FOCUS

Simpson Gumpertz & Heger Thrives on Challenging Projects

The 68-year-old consulting firm uses engineering expertise and applied science to provide integrated engineering solutions for forensic investigation, design, and rehabilitation projects

by Monica Schultes

Nearly 6000 precast concrete deck panels were manufactured for the Governor Mario M. Cuomo Bridge connecting New Jersey and New York. Simpson Gumpertz & Heger consulted with Unistress Corporation on this project, fine-tuning concrete mixture proportions and optimizing constructability at the Unistress precast concrete facility. Photo: Unistress Corporation.

Simpson Gumpertz & Heger (SGH) is a national engineering firm with 700 employees. The firm's diverse experience and technical expertise fall into five primary service areas: structures, building enclosures, advanced analysis, performance and code consulting, and applied science and research. The company, which bears the name of the three Massachusetts Institute of Technology professors who founded it in 1956, now provides services to clients in several major markets, including commercial, entertainment, education, energy, government, healthcare and life sciences, industrial, residential, science and defense, and infrastructure and transportation.

The ethos established by SGH's founders—a commitment to technical excellence and integrity—still rings true today. According to Dominic Kelly, senior principal at SGH, "Our breadth of technical skills and in-house laboratory and research capabilities give us the resources to help our clients. We take pride that they frequently seek us out for their most challenging projects."

Organic Growth

From the firm's early days as fledgling consultants to its prominent place in the ENR Top 200 design firms, SGH's growth has primarily been organic and has involved strategic hiring to meet clients' needs, expanding geographically, and developing capabilities in areas complementary to their core services. With offices in Atlanta, Ga.; Boston and Waltham, Mass.; Chicago, Ill.; Denver, Colo.; Houston, Tex.; Los Angeles, Newport Beach, and Oakland, Calif.; New York, N.Y.; and Washington, D.C., SGH performs work across the United States as well as internationally.

In addition to designing new construction, SGH works extensively with aging structures and infrastructure, performing thorough structural and building enclosure condition assessments to identify, prioritize, and design appropriate repair options. Kelly says, "We also have a long-standing practice in historic preservation, which uses research, field observation, testing, and analysis to protect and extend the useful life of our communities' most treasured and historic structures."

The firm often collaborates with large institutional clients, providing solutions for aging structures. "To communicate our findings and recommendations, SGH developed a web-based asset-management tool that can be used throughout the built environment, where we capture field observations and evaluations in a structured manner and provide our clients with a living record for them to update. Our asset-management tool gives clients insight into a vast amount of collected data and the means to prioritize repair and maintenance," Kelly says.

Applied Science and Research Center

To complement their professional consulting services, SGH operates the Applied Science and Research Center (ASRC), which consists of approximately 13,500 ft^2 of laboratory facilities at the firm's Waltham headquarters. There, SGH develops and performs comprehensive testing and research to better understand

The Applied Science and Research Center at Simpson Gumpertz & Heger's headquarters in Waltham, Mass., is ISO-certified to perform a wide range of concrete testing. Photo: Simpson Gumpertz & Heger.

how materials, components, and systems behave. The ASRC's main focus areas include physical testing, environmental simulations, materials science, microscopy, and research partnerships with academic and scientific institutions. The ASRC team members—chemists, geologists, metallurgists, material engineers, and laboratory technicians—explore questions such as why materials fail, how structural connections perform, and how building or structural components will behave when exposed to specific conditions or loading parameters.

"It is in our nature to understand how structures and materials behave," says Matthew Sherman, senior principal at SGH. "Laboratory testing helps us validate innovative designs, provide evidence for investigations, and inform our repair techniques. By executing our own hands-on analyses, and through our constant questioning, we solve complex issues, satisfy our curiosity, and create an environment where we can learn and improve."

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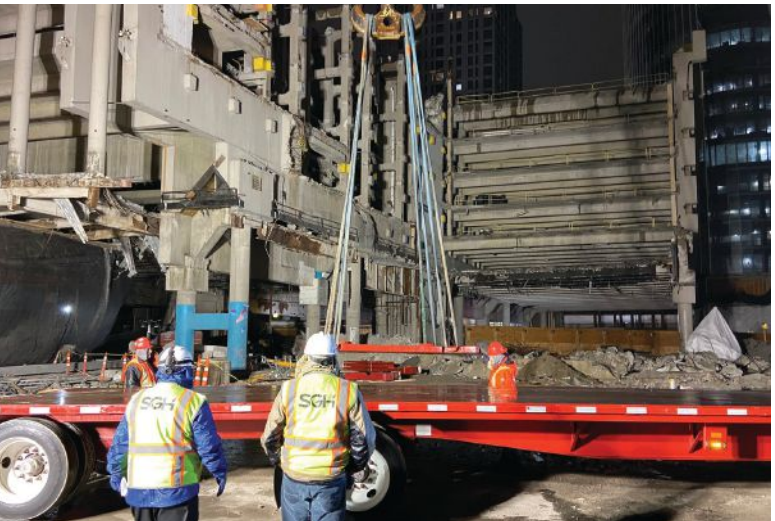
In 2022, the ASRC earned ISO certification for key concrete testing methods. The certification complements the center's American Association of State Highway and Transportation Officials (AASHTO) concrete testing lab accreditations, which include specific equipment requirements, procedures, training, and staff competency evaluations. SGH maintains active accreditations in Aggregates, Concrete, Quality Management Systems, and Concrete Materials Testing. Audits are performed by third-party inspectors to ensure that standards are maintained. The inspectors review SGH's quality-management system, how data are assessed, and how a competent, trained staff is maintained.

