Sustainability of Concrete.

Let There Be Light

Viettel Offsite Studio in Hanoi was strategically designed to let in light and nature

by Deborah R. Huso

Few materials demonstrate how simple design and construction can create startlingly beautiful places as well as concrete. This is especially true for the newly completed office space and pavilions for the Vietnamese telecommunications group Viettel on the outskirts of Hanoi, Vietnam.

Through a striking use of concrete walls placed to create a series of V-shaped rooms facing walls of glazing, the structure—known as the Viettel Offsite Studio—establishes a refuge from the city and guides the eye toward green space (Fig. 1).

Amplifying Nature

Designed by Vo Trong Nghia Architects (VTN Architects), which has offices in both Hanoi and Ho Chi Minh City, Vietnam, the 1427 m^2 (15,360 ft^2) Viettel Offsite Studio uses geometry to amplify visitors' experience of the building's natural surroundings. Situated on the Viettel Academy campus in Hanoi's Thạch Thất district about 30 km (18.6 miles) from the city center, the building is mainly a meeting space and retreat for the company's executives. The building's structure and façade are concrete and glass (Fig. 2), while the interior showcases tall walls of glazing and spaces designed with metal and wood (Fig. 3).

Defined by six V-shaped structures that open like books to a lake and garden view (Fig. 4), the facility contains four indoor studios, a reception space (Fig. 5), and a dining hall. Opening to the north, the interconnected rooms take advantage of soft daylighting. The terraced roof gardens serve as outdoor studio spaces. While the tall concrete walls shield the courtyards and roof gardens from the harsher sunlight of morning and afternoon, small openings in the walls provide

Fig. 1: The Viettel Offsite Studio on the Viettel Academy campus in Thạch Thất district, Hanoi, Vietnam

gentle lighting and breezes for the occupants (Fig. 6 and 7).

Vo Trong Nghia, Principal at VTN Architects, says his firm's first purpose was "to design a building with open spaces to take advantage of the site's surrounding landscape, such as hills, trees, and a big lake."

Fig. 2: Concrete and glass are the main components of the building's structure and façade

Fig. 3: One of the meeting spaces at the Viettel Offsite Studio

Fig. 4: V-shaped concrete structures open like books to a lake and garden view

Fig. 5: A reception area at the Viettel Offsite Studio

Fig. 6: One of the terraced rooftop gardens at the Viettel Offsite Studio

Fig. 7: Stepped square cutouts in the slabs allow some direct sunlight to pass onto the courtyards created by the V-shaped units

Segmenting Space

The V-shaped concrete façades pitch into one another at slight angles to create a triangular apex at the top of the connecting walls. Each apex shields the entrance to the enclosed space to the north. The overall effect is an architecture resembling the brutalist style of the mid-twentieth century.

Each set of bookended walls exhibits differing heights to create what Nghia calls "a rhythm that blends into the beautiful landscape of the faraway hills and mountains." This "open-book" design compels the structure's occupants to focus their attention on the outdoors. The V-shaped blocks follow the lay of the land and are all connected by a single-story open corridor (Fig. 8).

Made of cast-in-place concrete, each wall is 450 mm (18 in.) thick. The maximum wall height is 30 m (98 ft). Nghia indicates the design team employed cast-in-place concrete intentionally from the start. "Precast concrete would have provided a better quality of concrete," he adds, "but it cannot provide high units." Cast-in-place concrete also allowed for rigid connections between placements.

Fig. 8: A single-story open corridor connecting V-shaped buildings at the Viettel Offsite Studio

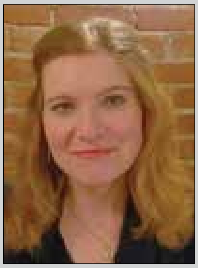
Nghia also points to the uniqueness of the concrete itself: "We used raw concrete with unfinished layers," he explains. While such finish is very popular in developed countries like Japan, Korea, and the United States, it is quite rare in Vietnam. The design team's goal was to use raw concrete to emulate the rustic, natural experience of the building while also reducing long-term maintenance needs.

While the total project construction time took about a year and a half, erection of the exterior structure took only about 10 months, according to VTN Architects. The building was opened for business in July 2019.

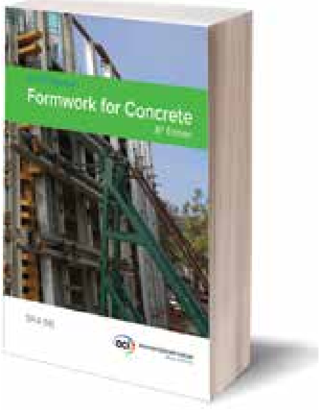
Acknowledgment

All photos courtesy of Vo Trong Nghia Architects.

Selected for reader interest by the editors.



Deborah R. Huso is Creative Director and Founding Partner of WWM, Charlottesville, VA. She has written for a variety of trade and consumer publications such as *Precast Solutions*, *U.S. News and World Report*, *Concrete Construction*, and *Construction Business Owner*. She has provided website development and content strategy for several Fortune 500 companies, including Norfolk Southern and GE.



Open-Recipe Ultra-High-Performance Concrete

Busting the cost myth

by Sherif El-Tawil, Yuh-Shiou Tai, John A. Belcher II, and Dewayne Rogers

Ultra-high-performance concrete (UHPC) is emerging as a game-changing technology for infrastructure applications. UHPC has self-consolidating properties and is an extremely durable cementitious product that achieves a compressive strength of at least 150 MPa (21.7 ksi). It is comprised of component materials with particle sizes and distributions carefully selected to maximize packing density, which enables the impressive mechanical and durability properties of the material. Another key feature of UHPC is that it is reinforced with a small percentage by volume (typically 1 to 3%) of short steel fibers, which enhance the material's tensile behavior and toughness.[1,2]

UHPC has rapidly grown in popularity in the United States and worldwide. The U.S. Federal Highway Administration (FHWA) and multiple state Departments of Transportation (DOTs) have shown strong interest in UHPC and its application to bridges. For example, the third and fourth rounds of the Every Day Counts (EDC) program (EDC-3 and EDC-4, spanning 2015 through 2018) focused on demonstrating the advantages that UHPC offers for connecting prefabricated bridge elements. The upcoming round of EDC (EDC-6) will address the use of UHPC for bridge repair and rehabilitation.

Although UHPC has shown strong benefits in the targeted FHWA applications, we, the authors, believe that the true potential of UHPC lies in precast technology, where the material's high strength enables light and durable components for accelerated construction. Lightweight UHPC products provide cost savings on multiple fronts, including transportation, substructure design, construction, and, most importantly, maintenance. Yet, in spite of these benefits, UHPC technology has not yet seen widespread adoption in the United States, primarily because most applications to date have used proprietary products that remain extremely expensive.

This article introduces open-recipe UHPC as an alternative to expensive proprietary products and with the potential to disrupt the precast concrete market. It describes the history of UHPC, discusses the components of open-recipe UHPC, and makes the case for broadening the use of this powerful new technology.

The Road to Open-Recipe UHPC: A Brief History

The development of UHPC can be traced back to the early 1980s, when Birchall et al.[3] proposed macro-defect-free (MDF) cement, which had a compressive strength in excess of 300 MPa (43.5 ksi). Densified small-particle (DSP) concrete was introduced at about the same time. DSP employed microsilica spherical particles having an average diameter of 0.1 micron to fill the voids between cement particles. The spherical shape improved workability and led to dense packing. A high-range water-reducing admixture (HRWRA) was used to ensure workability, and it was shown that the material could achieve compressive strengths of up to 250 MPa (36.3 ksi).[4] Richard and Cheyrezy[5,6] used finer and more reactive components to formulate what they called reactive-powder concrete (RPC). RPC is based on the principle of improving homogeneity by eliminating coarse aggregates, optimizing particle-packing density, and applying heat and pressure before and during setting. At about the same time RPC was proposed, de Larrard and Sedran[7] employed optimized particle packing and used a special selection of fine and ultrafine particles to develop a low-porosity, high-durability, and self-compacting concrete. The optimized particle packing was theorized to be the reason behind the material's high compressive strength and durability.

All of the previous efforts represent early versions of a class of materials now known as UHPC. Figure 1 compares the internal structure of regular concrete and UHPC. Note the homogeneity of the internal structure, which is the main reason for its exceptional properties.

UHPC has seen an exponential growth in research

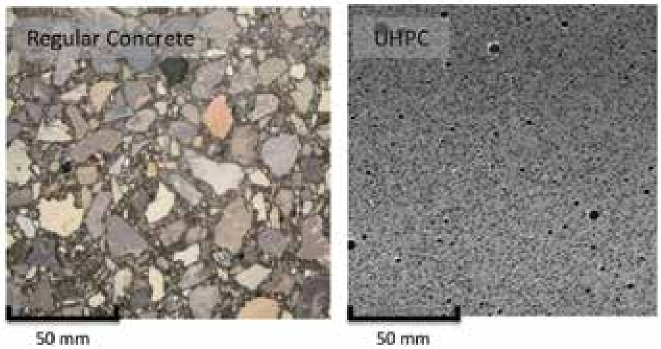


Fig. 1: Comparison between: (a) regular concrete; and (b) UHPC. Note the uniform nature of UHPC

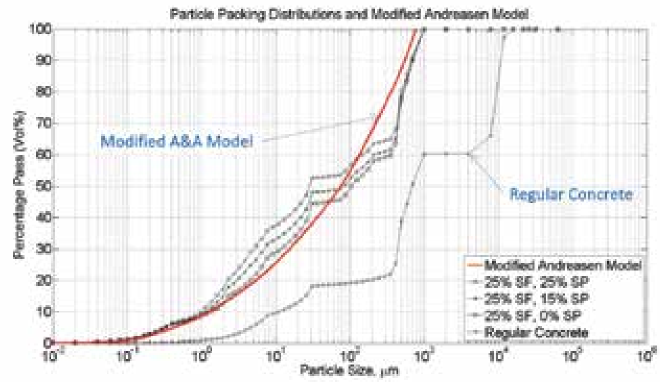


Fig. 2: Achieving high packing density in UHPC

activities over the past decade with a focus on developing nonproprietary products that are optimized for cost and use in structural applications. Notable examples include Hirshi and Wombacher[8]; Alkaysi and El-Tawil[9]; Meng et al.[10]; and Zhong et al.[11] To differentiate these efforts from proprietary products (which are closed or have protected formulas), the term "open-recipe UHPC" is employed by the authors. The formula and mixing method for an open-recipe UHPC are published (known) and conducive to further development by others. The concept of open development is well known in software engineering and has led to rapid and broad innovations that would have otherwise been stymied if development had been closed to generic users and coders.

Achieving High Packing Density

The packing theory developed by Andreasen and Andersen[12] (A&A) is the basic method used for designing open-recipe UHPC. Proper application of packing theory can control the fresh and hardened properties of UHPC because the improved particulate packing leads to more usable water as a lubricant. According to A&A theory, optimal packing can be achieved when the cumulative particle size distribution (PSD) obeys the following equation:

$$P(D) = \left(\frac{D}{D_{\max}}\right)^q \times 100\%$$

where $P(D)$ is the percentage of the material that can pass through a sieve with opening D, and D_{max} is the maximum particle size of the mixture. The distribution modulus q has a value between 0 and 1. The A&A model does not contain a minimum particle size. To account for that, a modified version of the model suggested by Funk and Dinger[13] is commonly used:

$$P(D) = \left(\frac{D^q - D^q_{\min}}{D^q_{\max} - D^q_{\min}}\right) \times 100\%$$

where D_{min} is the minimum particle size in the mixture. Andreasen and Andersen[12] found that optimum packing is obtained when $q = 0.37$. However, for mixtures with a high amount of powders ($D < 250$ μm), a smaller q value in the range of 0.22 to 0.25 is recommended. Figure 2 shows a plot of various UHPC mixtures in El-Tawil et al.[14] as compared to an optimum particle distribution in regular concrete. It is clear from the figure that regular concrete has a far from optimal packing density as opposed to various UHPC mixtures (note that the horizontal axis is logarithmic).

Ingredients of Open-Recipe UHPC

Open-recipe UHPC is made from common, off-the-shelf ingredients. Mixing them as reported in Alkaysi and El-Tawil,[9] without heat or pressure treatment, results in UHPC with properties that are comparable to proprietary products. For example, the mixture derived in Alkaysi and El-Tawil[9] reached a compressive strength of 192.7 MPa (28 ksi), peak tensile strength (direct tension) of 10.9 MPa (1580 psi), strain at peak stress of 0.64%, and energy absorption capacity of 57.2 kJ/m^3. Samples prepared with these mixtures also had negligible mass loss after 60 cycles of freezing and thawing, and they passed negligible to very low total charge[15] when tested per ASTM C1202, "Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration."

Main ingredients

The cement used in open-recipe UHPC is a 50-50 mixture of ordinary portland cement (OPC) Type I and slag cement. In general, OPC must have a tricalcium aluminate (C3A) content lower than 8% and a relatively low Blaine fineness to reduce water demand during the hydration. Many suppliers in the United States can meet this requirement. The use of slag cement decreases the cost and environmental and ecological burdens of using only OPC, and it has a positive influence on durability.

UHPC uses two kinds of silica products: silica fume and silica sand. The former is a by-product of the production of silicon alloys, and its superfine spherical particles (the median particle size is in the range of 0.1 to 10 microns) and pozzolanic reactivity densify the microstructure and significantly improve the compressive strength of UHPC. Two types of quartz silica sand are also used, with grain sizes of 70 to 200 μm and 400 to 800 μm. These grain sizes are optimized to enhance packing density.

Steel fibers are added to enhance the tensile properties of

Fig. 3: Fractured surface of a UHPC structural member with visible fiber pullout

UHPC. Once a crack occurs, fibers bridge the crack, resisting further crack growth and propagation. This type of behavior promotes multiple cracking prior to crack localization, leads to strain hardening response, and is directly responsible for the material's high energy absorption capacity. The behavior of UHPC in tension, particularly its postcracking response, is directly dependent on the fiber-matrix interaction that occurs during fiber pullout (refer to Fig. 3). The most commonly used fibers are made from high-strength steel (yield strength greater than 2000 MPa [290 ksi]) and are 0.2 mm (0.008 in.) in diameter and 13 to 19 mm (1/2 to 3/4 in.) in length.

Table 1:
Mixture proportions by weight of cement (OPC + GGBS = 1.0) for a family of UHPC mixtures

Materials	Mixture*			
Cement blend:	A	B	C	D
Ordinary portland cement Type I, lb/yd^3	653			
Slag cement, lb/yd^3	653			
Silica sand:				
Fine sand,† lb/yd^3	398	396	395	394
Coarse sand,‡ lb/yd^3	1590	1586	1582	1577
Silica fume, lb/yd^3	327			
Water, lb/yd^3	276	272	268	264
HRWRA,§‖ lb/yd^3	20	26	33	39
Steel fibers,# lb/yd^3	265			

*Mixtures A, B, C, and D have HRWRA dosages of 1.5, 2, 2.5, and 3%, respectively

†Grain sizes 80 to 200 microns

‡Grain sizes 400 to 800 microns

§Polycarboxylate ether-based HRWRA

‖HRWRA dosage rates can be adjusted to meet the paste flowability requirements. Dosages vary with the type of silica fume and range from 1.5 to 3.0% by weight of the cement

#Steel fibers are 2% by volume

Note: 1 lb/yd^3 = 0.6 kg/m^3

Mixture design

There are several published mixture designs. Table 1 shows a family of four UHPC mixtures. The difference between them is the amount of HRWRA used. Due to the extremely low water-cement ratio (*w/c*), users may have to experiment to achieve an optimal amount of HRWRA to ensure that the material passes the spread test (described next). Depending on its source, silica fume may have high levels of carbon content, which will increase the water demand, reduce the flowability, and adversely affect mixability, as noted by El-Tawil et al.[16] A lower carbon content is preferred. Silica fume with high carbon content is usually quite dark in color. Interpolation between the quantities in Table 1 can be done if different levels of HRWRA are needed.

Spread test

The spread test is a versatile test for checking the quality of the freshly mixed UHPC. The test is based on ASTM C1437, "Standard Test Method for Flow of Hydraulic Cement Mortar." After mixing the paste, the fresh mixture is placed into a spread cone. Special care should be taken to keep the spread cone and the base plate at the same humidity level prior to testing. Due to the inherent high flowability of the paste, there is no need to compact the UHPC in the mold. The spread cone is filled up to the rim and then lifted at a fixed speed. The leftover material sticking to the wall of the cone is scraped off and added to the material on the base plate as it spreads. After 2 minutes ± 5 seconds has elapsed, the diameter of the spread is measured along two orthogonal directions, and the average diameter is calculated and recorded as the spread value. The spread should be between 175 and 300 mm (7 and 12 in). Spread values outside this range indicate that the mixture should be rejected.

Busting the Cost Myth

One of the biggest impediments to using UHPC is the perceived high cost. On a unit volume basis, UHPC is indeed expensive when compared to traditional concrete. Per HiPer Fiber,[17] the cost of open-recipe UHPC ranged from \$567 to \$697/yd^3 USD in 2019. When the fibers were domestically sourced, the cost ranged from \$726 to \$856/yd^3 USD in 2019. If a high-quality, highway construction-grade concrete costs X = \$120/yd^3, then open-recipe UHPC costs about $6X$.

But a unit of concrete does not exist in isolation. For concrete to be placed in its final location, design and construction costs must also be expended. For example, a commonly cited highway construction cost is \$1 × 10^6/lane-mile in 2019 dollars. This translates into roughly \$500/yd^3 of placed concrete, suggesting that construction costs exclusive of the concrete itself are about \$380/yd^3. If the unit cost of a prestressed concrete girder was about \$1000/yd^3 USD in 2019, other costs (such as formwork, reinforcing, labor, overhead, and transportation) would be about \$880/yd^3.

Table 2:
Effect of Y and Z on change in short-term cost of UHPC (highlighted area corresponds to reduction)

	Case 1					
Y \ Z	0.1	0.2	0.3	0.4	0.5	0.6
0.4	57.5%	50.0%	42.5%	35.0%	27.5%	20.0%
0.5	42.5%	35.0%	27.5%	20.0%	12.5%	5.0%
0.6	27.5%	20.0%	12.5%	5.0%	−2.5%	−10.0%
0.7	12.5%	5.0%	−2.5%	−10.0%	−17.5%	−25.0%
	Case 2					
Y \ Z	0.1	0.2	0.3	0.4	0.5	0.6
0.4	23.8%	15.0%	6.3%	−2.5%	−11.3%	−20.0%
0.5	16.3%	7.5%	−1.3%	−10.0%	−18.8%	−27.5%
0.6	8.7%	0.0%	−8.8%	−17.5%	−26.3%	−35.0%
0.7	1.3%	−7.5%	−16.3%	−25.0%	−33.8%	−42.5%

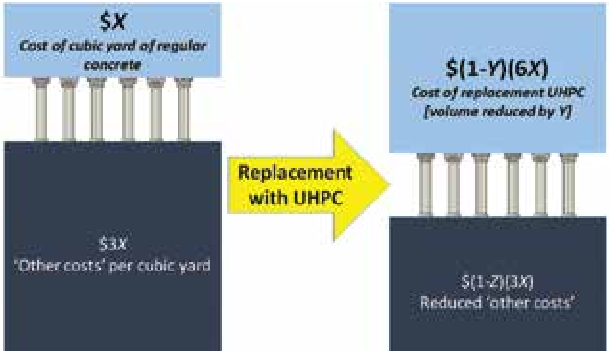


Fig. 4: Schematic representation of cost benefits of replacing regular concrete with UHPC

As such, the other costs for 1 yd^3 of placed regular concrete range from about $3X$ to $7X$.

The extreme strength of UHPC allows for a significant reduction in the amount of material used, leading to lower weight of concrete material. Let Y be the reduction in weight of a structurally competitive UHPC element, expressed as a percentage of the weight of the original concrete element. For example, a regular concrete deck replaced with a same-depth UHPC waffle-slab alternative will have $Y = 45\%$.[18] Aaleti et al.[18] noted that a substantially higher Y could be achieved because the replacement deck was much stronger than the original one. This significant reduction will certainly lead to a reduction in the other costs due to lower dead weight and reduced transportation cost. Let the reduction in other costs for the replaced product be Z, expressed as a percentage of the costs for the replaced product. Because Y and Z are not precisely known and would, moreover, depend on the specific application, their effect on the cost of a placed 1 yd^3 of UHPC as a function of X is bracketed in Table 2 for feasible ranges of Y and Z.

For example, when the other costs are at the low end (that is, $3X$), and assuming $Y = 60\%$ and $Z = 40\%$, the cost of replacing regular concrete with UHPC is:

Case 1:

$((100 - Y)/100) \times 6X$ [cost of open-recipe UHPC] $+ 3X$ [other costs] $\times ((100 - Z)/100) = 4.2X$

Compared to the original cost of $4X$ (original X plus $3X$ in other costs), this implies a 5% premium to use open-recipe UHPC, which indicates that it is just slightly more expensive than normal concrete.

At the other end of the spectrum, when the other costs are high (that is, $7X$) and again assuming $Y = 60\%$ and $Z = 40\%$, the cost of replacement is:

Case 2:

$((100 - Y)/100) \times 6X$ [cost of open-recipe UHPC] $+ 7X$ [other costs] $\times ((100 - Z)/100) = 6.6X$

Compared to the original total cost of $8X$ (original X plus $7X$ in other costs), using open-recipe UHPC results in a 17.5% savings in costs. The shaded regions in Table 2 represent zones where replacing regular concrete with open-recipe UHPC results in cost savings, while Fig. 4 shows the comparison in a schematic manner.

The numbers cited have substantial assumptions in them, but Table 2 brackets them and allows for engineers to explore variations. The possibility for saving is, however, quite real. Engineers in Malaysia and Australia have reported cost savings of 17% in a bridge application.[19] Also, cost savings may come in other ways. For example, if used to remove a load rating posting for a bridge, a deck replacement based on UHPC may lead to substantial, ongoing benefits for nearby communities.

The Real Opportunity for Cost Savings

The previous section suggests that the incremental cost of using open-recipe UHPC to replace regular concrete may be relatively small and that some savings in certain applications could be realized. The real opportunity to save on costs is in long-term maintenance. The extreme durability of UHPC is well documented. The results in Alkaysi and El-Tawil[9] suggest that open-recipe UHPC can be several times as durable as regular concrete. Also, the strain-hardening capacity of UHPC allows designers to ensure that the main steel reinforcement will yield before cracks localize. The ability to protect the main steel reinforcement and remain impervious to harsh environments implies that long-term maintenance costs will be significantly reduced.

It is likely, given current experimental research results, that UHPC structures will deliver at least a 100-year lifespan with minimal maintenance. Compared to regular concrete structures that may need to be extensively maintained during such a period (and possibly replaced at least once), the cost savings could be quite high as depicted schematically in Fig. 5. The longevity of UHPC may, however, lead to future challenges. For example, it may be wise to consider reconfigurability in the design of future UHPC structures so that components from decommissioned structures can be reused.

Conclusion

Open-recipe UHPC is a material with high disruptive potential. Its unique properties enable novel applications in infrastructure design and construction. The open nature of its composition will promote future innovation, including even greater reduction in the cost of the raw material itself and new opportunities for application.

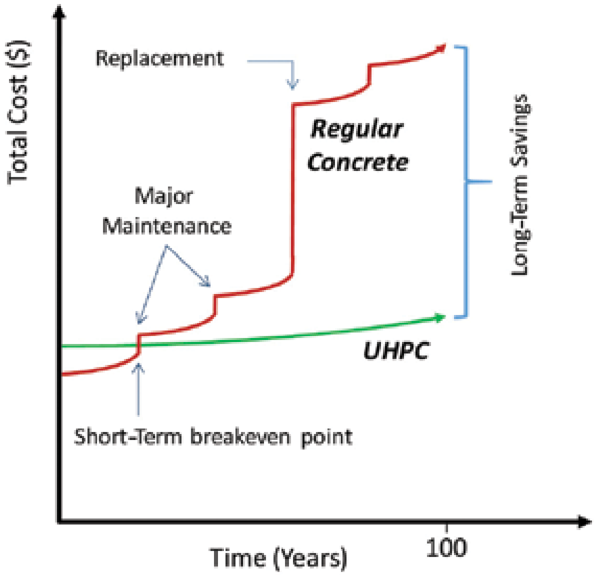


Fig. 5: Schematic diagram of life-cycle cost of UHPC and regular concrete

References

1. Wille, K.; Naaman, A.E.; and El-Tawil, S., "Optimizing Ultra-High-Performance Fiber-Reinforced Concrete," *Concrete International*, V. 33, No. 9, Sept. 2011, pp. 35-41.

2. Wille, K.; El-Tawil, S.; and Naaman, A.E., "Properties of Strain Hardening Ultra-High-Performance Fiber Reinforced Concrete (UHP-FRC) Under Direct Tensile Loading," *Cement and Concrete Composites*, V. 48, Apr. 2014, pp. 53-66.

3. Birchall, J.D.; Howard, A.J.; and Kendall, K., "Flexural Strength and Porosity of Cement," *Nature*, V. 289, No. 5796, Jan. 1981, pp. 388-390.

4. Bache, H.H., "Densified Cement Ultrafine Particle-Based Materials," *Proceedings of the 2nd International Conference on Super-Plasticizer in Concrete*, Ottawa, ON, Canada, 1981, pp. 185-213.

5. Richard, P., and Cheyrezy, M.H., "Reactive Powder Concretes with High Ductility and 200-800 MPa Compressive Strength," *Concrete Technology: Past, Present, and Future*, P.K. Mehta, ed., SP-144, American Concrete Institute, Farmington Hills, MI, 1994, pp. 507-518.