Concrete Anchorage

SGH values continual learning and actively works to further the standards of practice in the profession. "We have an obligation to share our knowledge outside the firm, and we participate in dozens of organizations by holding leadership positions, participating on codes and standards committees, and conducting research," says Neal Anderson, technical director at SGH.

Anderson has contributed his expertise to the industry by being active in the American Concrete Institute's (ACI's) concrete anchorage committee for many years. SGH took an active role in developing the new provisions for cast-in-place and post-installed anchors that were introduced into Article 5.13 of the *AASHTO LRFD Bridge Design Specifications*[1] in 2017. According to Anderson, rather than start from scratch, AASHTO cited the well-developed provisions in Chapter 17 of ACI 318,[2] with some exceptions. Anderson was also instrumental in helping to educate the bridge community in 2020 through a series of webinars and articles. Anderson recalls, "Sufficient use of anchorages necessitated the introduction of Article 5.13, and PCI wanted to be in the forefront in educating the bridge sector regarding the 'new' provisions." He also says, "AASHTO Article 5.13 is good for the industry and provides established design methodologies and quality control for cast-in anchor bolts and post-installed anchors in pier caps and bridge

A partial collapse at the Government Center garage during demolition, directly over the Haymarket Station tunnel in downtown Boston, Mass., halted subway service. The Massachusetts Bay Transportation Authority called on Simpson Gumpertz & Heger to evaluate the more than 120-year-old tunnel structure. SGH responded quickly, performing field observations and engineering analyses. Subway service was restored two weeks later. Photos: Simpson Gumpertz & Heger.



railings, sign structures, and guide rail attachments anchored into concrete." (See the four-part series in the Summer 2020, Fall 2020, Winter 2021, and Spring 2021 issues of *ASPIRE*® for the provisions of the AASHTO LRFD specifications related to concrete anchors.)

Recently, Anderson and others in the anchorage community have been assisting the AASHTO Committee on Bridges and Structures, Subcommittees T-4 (Construction) and T-10 (Concrete Design), with construction and installation phase issues, including determining the appropriate methods of field inspection when using post-installed anchors.

Boston Projects

SGH has been involved in numerous projects in downtown Boston. Following the 2022 collapse of a portion of the Government Center garage during planned demolition, the Massachusetts Bay Transportation Authority (MBTA) called SGH to help. The firm was recognized for their rapid response to determine the impact of the collapse on the Haymarket Station tunnel, located directly below the parking structure. SGH identified damage caused by the collapse and analyzed the impact effects on the tunnel carrying the MBTA's Green and Orange subway lines.

More recently, SGH worked with the MBTA to evaluate, test, and retrofit the rail attachments to the concrete slab sections in a downtown Boston tunnel. The assessment included evaluating the conditions of the mainline track system, including rail-fastening assemblies such as direct fixation fasteners and anchor studs in the cast-in-place slabs.

Washington State Route 520 Floating Bridge

Infrastructure and transportation systems are a critical sector for SGH. The firm works with owners and project teams to provide a wide range of engineering and code consulting services for new construction, evaluation, and rehabilitation projects for buried structures, tanks and pipelines, dams, airports, parking structures, pedestrian and vehicular bridges, and marine infrastructure. Their portfolio contains unique and challenging projects such as the world's longest floating bridge located in Seattle, Wash.

With a length of more than 7700 ft, the new State Route 520 Floating Bridge connecting Seattle and Bellevue, Wash., achieved a Guinness World Record for the longest floating bridge. The structure, completed in 2016, uses 77 precast, post-tensioned concrete floating pontoons joined together to support an elevated roadway above the pontoons. The pontoons are anchored with cables to the lakebed of Lake Washington.

Working with the joint venture of Kiewit, General Construction, and Manson Construction for the Washington State Department of Transportation, SGH performed specialty engineering tasks for construction engineering of the new bridge and served as engineer of record for the decommissioning of the original bridge.

According to Sam Yao, senior principal at SGH, during construction of the new bridge, SGH designed cable-anchor test frames used to evaluate the structural integrity of anchor cables, provided value engineering for the floating pontoon assembly, and designed the mooring facilities and fenders for berthing large concrete floating pontoons and construction vessels.

Decommissioning the original bridge was complicated by the retrofits, ballast modifications, and external post-tensioning along the entire length of the bridge. Errors during the removal work could have damaged the new floating bridge and its anchor cables. SGH performed a comprehensive engineering analysis to ensure that the original floating bridge could be safely disassembled and removed, including structural safety evaluation and floating stability analyses for ballasting, towing, mooring, assembly, and separation of floating pontoons. They also designed heavy lifts using floating derrick cranes to install and remove the bridge deck panels, girders, and columns. The bridge was successfully decommissioned, and the pontoons were repurposed as docks and artificial reefs. (For more on the State Route 520 Floating Bridge, see the Spring 2016 issue of *ASPIRE*.)