6. Richard, P., and Cheyrezy, M., "Composition of Reactive Powder Concretes," *Cement and Concrete Research*, V. 25, No. 7, Oct. 1995, pp. 1501-1511.

7. de Larrard, F., and Sedran, T., "Optimization of Ultra-High-Performance Concrete by the Use of a Packing Model," *Cement and Concrete Research*, V. 24, No. 6, 1994, pp. 997-1009.

8. Hirschi, T., and Wombacher, F., "Influence of Different Superplasticizers on UHPC," *Ultra High Performance Concrete (UHPC)*, E. Fehling, M. Schmidt, and S. Stürwald, eds., Kassel, Germany, Mar. 2008, pp. 77-84.

9. Alkaysi, M., and El-Tawil, S., "Effects of Variations in the Mix Constituents of Ultra-High-Performance Concrete (UHPC) on Cost and Performance," *Materials and Structures*, V. 49, No. 10, Oct. 2016, pp. 4185-4200.

10. Meng, W.; Valipour, M.; and Khayat, K.H., "Optimization and Performance of Cost-Effective Ultra-High-Performance Concrete," *Materials and Structures*, V. 50, No. 1, Feb. 2017, 16 pp.

11. Zhong, R.; Wille, K.; and Viegas, R., "Material Efficiency in the Design of UHPC Paste from a Life Cycle Point of View," *Construction and Building Materials*, V. 160, Jan. 2018, pp. 505-513.

12. Andreasen, A.H.M., with the collaboration of J. Andersen, "Ueber die Beziehung zwischen Kornabstufung und Zwischenraum in Produkten aus losen Körnern (mit einigen Experimenten) (About the Relationship Between Grain Gradation and Space in Loose Grain Products [with Some Experimentation])," *Kolloid-Zeitschrift*, V. 50, Mar. 1930, pp. 217-228. (in German)

13. Funk, J.E., and Dinger, D.R., *Predictive Process Control of Crowded Particulate Suspensions: Applied to Ceramic Manufacturing*, Springer, New York, 2013, 786 pp.

14. El-Tawil, S.; Tai, Y-S.; and Belcher II, J.A., "Field Application of Non-Proprietary Ultra-High-Performance Concrete," *Concrete International*, V. 40, No. 1, Jan. 2018, pp. 36-42.

15. Alkaysi, M.; El-Tawil, S.; Liu, Z.; and Hansen, W., "Effects of Silica Powder and Cement Type on Long-Term Durability of Ultra-High-Performance Concrete (UHPC)," *Cement and Concrete Composites*, V. 66, Feb. 2016, pp. 47-56.

16. El-Tawil, S.; Alkaysi, M.; Naaman, A.E.; Hansen, W.; and Zhichao, L., "Development, Characterization, and Applications of a Non-Proprietary Ultra-High-Performance Concrete for Highway Bridges," *Report No. RC-1637*, Michigan Department of Transportation, Lansing, MI, 2016, 41 pp.

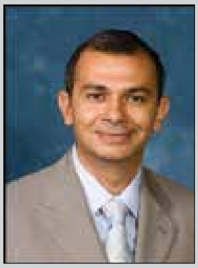
17. HiPer Fiber, www.hiperfibersolutions.com. Accessed Oct. 14, 2019.

18. Aaleti, S.; Petersen, B.; and Sritharan, S., "Design Guide for Precast UHPC Waffle Deck Panel System, including Connections," *Report No. FHWA-HIF-13-032*, Federal Highway Administration, Washington, DC, 2013, 125 pp.

19. Voo, Y.L.; Foster, S.J.; and Voo, C.C., "Ultra-High-Performance Concrete Segmental Bridge Technology: Toward Sustainable Bridge Construction," *Journal of Bridge Engineering*, V. 20, No. 8, Aug. 2015.

Note: Additional information on the ASTM standards discussed in this article can be found at **www.astm.org**.

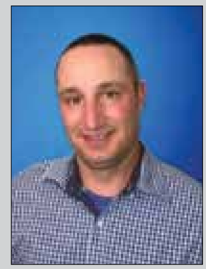
Selected for reader interest by the editors.



Sherif El-Tawil is the Antoine E. Naaman Collegiate Professor of Civil and Environmental Engineering at the University of Michigan, Ann Arbor, MI. He has been a licensed professional engineer in Michigan since 2003 and was a professional engineer in Florida prior to that. He is interested in the development of open-recipe UHPC and characterization of its short- and long-term properties. He is particularly interested in the effects of extreme loading on structural systems and how UHPC—with its unique properties—can be used to mitigate those effects.

Yuh-Shiou Tai is a Professor in the Civil Engineering Department at the ROC Military Academy, Taoyuan City, Taiwan. He has been a visiting research scientist at the University of Michigan since 2013. His research interests include interfacial bonding properties between steel fiber and the cementitious material; and experimental testing, analysis, and modeling of UHPC under quasistatic and high-strain rate loading.

John A. Belcher II has been with the Michigan Department of Transportation for 16 years. He is currently the Bridge Construction Engineer and previously served as the Concrete Construction Engineer. He is a licensed professional engineer.



Dewayne Rogers is the Managing Director for the Clare County Road Commission in Michigan. He has implemented the use of open-recipe UHPC on several bridge maintenance projects. He is particularly interested in replacing existing bridge decks with lighter precast panels made entirely of open-recipe UHPC to remove load-rating restrictions or to reduce superstructure weight to lessen foundation needs in new construction.

It Can Be Done

Van Guilder hollow-wall machines formed lasting legacies

by Rex C. Donahey and W. Agata Pyc

Readers of this magazine may recall that Rochester, NY, has a neighborhood comprised of concrete houses constructed by Kate Gleason between 1919 and 1925.[1,2] Because many of the 75 houses built by Gleason remain in service, her housing development serves as a reminder that concrete houses are indeed feasible, viable, and resilient.

However, readers are probably unaware that Rochester has an even older, larger neighborhood of concrete houses, and they may not be familiar with the forming system developed to construct them. Remarkably, this system was used throughout the United States, not only to construct concrete houses but also to build concrete warehouses, schools, and agricultural structures. Our hope is to repair that knowledge gap.

Thinking Inside the Box

In 1909 and 1910, several inventors independently conceived of building concrete walls using a small, open-ended box in which concrete could be consolidated by ramming. One of these creative entrepreneurs was Willis N. Britton, a Rochester real estate developer and builder. Britton owned a large tract of land (132 acres [53 ha]) near the Eastman Kodak Works in Rochester, and he set out to build houses for rent and for sale to Eastman Kodak employees. His tract had an ample supply of aggregate, so Britton investigated the use of concrete as an economical building material. Recognizing that his homes needed to be comfortable and energy efficient, he focused on constructing double concrete walls with an insulating air cavity—hollow walls.

His solution was a machine with four forming panels actuated using a lever. Two outer panels formed the exterior and interior faces of a wall, and two inner panels formed a void. By moving the machine's lever, a worker could increase the distance between the outer panels and decrease the distance between the inner panels, thus releasing the form from freshly placed concrete (Fig. 1). Britton initially used his invention to build a concrete cellar and then went on to use it to construct entire houses.

Workers constructed a wall by placing concrete in successive lifts. Starting at a corner work point, a lift was constructed by tamping a semiwet mixture of concrete in the machine (the box), releasing the form by pulling up on the machine's lever, and sliding the machine along the length of the wall. These steps were repeated over the perimeter of the building. Under ordinary conditions, the concrete would harden enough to enable workers to continue with the next lift as soon as they had traversed the building perimeter. A neat cement slurry was applied to the top of the concrete in the previous lift, a length of steel wire was placed along the center of each concrete layer (wythe), and heavy-gauge galvanized steel wire ties with hooks were placed across the air gap at spacings variously reported as 9 to 36 in. (229 to 914 mm). The ties served two purposes: they supported the machine during placement of the next lift, and they tied the two layers together during service. No vertical steel was installed, so the wall was functionally a two-wythe brick cavity wall.

Shortly after Britton filed a patent application for his system on July 13, 1910, he passed on the rights to the machine to the Van Guilder Double Wall Co., Rochester, NY, founded by Will H. Van Guilder, New Rochelle, NY. From then on, the system was marketed as the Van Guilder hollow-wall machine. Britton continued to use his invention and eventually constructed about 200 concrete hollow-wall houses in Rochester.[3]

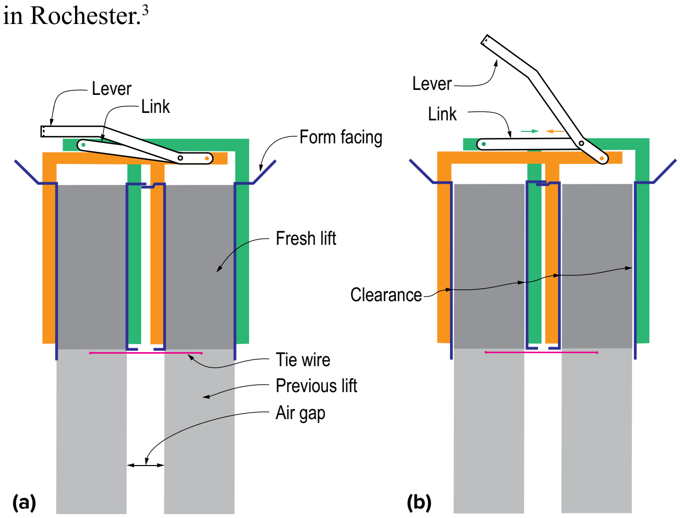


Fig. 1: A schematic of the concrete wall-forming machine invented by Willis N. Britton: (a) during concrete placement; and (b) before advancing along the wall

Van Guilder Machines

Van Guilder machines for construction of houses and concrete buildings were typically 5 ft (1.5 m) long, 15 in. (381 mm) wide, and 10 in. (254 mm) high (Fig. 2); and they weighed about 125 lb (57 kg). The lift height varied slightly but was typically about 9 in. (229 mm). For standard walls, the machine could form two concrete layers that were 2 to 6 in. (51 to 152 mm) thick, and the two layers were normally separated by a 2.5 in. (64 mm) air gap.[5] Improvements developed and patented by the Van Guilder Double Wall Co. included separate components for forming corners (Fig. 3).

Similar machines were used for construction of cold storage buildings (Fig. 4). These machines were also 5 ft long and 10 in. high. However, they were 22 in. (559 mm) wide and included two cores to improve the thermal performance of the constructed walls. The steel-reinforced concrete walls built with these machines consisted of three concrete layers separated by two 4 in. (102 mm) thick air spaces.[5]

Machines used for silo construction had the same dimensions as machines used to construct buildings (Fig. 1), but they were curved so that workers could produce a radiused wall. Silo walls were typically 4 to 6 in. thick separated by a 4 in. continuous air space from footing to roof plate.[5]

A detailed description of various improvements to the Van Guilder molding machine are provided in four patents: 1,173,229 (Feb. 29, 1916); 1,215,436 (Feb. 13, 1917); 1,245,538 (Nov. 6, 1917); and 1,250,394 (Dec. 18, 1917).

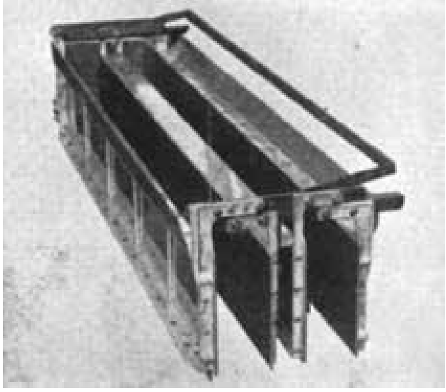


Fig. 2: The Van Guilder hollow-wall molding machine[4]

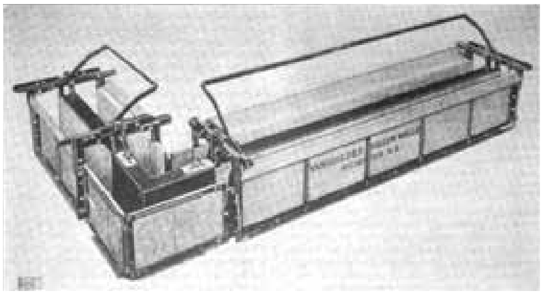


Fig. 3: Van Guilder hollow-wall molds set for construction of a corner of a building[6]

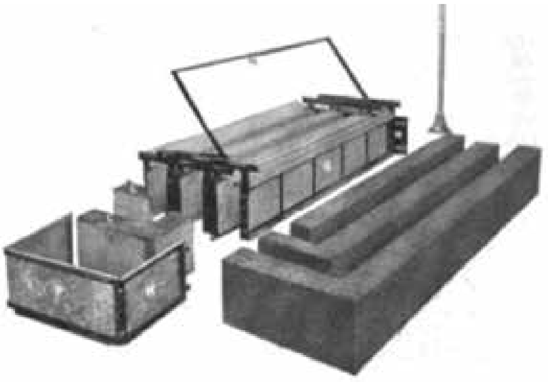


Fig. 4: The Van Guilder three-wall concrete machine was used to construct cold storage buildings. This image shows the machine, attachments used to form corners, a sample of a concrete placement, and a tamper[7]

Exemplary Structures

This section provides some notable examples of structures and developments that were constructed using Van Guilder machines. While many of these structures remain in service, it's not possible to locate all surviving examples because the property addresses were not reported in articles about the construction process. Further, it's uncommon for concrete homes to be accurately described in appraisals and real estate listings. Homes constructed using Van Guilder forms were given a stucco finish, and we've found that the homes are listed as stucco homes by owners and authorities.

Britton's houses

As noted previously, Britton's houses were the prototype structures for the Van Guilder system. These structures were 25 ft 9 in. by 26 ft 9 in. (7.9 by 8.2 m) in plan, and they had 7 ft (2.1 m) basements. Basement walls consisted of 6 in. thick outer wythes and 4 in. thick inner wythes. Aboveground perimeter walls consisted of two 4 in. wythes. In all locations, the wythes were separated by a 2.5 in. air space. The walls were reinforced lengthwise with 5 ft long pieces of twisted wires or rods. In addition, two or three pieces of wire were used as reinforcement above windows and doors.[4] Galvanized steel ties were placed across the air gap at 2 or 3 ft (0.6 to 0.9 m) intervals. The roof plate was anchored to the walls using 4 in. long anchor bolts embedded in the top lift.[8]

The concrete mixture proportions (by volume) were 1:2:4 of cement, sand, and gravel, respectively. The placement of one concrete lift took from 3 to 4 hours.[8] On average, nine lifts were placed for the basement walls and 23 lifts for the superstructure; and it took 14 days using a four-worker crew (one worker with some experience in placing concrete) to finish the concrete work on a house.[4,8]

Britton's houses were built with wood floors, with floor joists extending into pockets formed in the inboard wythe. Pockets were created using wood blocks held in the form at the appropriate spacing. As the machine was advanced, the blocks were removed. After the concrete had set, 2 x 9 in. stringers were dropped into place. During construction, the stringers provided scaffolding for the workers for the placement of the aboveground walls.[8]

Because the walls were 10.5 in. (267 mm) thick, windows and doors were set flush on the inside and 2 in. (50 mm) from the outside. The concrete was troweled smooth from the casing to the outside wall.[4]

According to Britton, the continuous 2.5 in. air space in the walls made them dampproof, so no additional waterproofing was needed. The air gap also provided $20 to $25 savings when purchasing coal for heating during winter in comparison to wood-frame houses.[4]

Two-story hollow-wall concrete houses with seven rooms, a hallway, a bathroom, and an attic built by Britton cost $1971.50 (excluding basement excavation). At that time, this was $219.10 cheaper than a similarly sized wood-frame house. The market value of a concrete house was also $300 to $500 greater than the market value of a wood-frame house, largely because the heating costs and insurance premiums were lower for the concrete homes. For the same reasons, Britton was able to charge rents of $5.50 per week for a concrete house, even as similarly sized wood-frame houses rented for $5.00 per week.[8]

Detailed information on estimating costs for the outside wall of a house, basement wall for a wood-frame house, and silo, all constructed using the Van Guilder hollow-wall machine, as well as actual costs of two houses built by the Walpole Tire & Rubber Co. of Walpole, MA, are provided in a booklet titled "Concerning Costs."[9]

Riley's bungalow

W.H. Riley, a carpenter and builder, experimented with the Van Guilder hollow-wall machine in 1910 in Rochester, where he built a house for himself. His positive experience with this new building technology led him to believe that he could construct concrete houses for large profits with no additional cost to his clients in comparison to wood-frame houses. He decided to move to southern California and devote his skills to promoting this new method of construction. He constructed a bungalow in Riverside, CA (Fig. 5). The hollow wall had two 3 in. (76 mm) wythes separated by a 2.5 in. air gap.[11]

Williamson house

One of the most notable homes constructed using Van Guilder machines was built by F.L. Williamson, then Vice President and General Manager of the Dewey Portland Cement Co., Kansas City, MO. The 68 ft (21 m) wide and 63 ft (19 m) deep house was built between October 1914 and July 1915 in Mission Hills, KS; a contemporary article incorrectly identified the location as Kansas City, MO (Fig. 6).

The home's basement walls were 12.5 in. (318 mm) thick (4 in. outside, 6 in. inside, and 2.5 in. continuous air space) on 12 in. (305 mm) deep reinforced concrete footings. Aboveground, perimeter walls comprised two 4 in. wythes and a 2.5 in. air space. These walls were finished with rough-cast stucco placed directly on the concrete surface with smooth finished borders around windows and doors.[12]

Fig. 5: Concrete hollow-wall bungalow built by W.H. Riley in Riverside, CA[10]

Fig. 6: A hollow-wall concrete residence built for F.L. Williamson in Mission Hills, KS. This home remains in service[12]

Fig. 7: A fireproof hollow-wall house built in 1914 in Tiffin, OH[13]

Unlike the homes constructed by Britton, the Williamson house had reinforced concrete suspended floors. Even the attic floor, which cantilevered beyond the perimeter walls to form the soffit of the eaves, was reinforced concrete. The concrete structural features were designed by the Trussed Concrete Steel Co. (founded by Julius Khan), which also furnished the reinforcing material.

Fireproof house

In 1914, a house was built in Tiffin, OH, using the Van Guilder machine (Fig. 7). This house had a continuous 2 in. air space and was constructed with reinforced concrete floors. Because the construction took place in cold weather, the materials for concrete had to be heated.[13]

The Experimental Building

In addition to houses, Van Guilder wall forms were used for the construction of the Experimental Building for the

Department of Terrestrial Magnetism in Washington, DC (Fig. 8). The building's outside dimensions were 28 by 53 ft (8.5 by 16 m), with the inside clear height below roof trusses of 12 ft (3.65 m). Concrete was selected as a main building material due to the shortages of most building materials and skilled labor, as well as the need to minimize the magnetic interference created by the building. The concrete mixture for the Experimental Building was 1:2:4 of portland cement, coarse sand, and gravel (1-1/2 in. [38 mm] and smaller for foundation and 1 in. [25 mm] and smaller for the walls), respectively.[14]

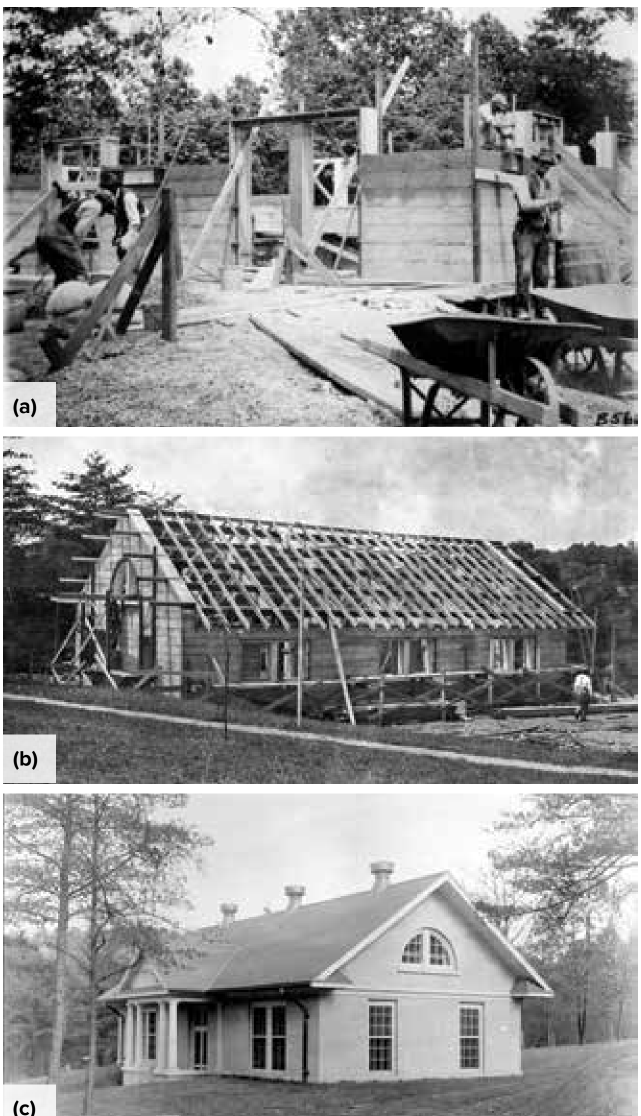


Fig. 8: The Experimental Building built in 1919-1920 for the Department of Terrestrial Magnetism in Washington, DC: (a) during construction with concrete walls formed using Van Guilder molds and visible rolled-steel angles to maintain plumb corners (the angles were removed after the walls were completed); (b) the walls supported a wooden roof structure; and (c) after completion *(photos courtesy of the Carnegie Institution for Science, Department of Terrestrial Magnetism Archives, Washington, DC)*

Hollow-wall concrete sections constructed with the Van Guilder form were 6 in. thick with a 2.5 in. air gap between them. Due to the need to minimize magnetic interference, the wire wall ties, wall reinforcing, bolts, lag screws, ties, nails, and hardware were made of brass or bronze.[14]

The construction of the Experimental Building started in April 1919 and was completed in March 1920. Total construction cost was $8500. The unit cost of 30 cents per ft^3 was considered favorable relative to ordinary lumber construction of that time.[14]

Sadly, according to the information we received from the Carnegie Institution for Science, Washington, DC, the original structure was demolished in 2005.

Southmont houses

In 1920, 89 hollow-wall concrete houses were built with the Van Guilder system in Southmont, PA, a suburb of Johnstown, for the workers of Cambria Steel Co.[15,16]

Appropriately, concrete mixtures were produced using steel slag for the coarse aggregate. It's also of interest that the contractor took advantage of the hilly terrain by mixing the concrete on the hillside above each house and delivering it to the construction crew using a chute. The houses were still fully occupied and functioning in 2009 (Fig. 9) even though the factory for which they were built ceased to exist.[16]

School building

A large building at the Berkshire Industrial School in Canaan, NY, was constructed using the Van Guilder hollow-wall machine. The building had outside dimensions of 48 by 80 ft (15 by 24 m). The hollow walls had a 6 in. thick inside portion and a 4 in. thick outside portion separated with 2.5 in. of air space. The wall was reinforced with No. 9 galvanized wire spaced 9 in. apart around the building. Two 1/2 in. (12.5 mm) twisted rods were also placed over openings less than 4 ft (1.2 m), and steel lintels consisting of two 7 ft (2.1 m) channels bolted together with channel separators and covered with wire

Fig. 9: Typical hollow-wall concrete house built in 1920 in Southmont, PA (near Johnstown)[16] *(photo courtesy of Lu Donnelly/ Western Pennsylvania History)*

mesh were placed over mullion windows. The exterior of the building was finished with white stucco.[6]

Concrete wall

A 430 ft (131 m) concrete wall was built using the Van Guilder hollow-wall machine around Old Fort Johnson, Akin, NY. The wall was 3 ft high and 14.5 in. (368 mm) wide (two 6 in. thick sides separated by a 2.5 in. air gap). The wall was finished with plaster composed of half-part lime putty, half-part portland cement, and enough sand for a smooth mortar.[17]

Agricultural structures

One of the early agricultural applications of the Van Guilder system was a concrete silo built for W.H. Anderson, Greece, NY. The silo was 40 ft (12.2 m) high, with a 16 ft (4.9 m) outside diameter. The wall consisted of two 4 in. wythes with a 4 in. air space between them. The wythes were tied together with 3/16 in. (5 mm) thick, 2 in. wide, and 9 in. long flat galvanized iron ties. Three workers, one operating the machine and two mixing concrete and delivering it to the machine, built the silo in 18 days. The silo wall was finished on both sides with plaster (a mixture of one part cement and three parts sand).[18]

Building concrete silos with the Van Guilder hollow-wall machine was promoted by Ellis M. Santee of Cortland, NY, one of the leading sanitary, dairy, and building experts of that time. After visiting Rochester and examining the hollow-wall machines, he recommended that all farm buildings (including silos) be built out of concrete for durability and sanitary reasons. In his opinion, Van Guilder machines were the best for ease of operation and low construction cost to serve that purpose.[11]

We can only speculate that Santee's endorsement led to more projects, but we can report that the Van Guilder system was used to reconstruct a dairy station near Wells River Junction, VT.[19] The station had been destroyed by fire in the summer of 1913. For various reasons, rebuilding was delayed until after November 1, so the builder had to deal with cold weather concreting. The buildings consisted of an icehouse, 30 x 45 ft (9 x 14 m) in plan with 19 ft (6 m) tall walls; a creamery, 41 x 50 ft (12.5 x 15 m) in plan with 12 ft (3.7 m) tall walls; and a receiving shed, 15 x 13 ft (4.6 x 4 m) in plan, also with 12 ft tall walls. This large exposed area had to be protected from the cold, so C.D. Gilbert (representing the Van Guilder Co.) suggested using the boiler on the premises to generate steam that might be turned into the continuous air space to cure the concrete wythes. According to Reference 19:

"Plenty of old pipe was at hand and lines were run so as to reach every part of the building by means of steam hose connected to the walls. As fast as built, the walls were covered with strips of tar paper, weighted with boards, and steam turned on, with the result that the concrete set in about 3 hours, so as to allow another course to be laid, and was past danger of freezing in 6 hours. All of the walls were erected in 3 weeks. The thermometer went as low 20°F, and there was at one time 4 in. of snow, yet the work was carried on successfully."