Governor Mario M. Cuomo Bridge

SGH performs a wide range of construction-related services, including the construction materials and operations side of a project. "We are structural engineers by training, but we also work with construction materials to solve problems," says Sherman.

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For the construction of the Governor Mario M. Cuomo Bridge connecting New Jersey and New York, which was fully

History of Simpson Gumpertz & Heger

Three innovators, Howard Simpson, Werner Gumpertz, and Frank Heger, founded Simpson Gumpertz & Heger (SGH) in 1956. They were professors at the Massachusetts Institute of Technology and renowned engineers, who used their passion and expertise to establish the guiding philosophies for SGH, which are still relevant today. "They possessed an unwavering commitment to excellence and integrity—and the trio dedicated their careers to perpetuating this culture," says Dominic Kelly, senior principal at SGH.

Each of the three founders had a specific area of expertise important to formulating the firm's three-pronged approach to engineering. Simpson led the structural mechanics group, Gumpertz oversaw the building technology group, and Heger directed the structural engineering group. "As SGH grew, so did our expertise in each of these areas, as team members were encouraged to advance their skills." says Kelly. "Today, SGH has five core services, and dozens of specialized capabilities."

The firm is nationally recognized as an expert on the causes of structural failure. For example, SGH was hired by the National Institute of Standards and Technology to investigate the collapse of the World Trade Center in New York City and assess the towers' structural response to impact damage and fire after the September 11, 2001, attacks.

On the Washington State Route 520 floating bridge project, Simpson Gumpertz & Heger served as the structural and marine engineer, as well as the engineer of record for many critical tasks. This epic 7700-ft-long structure crossing Lake Washington uses post-tensioned, precast concrete pontoons (360 × 75 × 28 ft) to support an elevated roadway. Photo: Simpson Gumpertz & Heger.

opened to traffic in 2018, SGH helped the precaster maximize the efficiency of concrete production while minimizing rejections and delays, all while meeting the strict project requirements. "We frequently collaborate with contractors and precasters," says Sherman. "On this large project we partnered with Unistress Corporation, one of four companies that supplied precast concrete products to the Tappan Zee Constructors joint venture."

Unistress was responsible for manufacturing precast concrete bridge deck panels and collaborated with SGH on the fabrication and production of the panels to meet the rigorous durability requirements specified by the New York State Thruway Authority. SGH helped the Unistress team produce 6000 full-depth deck panels efficiently and optimize the mixture proportions to meet the goal of a 100-year service life.

According to Brett Holland, senior project manager at SGH, it was a challenge to develop concrete mixture proportions that met the durability requirements while consistently maintaining the workability and constructability of the concrete. In addition to serving as liaison for engineering, production, and the owner, SGH performed special laboratory testing outside of the capabilities of the precaster's own quality-control laboratory. These tests included chloride permeability, resistance to freezing and thawing, shrinkage, and alkali-silica-reaction mitigation for the specialty concrete. SGH petrographers also monitored air entrainment and the air-void system of the concrete.

Working together, SGH and Unistress fine-tuned the mixture, which contained slag cement, fly ash, and silica fume, for production at Unistress's existing facility, as well as a temporary casting bed specifically dedicated for the megaproject. The typical precast concrete deck panels for this bridge are 45 ft long, 12 ft wide, and 11 in. thick, and weigh 74,000 lb. However, many panels are biplanar to accommodate variable roadway crown lines.

Casting the precast concrete deck panels was no small feat, but it was only a small part of the massive bridge project. The project involved 6 linear miles of bridge, which included approach viaducts and cable-stayed structures. The project used a vast quantity of structural precast concrete components, including pile caps, pier caps, deck panels, and crossbeams between its iconic towers.

Lightweight Solutions

When designers and precasters incorporate larger components and faster construction into projects, they often prefer high-strength structural lightweight concrete to avoid the possible complications of shipping, transporting, and lifting that can be associated with normalweight concrete. When project stakeholders are unfamiliar with the design and production of high-strength lightweight concrete, project collaboration is needed earlier than usual, with transparency and excellent communication between the project partners. SGH is often behind the scenes supporting precasters in this collaboration, helping the design and production teams better understand creep, shrinkage, resistance to freezing and thawing, and production aspects of high-strength lightweight concrete, all of which differ from the qualities of conventional concrete.

SGH has a long history of playing prominent engineering roles in design, investigation, and rehabilitation projects. The company's influence has played an important part in propelling SGH into the top 200 design firms in the United States.

References

1. American Association of State Highway and Transportation Officials (AASHTO). 2017. *AASHTO LRFD Bridge Design Specifications*. 8th ed. Washington, DC: AASHTO.
2. American Concrete Institute (ACI). 2014. *Building Code Requirements for Structural Concrete* (ACI 318-14) *and Commentary* (ACI 318R-14). Farmington Hills, MI: ACI.