Other constructed or planned projects

In 1911, E.R. Hall, a real estate man in Chicago, was reportedly planning to develop hollow-wall concrete houses in Evanston, IL, using the same methods of construction and building the same style of houses as Britton. The Island Cities Real Estate Co. and Garden City Co. were also reportedly using the Van Guilder system to build houses on Long Island, NY.[8]

The Van Guilder system was used by Joseph Mulvey, New Rochelle, NY, to build the F.J. Wagner residence in Smithtown, Long Island, NY.[20] C.B. Potter reported on the construction of his "cottage" in Delmar, NY, using the Van Guilder machine.[21]

C.D. Gilbert, Associate Editor of *Concrete* from April 1915 until his death in October 1918, documented the construction of his concrete house in "My Own House—How It Was Built."[22] In addition to using the Van Guilder machine to cast the walls, the home construction was noteworthy in that the floors, roof, and stairs were also concrete.

Lastly, the Carnegie Steel Company built 50 concrete houses for employees near its Steelton Plant, Youngstown, OH.[23] It was later reported that the project was so successful that the company built additional houses using the system in nearby McDonald, OH.[24] The referenced article notes that houses were constructed using "slag concrete." Although that term is not defined, the article does note that the Carnegie Steel Company produced slag as aggregate as well as quenched and granulated slag that was used by the Universal Portland Cement Company as a cement ingredient.

What Did ACI Report?

The only mention of the system that we can find is from the proceedings of the 1918 convention, in a paper presented by C.D. Gilbert.[3] The paper comprises excerpts from articles published in *Concrete*, edited by Gilbert and others, including Managing Editor Harvey Whipple. Whipple would soon become ACI Secretary, a position he held from 1919 to 1952. Lastly, although the construction method is not described, ACI Committee S-5, Concrete Houses, included double concrete wall construction in its recommended practice, first published in 1922.[25]

In Closing

In early 1920, Whipple reported that about a hundred of the Van Guilder machines were in use. However, he also noted that the machines were no longer for sale, as the "Van Guilder company now is operating as a parent company in the development of contracting organizations in various centers of population."[26] Although the machines were probably still in use, we were unable to find reports about later projects. The shift in the company's focus, the passing of C.D. Gilbert in 1918, and Whipple's appointment as Secretary of ACI in November 1919 all were probable factors in the decline in publicity.[27]

Fortunately, however, many of the structures built with Van Guilder machines remain in use. These include many of the houses Britton built in Rochester, NY; the mansion in the Kansas City suburb of Mission Hills; and many of the houses built by Cambria Steel Co. near Johnstown, PA. These structures serve as additional reminders that concrete houses are indeed feasible, viable, and resilient. One simply has to believe that it can be done:

"There are thousands to tell you it cannot be done,
There are thousands to prophesy failure,
There are thousands to point out to you, one by one,
The dangers that wait to assail you; …
Just start in to sing as you tackle the thing,
That 'can not be done,' and you'll do it."[9]

Acknowledgment

Thanks to Marie Kaplan, Hazel Crest, IL, for asking her son-in-law (Rex Donahey) about a company from her hometown of Rochester, NY. That question, inspired only by a small ad in a historical publication, unexpectedly led us on a journey across the country and back.

References

1. Hurd, M.K, "Concrete Houses Alive and Well after More than 80 Years," *Concrete International*, V. 30, No. 5, May 2008, pp. 34-38.

2. Gleason, K., "Small Concrete Houses at Rochester, N.Y.," *ACI Journal Proceedings*, V. 18, No. 2, Feb. 1922, pp. 124-128. (Reprinted as part of the Landmark Paper Series in *Concrete International*, V. 25, No. 12, Dec. 2003, pp. 30-38.)

3. Gilbert, C.D., "The Concrete Industrial House: A Record of Achievement," *Proceedings of the 14th Annual Convention*, Atlantic City, NJ, June 27-29, 1918, V. 14, pp. 398-407.

4. "Hollow Wall Concrete House of Low Cost," *Cement and Engineering News*, V. 24, Jan.-Dec. 1912, pp. 37-39.

5. "Silo and Wall Forms," *The Cement Era*, V. 10, No. 7, July 1912, pp. 49-50.

6. "Concrete Hollow Walls for School Building," *Municipal Engineering*, V. 54, Mar. 1914, pp. 284-285.

7. "The Van Guilder Three-Wall Concrete Machine," *Building Age*, V. 34, Oct. 1912, pp. 551-552.

8. "How Concrete Houses Are Built for Less than Frame and Are Worth More," *Concrete*, V. 11, No. 8, Aug. 1911, pp. 32-36.

9. "Concerning Costs," The Van Guilder Hollow Wall Co., Rochester, NY, 1914, 14 pp.

10. "Helping the Home Makers of America," *The Craftsman*, The Craftsman Publishing Company, New York, NY, V. 27, 1914, p. 229.

11. "Modern Concrete House and Bungalow Construction," *The Concrete Age*, The Concrete Age Publishing Company, Atlanta, GA, June 1912, pp. 36-37.

12. "An Example of Fireproof Residence Construction at Kansas City, Mo.," *Concrete Houses: How They Were Built*, H. Whipple, ed., Concrete-Cement Age Publishing Co., Detroit, MI, 1920, pp. 97-99.

13. Baumgardner, C.W., "A Double Wall Concrete House Economically Built in Cold Weather," *Concrete*, V. 8, No. 3, Mar. 1916, pp. 111-112.

14. Fleming, J.A., "Construction of Non-Magnetic Experiments Building of the Department of Terrestrial Magnetism," *Land Magnetic Observations 1914-1920*, Carnegie Institution of Washington, Washington, DC, Publication No. 175 (V. 4), 1921, pp. 351-358.

15. Gray, E.T., "Cambria Steel Company Completes 89 Hollow Wall Houses," *Concrete*, V. 20, No. 1, Jan. 1922, pp. 19-22.

16. Donnelly, L., "Architecture around Us," *Western Pennsylvania History*, Fall 2009, pp. 8-11.

17. *Concrete*, V. 11, No. 11, Nov. 1911, p. 39.

18. "Hollow Wall Silo Represents 18 Days' Work of Three Men," *Concrete*, V. 11, No. 11, Nov. 1911, p. 48.

19. "Using Steam to Heat and Cure Double Walls in Cold Weather," *Concrete-Cement Age*, V. 4, Feb. 1914, pp. 95-96.

20. "Van Guilder of Hollow Wall Construction," *Building Age*, V. 34, Sept. 1912, p. 498.

21. Potter, C.B., "Double Wall Concrete Cottage at Delmar, N.Y.," *Concrete*, V. 10, No. 1, Jan. 1917, pp. 30-31.

22. Gilbert, C.D., "My Own House—How It Was Built: Plans, Construction Details, Cost of a Dwelling with Concrete Walls, Floors, Roof, Stairs," *Concrete*, V. 12, No. 1, Jan. 1918, pp. 10-15.

23. "50 Double Wall Houses for Carnegie Employees," *Concrete*, V. 14, No. 1, Jan. 1919, pp. 24-27.

24. Wright, C.E., "Widening Demand for Blast Furnace Slag," *The Iron Age*, V. 103, No. 4, Jan. 23, 1919, pp. 241-243.

25. ACI Committee S-5, "Recommended Practice for Concrete House Construction," American Concrete Institute, Farmington Hills, MI, June 1922, pp. 57-58

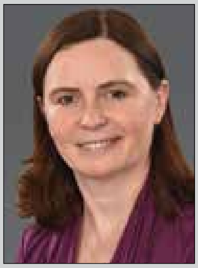
26. Whipple, H., "How Will the Individual Builder Get a Concrete House," *Concrete*, V. 16, No. 1, Jan. 1920, pp. 1-2.

27. Wilde, R.E., *ACI: A Century of Progress*, 123 pp. Accessed May 5, 2020. www.concrete.org/Portals/0/Files/PDF/ACI_History_Book.pdf.

Note: A copy of Reference 9 is included with the online version of this article.

Selected for reader interest by the editors.

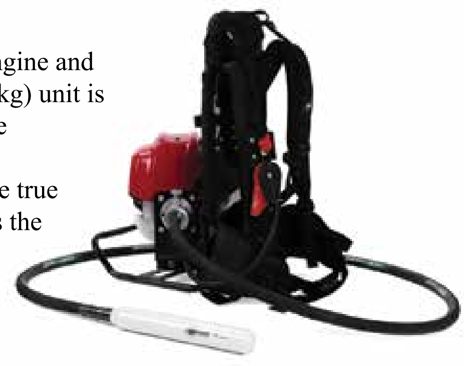
ACI member **Rex C. Donahey** is Editor-in-Chief of *Concrete International*. He was previously Director of Engineering and Development with Composite Technologies Corp., Boone, IA. Donahey received his PhD in structural engineering from the University of Kansas, Lawrence, KS. He is a licensed professional engineer in Oklahoma and Florida.



ACI member **W. Agata Pyc** is Engineering Editor of *Concrete International*. Prior to becoming ACI staff, she worked as an Engineer in the Materials Group at CTLGroup, Skokie, IL. She received her PhD in civil engineering, with emphasis on construction materials, from Virginia Tech, Blacksburg, VA, in 1998.

Products &
Practice

Minnich 50 cc Backpack Concrete Vibrator



This backpack concrete vibrator is driven by a Honda 50 cc four-stroke gasoline engine and has an ergonomically designed, fully adjustable harness. The lightweight 20.5 lb (9.3 kg) unit is equipped with many new features, including a removable throttle assembly that can be repositioned for easy and comfortable operation. Core/casings and vibrator heads are interchangeable between all Minnich gas-powered and electric flex shaft units with the true universal quick disconnect system. The Honda GX50 general-purpose engine expands the Minnich lineup with a model that offers high output and light weight for excellent performance and fuel efficiency in demanding commercial and rental applications.

—Minnich Manufacturing, www.minnich-mfg.com

Pure Safety Group Checkmate Xplorer

The Checkmate Xplorer industrial full-body harness for fall protection is designed to be more comfortable during periods of suspension and frequent loading. Its limited slip dorsal D-ring has a precise amount of vertical adjustment built in and is designed to keep the D-ring in place after multiple loadings. Its large front ring allows for multiple attachments and uses a lightweight aluminum quick-connect buckle to ensure a safe final connection. The harness also features visual alert stitching, an intuitive way for the user to understand the correct way to wear the harness. Hardware on the Xplorer is specifically designed to reduce wear on the webbing, allow for easy connections, and provide critical pivot points for a greater range of motion. For comfort, the harness features unique curved webbing that follows the contours of the body for a closer fit and an innovative subpelvic assembly for greater support and increased comfort during suspension.

—Pure Safety Group, **www.puresafetygroup.com**

Alchemco TechCrete 2500 Waterproofing Agent

TechCrete 2500® Waterproofing Agent is a nontoxic, VOC-free, spray-applied product that requires only one application to protect over the design life of a concrete structure. It penetrates the concrete to form a calcium silicate gel, quickly filling cracks, pores, and capillaries to provide maximum protection from the inside, and it also seals future cracks up to 1/64 in. (0.4 mm) in width. TechCrete 2500 is clear and colorless, so it does not change the appearance of the concrete surface, making it a solution for protecting historical structures. Treated surfaces can be opened to traffic within 8 hours. TechCrete 2500 is available in 1 gal. (3.8 L) bottles, 5 gal. (18.9 L) pails, and 55 gal. (208 L) drums.

—Alchemco, **www.alchemco.com**

Tenna TennaMINI GPS Tracker

The TennaMINI is a GPS tracking device that is ideal for heavy equipment and machines that do not have power sources. Small, durable, and easy to install, the device is designed to provide reliable service in harsh external environments. The TennaMINI is available in battery and solar models and can report in intervals of every 5 minutes to 24 hours. As long as there is a continuous light source, operating time is indefinite at a reporting rate of once per day for the solar-powered model. Tenna's One Platform solution and the company's family of integrated hardware, like the TennaMINI, can track, process, automate, and inform contractors on how to manage their entire mixed fleet.

—Tenna, **www.tenna.com**

Rapid International Trakmix

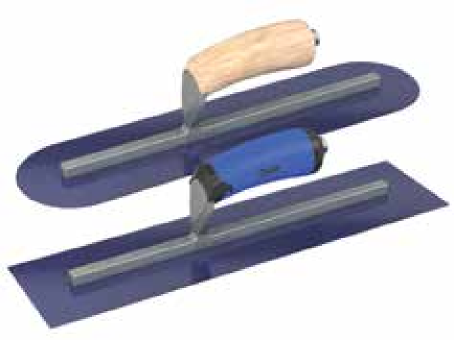
Trakmix is a track-mounted mobile continuous mixing plant. It has an entirely self-contained design mounted on tracks, including an onboard genset, providing flexibility. Patent-pending features include a control system that weighs all materials and a double-hopper cement-weighing system. Applications include semi-dry mixing applications such as roller-compacted concrete (RCC), cement-treated base (CTB), soil stabilization, and soil cement.

—Rapid International, **www.rapidinternational.com**

Bon Steel City Trowels

Bon's line of Steel City Trowels™ has been expanded to include 22 new trowels made of Ultra Flex Blue Steel, joining finishing trowels with blades made of Carbon Steel, Golden Stainless Steel, Razor Stainless Steel, and Blue Steel. The Ultra Flex Blue Steel Trowels feature a 0.019 in. (0.5 mm) blade for superior flexibility. Blade sizes range from 12 to 20 in. (305 to 508 mm). Trowel options include square end or round end and short or long shank. All blades are precision ground. Steel City Trowels feature lightweight and durable aluminum shanks and can be equipped with Bon's patented, ergonomic Comfort Wave or Camel Back Wood handles.

—Bon Tool Co., **www.bontool.com**



Comansa LCL310 Luffing-Jib Crane

The LCL310 luffing-jib crane comes in a few versions, including an 18 tonne (19.8 ton) maximum load version. Its maximum jib length is 60 m (197 ft), and the different configurations allow for maximum jib steps every 5 m (16.4 ft). With its compact design and reduced out-of-service radius, this luffing-jib crane is ideal for use in cities or congested building sites. The LCL310 comes standard with Comansa's CUBE cab, from which the electronic coordination system for luffing and hoist movements can be activated. The hook and work area are fully visible from the cab.

—Comansa, **www.comansa.com**

Thermal-Chem ArmorPrime Ultra-fast 727

ArmorPrime Ultra-Fast 727 is a two-component, pigmented, fast-curing epoxy resin system that deeply penetrates concrete and creates a tenacious bond. It is designed as a prime coat to promote adhesion and help reduce outgassing from porous or heavily abraded concrete under any of Thermal-Chem's resurfacers and topcoats. Color chips and colored quartz aggregate can be broadcast directly into it, so it can be used as a basecoat in Thermal-Chem's DecoFlake and DecoQuartz systems. With a cure time of around 2-1/2 hours at 75°F (24°C), ArmorPrime Ultra-Fast 727 helps to minimize downtime.

—Thermal-Chem, **www.ThermalChem.com**

Web Notes

GSSI Video Training Series

Geophysical Survey Systems, Inc. (GSSI), a manufacturer of ground-penetrating radar (GPR) equipment, launched a video series as part of their GPR training academy. The series features short and informative videos focusing on individual product lines and addressing frequently asked questions. The first series is on the StructureScan™ Mini XT—the newest generation of GSSI's all-in-one concrete inspection GPR system. The video segments include:

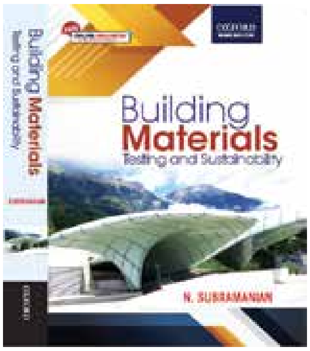
- Getting started—provides simple steps to get the StructureScan Mini XT up and running;
- How to use the StructureScan Mini XT LineTrac accessory—adds the ability to detect AC power and induced RF energy present in conduits;
- Working with the Palm XT miniaturized GPR antenna—gives users access in tightly spaced areas and enables overhead scanning;
- Set dielectric function—shows how to calibrate the dielectric value for the concrete, which is critical for estimating accurate depths of subsurface targets; and
- Collecting a 3D grid—offers instructions on setting up the grid and collecting data.

The videos can be found on GSSI's YouTube channel at **www.youtube.com/user/GPRbyGSSI**.

—Geophysical Survey Systems, Inc., **www.geophysical.com**

Book Notes

Building Materials: Testing and Sustainability
by N. Subramanian



Each chapter of this comprehensive textbook begins with an introduction and historical review and proceeds to discuss classifications, manufacture, important properties, advantages and disadvantages, green substitutes (if any), and sustainability. Traditional materials such as stone, brick, lime, cement, mortar and plaster, aggregate, concrete, iron, steel, wood, glass, and paint are discussed. Modern materials such as plastics, gypsum, special structural concretes, wood products, and ceramics are also discussed. There is also a separate chapter on testing and evaluation of these materials.

—Oxford University Press India, **www.india.oup.com**

699.00 INR; 816 pp.; ISBN 9780199497218

Products&Service Literature&Videos

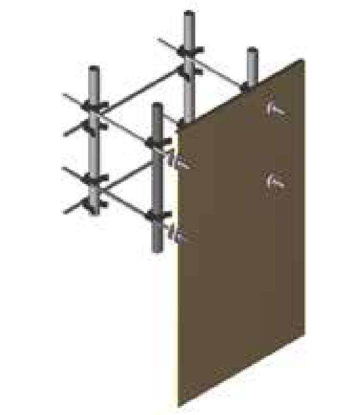
"Terminology and Evaluation Criteria of Crosshole Sonic Logging (CSL) as Applied to Deep Foundations"
by the Deep Foundations Institute CSL Task Force

The Deep Foundations Institute (DFI) released a new white paper titled "Terminology and Evaluation Criteria of Crosshole Sonic Logging (CSL) as Applied to Deep Foundations." The paper was produced by a CSL Task Force comprised of members of the DFI Codes and Standards Committee, Drilled Shaft Committee, and Testing and Evaluation Committee. The white paper reviews the state of the practice (including experience gained over the past 20 years), proposes improved CSL rating criteria, and makes recommendations for additional assessment. The 17-page paper is available at no cost at **www.dfi.org/publications.asp?goto=1058#P1058**.

—Deep Foundations Institute, **www.dfi.org**

Product
Showcase

Formwork & Accessories



E-ZBAR Universal Anchor Bolt Template

The latest addition to the E-ZBAR line of products is the Universal Anchor Bolt Template. E-ZBAR's coil rod, reinforcing bar clips, and retainers can be used to support anchor bolts from a concrete form. This system eliminates the possibility of shifting during concrete placement and works with anchor bolts measuring 1/2 to 1-1/8 in. (13 to 29 mm) in diameter. The E-ZBAR system allows users to support anchor bolts from above or below the surface of the concrete, with no need to work around traditional templates. Supports can be ordered preassembled or components can be purchased individually.

—E-ZBAR, **www.e-zbar.com**

CustomTech TechPatch TW

TechPatch™ TW (Tilt Wall) is a rapid-curing, calcium-aluminate cement-based compound that makes finishing vertical interior and exterior concrete and masonry surfaces fast and easy. Ideal for hiding chips, holes, and irregularities on tilt-up concrete as well as preparing cast concrete and masonry surfaces for painting or sealing, TechPatch TW dries in 15 to 60 minutes. Available in 10 lb (4.5 kg) boxes, it can be applied from 1/16 in. (2 mm) featheredge to 3 in. (76 mm) thick.

—CustomTech, **www.customtechflooring.com**

EFCO SUPER PLATE GIRDER

The SUPER PLATE GIRDER® forming system is designed to form wide-spanning bridge caps. It comprises high-strength alloy steel with precision-built panels providing excellent alignment of form joints. Its self-spanning capability reduces the need for external supports. It allows for large gang crane handling without the need for stiffbacks. The form can be easily climbed using the upturned leg of the rib when installing it horizontally for column and wall-forming applications. SUPER PLATE GIRDER features a minimum of twice the moment carrying capacity of EFCO's classic PLATE GIRDER to form larger, longer spans without shoring to the ground. On average, it has two times the placement pressure rating of classic PLATE GIRDER, so placement rates can be increased. In addition, compared to the classic PLATE GIRDER, half the labor is required to assemble the system with tension and compression beams. SUPER PLATE GIRDER's modular design offers versatility and flexibility when combined with standard accessories. For more information on EFCO products for bridges and highways, visit **www.efcoforms.com/learn-more-about-efco-bridges-highways/**.

—EFCO, **www.efcoforms.com**

(photo courtesy of PERI GmbH)

PERI SKYMAX

SKYMAX, a large-panel formwork system, makes it possible to carry out slab-forming procedures from a safe position on the level below. The panels, support heads, and other system components can be combined in many ways. From below, the panels are fed through the patented guide openings, which feature retaining teeth, and onto the head where they are automatically secured in place and cannot be lifted out. Additional system components such as column frames and adjustment beams make it safe and easy to marry up mating surfaces. The large-scale aluminum and polymer-based panels used in the SKYMAX system are lightweight; none of the formwork elements weighs more than 32 kg (71 lb). The handle strips in the lateral and longitudinal profiles also make the panels ergonomic to handle. SKYMAX comes standard with dual-frequency radio frequency identification (RFID) transponders, enabling users to detect and clearly identify the SKYMAX panels from significant distances and en masse using a scanner.

—PERI GmbH, **www.peri.com**

BoMetals QuicDiamond Basket

The QuicDiamond™ Basket is an optimal load transfer solution for slab contraction joints. The diamond shape positions the widest portion of steel where it is needed most, providing expansion flexibility. Diamonds are available in multiple thicknesses of 3/8, 1/2, or 3/4 in. (10, 13, or 19 mm). Manufactured from ASTM A36/A36M steel, all plates are smooth-edged sawn to allow for unrestrained movement. Solidly constructed basket framework maintains positioning under rigorous jobsite conditions. The QuicDiamond Basket is a companion product to the QuicDiamond Sleeve System.

—BoMetals, **www.bometals.com**

Stego Industries Beast Form Stake

The Beast® Form Stake is a lightweight, reusable composite stake for support of concrete formwork needed to create elevation changes in slabs-on-ground. When coupled with Stego Industries' adhesive-backed Beast Foot pads, Beast Form Stakes can support and brace form boards without penetrating the slab vapor retarder. Four SpeedTrack™ fastening grooves in the composite stake allow rapid attachment to the form board at any height along the stake using a nail or screw. Stakes can be removed after the concrete has set, allowing finishers to fill and repair resulting voids. This product was designed as part of Stego's vapor-retarder-safe forming system, which adheres to the installation standards in ASTM E1643.

—Stego Industries, LLC, **www.stegoindustries.com**

Industry Focus

Mecalac Opens New Facility

Mecalac opened a new 14,000 ft^2 (1300 m^2) facility in Norfolk, MA, to serve as the company's North American headquarters and support the growth of the brand in the North American market. Mecalac manufactures excavators, loaders, backhoe loaders, site dumpers, and compaction rollers. Most of its equipment is designed for multifunctionality to help reduce the number of machines on a jobsite. The new facility centralizes Mecalac's administrative offices, equipment inventory, parts, and service support in one building, replacing the three separate locations the company maintained previously. The facility is home to a diverse team of 14 Mecalac employees.

Indiana School Wins Grand Prize at 28th Annual Future City Competition

Yemoja, a city of the future designed by students from Norwell Middle School in Ossian, IN, won the grand prize at the 2020 Future City Competition. The competition finals, held in Washington, DC, were organized by DiscoverE and sponsored in part by Bentley Systems, Inc. Sixth-, seventh-, and eighth-grade students from 1500 schools in more than 40 regions, as well as teams from Canada, imagined, designed, and built models of cities for the 2019-2020 Future City Competition. The year's theme, "Clean Water: Tap into Tomorrow," challenged students to identify an urban water system threat and develop a futuristic solution to ensure a reliable supply of clean drinking water.

A team from Norwell Middle School, Ossian, IN, won the grand prize at the 2020 Future City Competition

B2W Software 2020 Client Innovation Awards

B2W Software presented its 2020 Client Innovation Awards to four contractors, recognizing achievements such as high returns on investment and improvements in efficiency with the B2W platform for construction estimating and operations. Winners were selected by a panel of judges based on applications submitted by contractors using B2W Software throughout North America.

Lancaster Development, a highway construction contractor based in Richmondville, NY, earned the Best Use of the B2W ONE Platform Award. B2W presented the Outstanding Vision Award for unique use of its software to Lakeside Industries, Issaquah, WA. EPCOR, a large utility contractor based in Edmonton, AB, Canada, and Severino Trucking, Candia, NH, tied for the Best Use of a Single B2W Product Award.

Charah Solutions Awarded Large-Scale Pond Closure Contract

Charah® Solutions, Inc., announced that it was awarded a closure-by-removal (CBR) impoundment project by a Southeastern utility. Charah Solutions will be responsible for the closure of about 100 acres (40 ha) of ash ponds located at a former coal-fired power station that was retired in 2015. The scope of work includes the installation of environmental controls, installation of new rail, improvements to existing rail infrastructure, and the construction of a large concrete loadout area. Over the next several years—as the closure of the ponds is underway—over 2 million tons (1.8 million tonnes) of ash is expected to be beneficially used in the concrete industry. At the project's conclusion, the former ash ponds will be restored as useable property.

Tindall Corporation Expands Operations

Tindall Corporation announced plans to expand operations in Spartanburg County, SC. The more than $27.9 million investment will create 20 new jobs. Tindall Corporation's in-house engineering, manufacturing, logistics, and on-site resources support both traditional and specialized construction project applications using precast concrete. Precast concrete made at the new facility will be shipped throughout the southeast United States and beyond, accommodating a wide range of construction needs. The company's expansion is expected to be completed in early 2021.

2020 ACEC Engineering Excellence Awards Gala Postponed Until Fall

The American Council of Engineering Companies (ACEC) postponed the 2020 Engineering Excellence Awards (EEA) Gala, originally scheduled for April 28 in Washington, DC, until fall. The 2020 gala will honor a record 203 entries representing engineering excellence from across the nation and world. Judging for the awards program took place in February and was conducted by a national 35-member panel of built environment leaders, along with experts from government, the media, and academia. Award criteria focused on uniqueness and originality, technical innovation, social and economic value, and generating excitement for the engineering profession. For updates on the event's new date and location, visit **www.acec.org** and ACEC's Last Word Blog at **www.acec.org/last-word-blog**.

Rinker Materials and PSI Contribute to MYR Taxiway Restoration

Serving more than two million passengers annually, Myrtle Beach International Airport (MYR) recently restored Taxiway A—Phase I as the first step in a multiphase, multiyear project to improve the traveler experience. The 30-year-old asphalt taxiway was upgraded with a concrete surface protected by a new stormwater management system capable of accommodating the severe weather common in the area.

Delta Airport Consultants, Inc., was enlisted by the MYR owner, Horry County Department of Airports, to lead the project design, which included a custom stormwater management system installed over an existing fiber-optic infrastructure buried less than 10 ft (3 m) underground. PSI of Conway, LLC, installed the stormwater management system using structural concrete components from Rinker Materials™. In addition to navigating the fiber optics, PSI of Conway, LLC, also replaced unsuitable soil with compacted No. 57 stone to stabilize the stormwater management system constructed with 6500 ft (1981 m) of Federal Aviation Administration-approved Class V C443 reinforced concrete pipe.

Taxiway A—Phase I was successfully completed despite 70 mph (113 kph) winds and more than 10 in. (254 mm) of rain delivered by Hurricane Dorian.

CROM LLC Achieves ASA Qualified Shotcrete Contractor

The American Shotcrete Association (ASA) announced that Bruce Russell (CROM LLC) was named an ASA Qualified Shotcrete Contractor (Advanced Wet-Mix). CROM LLC joins American Concrete Restorations Inc. (Advanced Wet-Mix), Coastal Gunite Construction Company (Advanced Dry-Mix), and Dees-Hennessey Inc. (Advanced Wet-Mix) as the latest addition to ASA's Qualified Shotcrete Contractors. The program recognizes shotcrete contractors who have shown by their company resources and past performance a proven commitment to quality shotcrete placement.

The ASA Contractor Qualification program requires a significant time commitment to attend the ASA Contractor Education seminar as well as fully documenting shotcrete-related business. Shotcrete experts (contractors, engineers, suppliers, and educators) review and verify applicant submittals of past successful work and aspects of shotcrete critical to quality placement. The Contractor Qualification committee reviews the shotcrete team, including contractor management, ACI-certified nozzleman, crew experience, proper equipment, and knowledge and ability to consistently place quality shotcrete.

BSD Headquarters Relocated

After a year of record growth, Building Systems Design, Inc. (BSD), relocated its company headquarters from Atlanta, GA, to Alpharetta, GA, in March of this year. BSD provides master guide specification content and software for the architecture, engineering, construction, and owner sectors. BSD's leadership team was drawn to Alpharetta by its growing business community and technology infrastructure. Many of the company's employees live near the company's new headquarters.

DFI Educational Trust Announces New Engineering Scholarship Fund

The Deep Foundations Institute (DFI) Educational Trust, the charitable arm of DFI, announced the establishment of the Clyde N. Baker Jr. Foundation Engineering Scholarship Fund. The fund, which honors Baker's contributions to the deep foundations industry, will provide scholarships to students enrolled full-time in an undergraduate or graduate civil engineering program at any accredited college or university in the United States. Recipients must demonstrate academic merit, an interest in the area of foundations engineering, and financial need.

Clyde N. Baker Jr. has retired after a successful career as Senior Principal Engineer at STS Consultants and later as a Senior Consultant at GEI Consultants, Vernon Hills, IL. During his career, he served as a geotechnical engineer or consultant on several of the tallest buildings in the world.

Hilti Streamlines Anchor Design Workflow with One-Click RISA Integration

Hilti streamlined the anchor and base plate design workflow by integrating its cloud-based PROFIS Engineering Suite software with RISAConnection from RISA Tech, Inc. PROFIS Engineering Suite helps handle the analysis of the elements of a steel-to-concrete connection, including base material and anchors. RISAConnection v11 helps engineers analyze and design steel connections and now can export base plate connections as well as reactions directly to PROFIS Engineering Suite, thereby helping reduce errors and saving time on designs. Previously, users would manually input information for each load combination. Now they can simultaneously check anchor and base plate capacities. Additionally, users can export the design report back to RISAConnection to create a comprehensive calculation package.

Calls for Papers

Advances in Rheology and Additive Manufacturing in Construction

Publication: Special issue of the *ACI Materials Journal*; Kamal H. Khayat and Shiho Kawashima, Guest Editors.

Solicited: Original papers are invited for a special issue of the *ACI Materials Journal* on "Advances in Rheology and Additive Manufacturing in Construction." Topics of interest include, but are not limited to, advanced rheological characterization of fresh cement-based systems; thixotropy, shear thickening, shear-induced migration, and other complex rheological behavior; analytical and computational flow models; rheometry and workability measurements for extrusion-based three-dimensional printing, particle-bed printing, and other additive manufacturing (AM) techniques; novel AM techniques; mixture design and use of chemical and mineral admixtures to control rheology for successful AM; use of alternative binders and solidification methods for AM; adjusting rheology and print parameters for printability, buildability, reinforcement, interlayer bonding, and other key features of AM.

Requirements: 1) paper title; 2) author name(s), title, affiliation, contact information, and corresponding author; and 3) abstract with a maximum length of 300 words.

Deadlines: Abstracts are due by June 15, 2020; notification of acceptance to submit full paper by June 30, 2020.

Send to: s-kawashima@columbia.edu.

Notable Concrete in Raleigh and Vicinity

Document: Compendium of notable concrete in and near Raleigh, NC, for e-publication at the ACI Concrete Convention – Fall 2020, October 25-29, 2020, Raleigh, NC; compiled by ACI Committee 124, Concrete Aesthetics, and cosponsored by Carolinas Chapter – ACI and the AIA Triangle Chapter. The document also will be available as an electronic file on the ACI website and may be excerpted in *Concrete International.* Images submitted may be stored and available as electronic files on the ACI website and may be used in ACI educational and promotional materials. Exceptional images may merit placement on the cover of *Concrete International*.

Solicited: Image and brief description of notable concrete (including cast-in-place, precast, post-tensioned, masonry, and tilt-up) in all types of uses—buildings, monuments, pavement, silos, bridges, crypts, furniture, retaining walls, utility poles, tanks, sculpture, culverts, plazas, and whatever else has caught your attention. Significance may be historical, aesthetic, sustainable, functional, structural, construction-related, unusual use or application, or simply personal affection.

Requirements: 1) project name and location, including postal code; 2) image (photograph, drawing, or sketch) that is not copyrighted; 3) brief description that establishes significance and lists credits; and 4) submitter's name, title, organization, city, province or state, telephone, and e-mail address. Submit all information in electronic format: image as JPG or TIF file at least 1 MB (but no more than 4 MB); text in e-mail or as MS Word document (120 words maximum). No PDF files, please.

Deadline: Materials are due by July 1, 2020.

Send to: Michael J. Paul, Larsen & Landis, 11 W. Thompson St., Philadelphia, PA 19125, mpaul@larsenlandis.com.

Durability, Service Life, and Long-Term Integrity of Concrete Materials, Bridges, and Structures

Meeting: Technical session on "Durability, Service Life, and Long-Term Integrity of Concrete Materials, Bridges, and Structures" at the ACI Concrete Convention, October 17-21, 2021, Atlanta, GA; sponsored by ACI Committee 345, Concrete Bridge Construction and Preservation; moderated by Yail Jimmy Kim, University of Colorado Denver; Chris P. Pantelides, University of Utah; and Xianming Shi, Washington State University.

Solicited: In this session, presentations of both experimental and analytical investigations are of interest, which may include the durability of concrete structures reinforced with steel or fiber-reinforced polymer bars, modeling of service life for concrete under aggressive environments, and the structural integrity and resilience of rehabilitated members. The session will emphasize recent research findings and provide an opportunity to discuss present challenges and technical issues.

Requirements: 1) presentation title; 2) author/speaker name(s), title, organization, mailing address, telephone number, fax, and e-mail; and 3) abstract of 200 words.

Deadline: Abstracts are due by August 31, 2020.

Send to: Yail Jimmy Kim, University of Colorado Denver, jimmy.kim@ucdenver.edu.

Calls for Papers: Submission Guidelines

Calls for papers should be submitted no later than 3 months prior to the deadline for abstracts. Please send meeting information, papers/presentations being solicited, abstract requirements, and deadline, along with full contact information to: Keith A. Tosolt, Managing Editor, *Concrete International*, 38800 Country Club Drive, Farmington Hills, MI 48331; e-mail: keith.tosolt@concrete.org. Visit www.callforpapers.concrete.org for more information.

ACI draft standards open for public discussion that are being processed through ACI's ANSI-approved standardization procedures can be found at **www.concrete.org/discussion**. **These ACI standards are not yet official.**

Public Discussion and Closure
"Specification for Pervious Concrete Pavement (ACI 522.1-20)"

The ACI Technical Activities Committee (TAC) approved the draft standard subject to satisfactory committee response to TAC comments in July 2019. The committee responded adequately to TAC's comments and all balloting rules were adhered to. Public discussion was announced on February 3, 2020, and closed on March 19, 2020. The committee responded to the public discussion. TAC reviewed the closure and approved it in April 2020. The Standards Board approved publication of the ACI standard in May 2020.

The public discussion and the committee's response are available at **www.concrete.org/discussion**.

What's New from aci

TECHNICAL DOCUMENTS

SP-339: Performance-Based Seismic Design of Concrete Buildings: State of the Practice (ACI Concrete Convention, October 15-19, 2017, Anaheim, CA, USA)

During the ACI Concrete Convention, October 15-19, 2017, in Anaheim, CA, Committee 374 sponsored three technical sessions titled "Performance-Based Seismic Design of Concrete Buildings: State of the Practice." The sessions presented the state of practice for the PBSD of reinforced concrete buildings. These presentations brought together the implementation of PBSD through state-of-the-art project examples, analysis observations, design guidelines, and research that supports PBSD.

ACI UNIVERSITY ONLINE COURSES

On-Demand Course: Foundations for Dynamic Equipment (Chapters 3 and 7)

Learning objectives:

1. Identify the different types of foundations for equipment;
2. Understand design information necessary to preliminarily size a foundation;
3. Recognize the performance requirements of the concrete; and
4. Discuss minimum reinforcement requirements for dynamic equipment foundations.

Continuing Education Credit: 0.10 CEU (1.0 PDH)

On-Demand Course: How To Handle Concrete Placements Exposed To Rain

Learning Objectives:

1. Understand the four main properties of rainstorms and what effect they can have on concrete placements;
2. Timing of a rainstorm during a concrete placement will influence how the rain event should be handled. Learn what options are available to contractors during the main stages of placing and finishing concrete;
3. Understand what a "wet weather plan" is and what should be included in one; and
4. Learn what repair options are available if a concrete placement is affected by rain.

Continuing Education Credit: 0.10 CEU (1.0 PDH)

Meetings

Editor's Note: Many conference dates were in flux prior to this issue's publication. Verify all conference dates by visiting conference websites.

JUNE

18-19 - **DFI SuperPile '20**, Online
www.dfi.org/dfieventlp.asp?13389

JULY

6-9 - **Digital Concrete 2020: 2nd RILEM International Conference on Concrete and Digital Fabrication**, Eindhoven, Netherlands
www.digitalconcrete2020.com

19-25 - **ICCE-28: 28th International Conference on Composites and Nano Engineering**, Prague, Czech Republic
www.icce-nano.org

23-25 - **Concrete Foundations Convention 2020**, Charleston, SC
www.cfawalls.org/event/concrete-foundations-convention-2020-charleston-sc

27-29 - **ACI Professors' Workshop**, Online
www.concrete.org/events/professorsworkshop.aspx

AUGUST

3-8 - **EURO-MED-SEC-3: The Third European and Mediterranean Structural Engineering and Construction Conference**, Limassol, Cyprus
www.isec-society.org/EURO_MED_SEC_03

4-7 - **2020 NCMA Midyear Meeting**, Milwaukee, WI
www.ncma.org/event/midyear-meeting

16-19 - **Building Innovation 2020 Conference & Expo**, Arlington, VA
www.buildinginnovation.org

AUGUST-SEPTEMBER

30-4 - **74th RILEM Annual Week & 40th Cement and Concrete Science Conference**, Online
www.rilem.net/agenda/74th-rilem-annual-week-1274

SEPTEMBER

10-11 - **International Conference on Cement-Based Materials Tailored for a Sustainable Future**, Istanbul, Turkey
www.cbmt2020.org

18-20 - **ICDCS 2020: 7th International Conference on Durability of Concrete Structures**, Jinan City, China
http://icdcs2020.ujn.edu.cn

21-24 - **CAMX: The Composites and Advanced Materials Expo**, Orlando, FL
www.thecamx.org

23-26 - **2020 PCI Committee Days and Technical Conference**, Rosemont, IL
www.pci.org/PCI/News-Events/Event_Display.aspx?EventKey=20CD

24-27 - **ASCC Annual Conference**, St. Louis, MO
www.ascconline.org/events

27-30 - **PTI 2020 Convention & Expo**, Miami, FL
www.post-tensioning.org/events/convention/upcomingconvention.aspx

OCTOBER

3-7 - **HINDSIGHT 2020: Conservation, Disruption, and the Future of Heritage**, Online
www.eventscribe.com/2020/APTNT

5-7 - **2020 ICRI Fall Convention**, Minneapolis, MN
www.icri.org/event/2020-ICRI-Fall

THE ACI CONCRETE CONVENTION: FUTURE DATES

2020 — October 25-29, Raleigh Convention Center and Raleigh Marriott, Raleigh, NC

2021 — March 28-April 1, Hilton and Marriott Baltimore, Baltimore, MD

2021 — October 17-21, Hilton Atlanta Downtown, Atlanta, GA

For additional information, contact:

Event Services, ACI, 38800 Country Club Drive,
Farmington Hills, MI 48331
Telephone: +1.248.848.3795
www.concrete.org/events/conventions.aspx

ACI Industry Events Calendar:

For more information and a listing of additional upcoming events, visit **www.concrete.org/events/eventscalendar.aspx**. To submit meeting information, e-mail Rebecca Emanuelsen, Editor, *Concrete International*, at rebecca.emanuelsen@concrete.org.

Sinopsis en español

Las declaraciones de posición facilitan la promoción

Frosch, R.J., y Szoke, S.S., *Concrete International*, V. 42, No. 6, junio de 2020, pág. 26-28

ACI tiene seis declaraciones de posición sobre los esfuerzos de promoción relacionados con el desarrollo y adopción de códigos y tres declaraciones sobre el fomento del desarrollo y el uso de programas, servicios y normas del ACI. Estas declaraciones enfatizan el papel del ACI en la influencia de los programas, políticas, normas y reglamentos relacionados con el concreto y la tecnología del concreto. Dado que muchas otras organizaciones comunican sus posiciones y políticas mediante declaraciones, las declaraciones de posición del ACI pueden permitir al Instituto alinear más fácilmente sus esfuerzos con organizaciones afines.

Que haya luz

Huso, D.R., *Concrete International*, V. 41, No. 6, junio de 2019, pág. 30-32

Inaugurado en julio de 2019, el Viettel Offsite Studio en el distrito Thạch Thất, de Hanoi (Viet Nam), utiliza la geometría para amplificar la experiencia de los visitantes en el entorno natural del edificio. Definida por seis estructuras de concreto y vidrio en forma de V que se abren como libros a la vista de un lago y un jardín, la instalación contiene cuatro estudios interiores, un espacio de recepción y un comedor. Los jardines de la azotea sirven como espacios de estudio al aire libre.

Concreto de ultra alto rendimiento de receta abierta

El-Tawil, S.; Tai, Y.-S.; Belcher II, J.A.; y Rogers, D., *Concrete International*, V. 42, No. 6, junio de 2020, pág. 33-38

El concreto de ultra alto rendimiento (UHPC por sus siglas en inglés) está emergiendo como una tecnología que cambia el juego para las aplicaciones de infraestructura. Sin embargo, debido a su naturaleza propietaria y a los costos conexos, la tecnología de UHPC no ha sido adoptada de manera generalizada en los Estados Unidos. El artículo resume la historia del UHPC, discute los componentes del UHPC de receta abierta y aboga por la ampliación del uso de esta tecnología en los Estados Unidos.

Se puede hacer

Donahey, R.C., y Pyc, W.A., *Concrete International*, V. 42, No. 6, junio de 2020, pág. 39-44

Entre 1910 y 1920, las máquinas de paredes huecas de Van Guilder se utilizaron para construir casas de concreto, edificios de almacenamiento en frío, silos y otras estructuras en todos los Estados Unidos. Algunas de las casas siguen en uso y sirven como recordatorio de que las estructuras de concreto son realmente factibles, viables y resistentes. El artículo analiza la historia y los detalles de las máquinas y proporciona ejemplos de estructuras de concreto construidas con esta tecnología.

Advertiser Index

June *CI* Advertisers

For more information, contact:

Jeff Rhodes, VP Sales
MCI USA +1.410.584.8487
E-mail: jeff.rhodes@mci-group.com

CI Advertisers in the 2020 Concrete Product & Service Guide

Allplan, Inc.
+1.610.429.9800, www.allplan.com

CHRYSO Inc.
+1.800.936.7553; +1.972.772.6010, www.chrysoinc.com

Computers and Structures, Inc.
+1.510.649.2200, www.csiamerica.com

The Euclid Chemical Company
+1.800.321.7628; +1.216.531.9222, www.euclidchemical.com

GCP Applied Technologies
+1.617.876.1400, www.gcpat.com

Jordahl USA, Inc.
+1.866.332.6687, www.jordahlusa.com

Larsen Products Corp.
+1.800.633.6668; +1.301.776.4595, www.larsenproducts.com

Oztec Industries, Inc.
+1.800.533.9055; +1.516.883.8857, www.oztec.com

Simpson Strong-Tie
+1.800.999.5099, www.strongtie.com

StructurePoint LLC
+1.847.966.4357, www.structurepoint.org

Xypex Chemical Corporation
+1.800.961.4477; +1.604.273.5265, www.xypex.com

Visit the Product & Service Guide at **www.concrete.org/publications/concreteinternational/ciproductguide.aspx**

Upcoming Ci Themes

July—Floors & Foundations
August—Mixing, Placing & Curing
September—Emerging Technologies

For advertising details, contact Jeff Rhodes
Phone: +1.410.584.8487
E-mail: jeff.rhodes@mci-group.com

Concrete Placement for Ogee Dam

Q. *My company has a new project that includes a 10 ft (3 m) tall dam crest wall. In section, one side of the wall is a vertical line and the other side is an ogee curve, so the wall is 2 ft (0.6 m) wide at the top and 12 ft (3.7 m) wide at the bottom. The wall will be formed using a steel gang form in conjunction with a plywood insert to create the ogee shape. We need to avoid honeycombing, and we are concerned that the ogee shape will make it impossible to place internal vibrators near the form face. External vibrators seem like a good alternative, but we have no experience with them. Can you provide any information on the use of this equipment as well as positive and negative experiences?*

A. When it comes to external vibrators, one contractor indicated that he had used them frequently with fairly good results. But he also cautioned that depending on how they are spaced, it may be necessary to move the vibrators several times during concrete placement. The contractor did not indicate if this experience was with ogee-shaped forms.

A contractor with ogee spillway experience recommended contacting external vibrator manufacturers for advice. His company had used external vibrators on a couple of jobs. The manufacturers helped by providing technical assistance during preconstruction, with suggested spacing and cost analysis, and during field service, as part of the rental of the machines. Both manufacturers recommended moving the vibrators up the wall during the placement to save on the number furnished and therefore the cost. However, this was time-consuming, and the contractor believes that they would have benefitted by adding more units.

Also, the form system has a direct impact on the results. For ogee spillways, one contractor achieved best results using timber or laminated veneer lumber (LVL) beams, aluminum strongbacks, and shaping wood between to get the required shape. Sheathing the shaping wood with high-density overlay (HDO) or phenolic film plywood (kerfed to ease bending), as well as proper application of reactive form release agents, helped to produce a slick surface and prevent trapped air bubbles. In addition, when using external vibrators, the contractors noted that it's important not to have too much form depth or "layers," as the extra thickness diminishes the effectiveness of the vibrators. One noted that attaching the external vibrators directly to the LVL beams helped with consolidation.

Another contractor suggested the use of a digital borescope (an industrial inspection camera) to view inside the form through small holes in the form face. While the holes leave little nubs that must be chipped off and rubbed smooth, they also serve as boil holes that allow entrapped air to escape during placement.

Lastly, one contractor suggested using self-consolidating concrete (SCC). Even though SCC is more expensive than regular concrete, the cost add would probably be less than the cost of external vibrators. Note that the concrete will need to flow horizontally, without segregation, to fill the ogee shape (Fig. 1(a)). Also, even with a combination of internal and external vibration, some concrete would not be properly consolidated (Fig. 1(b)). Therefore, in your case, SCC is likely the best solution because it provides for better flow during placement, minimizes segregation concerns, and reduces consolidation concerns.

Acknowledgment

The question and answers were obtained from the American Society of Concrete Contractors (ASCC) Email Forum, which is a contractor member benefit from ASCC.

Thanks to Bruce Suprenant, ASCC, St. Louis, MO, for consolidating the various responses from these ASCC Email Forum participants.

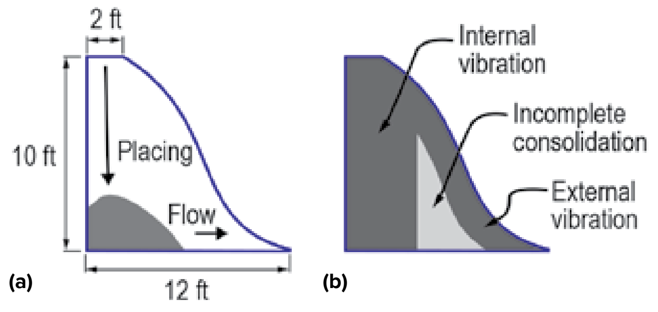


Fig. 1: Dam crest wall construction with conventional concrete: (a) concrete placement; and (b) concrete consolidation

Tie Spacing Tolerances

Q. *For some wall placements, my company uses gang forms with predrilled tie holes. On our latest project, the engineer made us drill new holes in some of the forms because the spacing between lines of ties was 1/4 in. (6 mm) less than the spacing shown on the plans. Do any ACI documents provide a tolerance for form tie spacing?*

A. The maximum designed tie spacing is based on the tie capacity in pounds of safe working load and wale capacity based on bending, deflection, and horizontal shear. It's a safety-related requirement used to minimize the probability of a formwork failure caused by an inadequate number of ties. Reducing the tie spacing from that shown on the shop drawings for formwork would thus be allowed. Even if the tie spacing was +1/4 in., there are enough safety factors involved to allow a plus tie spacing tolerance.

ACI 117-10 (15)[1] does not include a specific tolerance for tie-hole spacing. However, Section 2.3.2 provides a tolerance of ±1 in. (25 mm) on centerline of assembly from specified location for embedded items. It is reasonable to consider form ties as embedded items. And this conclusion is supported by Section 2.2.1.2 of ACI 301-05,[2] which states: "Use commercially manufactured accessories for formwork accessories that are partially or wholly embedded in concrete, including ties and hangers." Although the phrase "that are partially or wholly embedded in concrete" has been removed in the 2010 and 2016 editions,[3,4] ties are certainly embedded in concrete. Further, based purely on structural behavior of the formwork, ±1 in. seems reasonable. If the required number of ties is provided, exceeding the nominal spacing by 1 in. is unlikely to have any effect on structural capacity. This is analogous to the spacing requirements for reinforcing bars in a slab: if the specified number of bars is used, the spacing of individual bars can vary widely.

Acknowledgment

The question and answer were obtained from the American Society of Concrete Contractors (ASCC) Email Forum, which is a contractor member benefit from ASCC.

Thanks to Bruce Suprenant, ASCC, St. Louis, MO, for consolidating the various responses from ASCC Email Forum participants.

References

1. ACI Committee 117, "Specification for Tolerances for Concrete Construction and Materials (ACI 117-10) and Commentary (ACI 117R-10) (Reapproved 2015)," American Concrete Institute, Farmington Hills, MI, 2010, 76 pp.

2. ACI Committee 301, "Specifications for Structural Concrete (ACI 301-05)," American Concrete Institute, Farmington Hills, MI, 2005, 49 pp.

3. ACI Committee 301, "Specifications for Structural Concrete (ACI 301-10)," American Concrete Institute, Farmington Hills, MI, 2010, 77 pp.

4. ACI Committee 301, "Specifications for Structural Concrete (ACI 301-16)," American Concrete Institute, Farmington Hills, MI, 2016, 64 pp.


aci CONCRETE CONVENTION
Registration is
NOW OPEN
October 25-29, 2020
Raleigh Convention Center &
Raleigh Marriott City Center
Raleigh, NC
Photo courtesy of Visit Raleigh
For more information, please visit aciconvention.org.