

# ENGINEERING RELATIONSHIPS

Jacobs relies on strong relationships, repeat clients, and value-focused design decisions as it delivers innovative and efficient bridges in an evolving bridge market

by Craig A. Shutt

Since its founding in 1947, Jacobs has risen to become one of the world's largest and most diverse providers of technical professional and construction services. It also has become a specialist in total project delivery for major, award-winning bridge projects. Ever evolving, Jacobs has recently developed a value-oriented analytic tool, named JacobsValue+, that allows clients to verify savings the firm has produced, which in 2014 totaled a record \$5.3 billion.

"We have built our reputation on being relationship-based, which is one of the core values of our company," explains National Bridge Principal Marcos P. Loizias. "We focus on forging strong, long-term relationships, and it's a major contributor to our success in becoming one of the world's largest engineering firms." He notes that more than 90%

of the firm's work comes from repeat customers.

"Clients rely on us to be strategic and practical," he says. "In designing and building bridges—and in delivering all the different types of projects we do in a diverse range of markets—our customers want us to help them save money while being innovative, environmentally sensitive, and understanding of community concerns."

## JacobsValue+

One of the key ways Jacobs proves its value comes through its JacobsValue+ program, in which the company documents the savings that it provides through ideas, innovations, value-engineering, and constructability reviews of designs as they are being developed. "The clients confirm these

savings through a formal verification process to support our claims," Loizias explains.

Many of the changes that drive these savings result from engaging subject-matter experts and specialists from the firm's resources around the globe. "While local expertise is sufficient for many projects, our access to uniquely specialized expertise at Jacobs provides our clients with the best technical knowledge, experience, and methods available," Loizias says. "Our design and technical groups regularly confer with other value-engineering experts, who help us brainstorm new ideas."

Creating value-engineered, cost-effective solutions has become more prevalent as many clients began adopting alternative delivery forms,

As part of the improvements at Boston-Logan International Airport, a 1700-ft-long concrete pier was constructed to support the approach lights. All Photos: Jacobs.



especially public-private partnerships (P3) and design-build options. "Currently, more than 70% of our bridge work is done on design-build and P3 projects, primarily supporting contractors as the lead engineer and design manager," notes Loizias. "Doing so much design-build work with contractors allows means and methods to be incorporated as cost-effective ideas early into the design process. I see this bringing more innovation. It allows us to think outside of the box."

## Design-Build Grows

Jacobs is currently involved with multiple national design-build projects, including serving as the lead designer for the two Ohio River Bridges connecting Indiana and Kentucky. The project consists of the \$860-million Downtown Crossing, which is being done on a design-build basis, and the \$760-million East End Crossing, which is a P3 project. Both projects feature signature cable-stayed bridges over the Ohio River. For the Downtown Crossing, 47 bridges feature prestressed concrete girder designs. The East End Crossing includes 11 new prestressed concrete girder bridges and five rehabilitated concrete structures.

Jacobs is also working with joint-venture partner HDR to deliver final design of



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the \$2.3-billion I-4 Ultimate P3 project in Florida, in which 95 bridges will use precast, prestressed concrete Florida I-beams and U-beams.

Jacobs has thrived on design-build projects, working both for the contractor and as the owner's advisor. In 2003, it handled design, construction oversight, environmental impact statements (EIS), permitting, and other areas of the \$71.6-million St. George Island Bridge Replacement Project for the Florida Department of Transportation (FDOT). One of the largest design-build projects undertaken by FDOT at the time, the bridge is the third longest in the state at 4.1 miles.

The new bridge, which is more efficient and safer than the original, featured new high-capacity, 54-in.-diameter precast concrete cylinder piles with precast concrete caps. The design provided greater corrosion resistance, sped up construction, carried greater load, and included the longest post-tensioned, spliced-girder structural unit at the time (comprised of five spans varying in length from 208 to 258 ft for a total length of channel unit of 1180 ft). The total length of the prestressed concrete bridge from abutment to abutment is 21,615 ft. The other 160 spans consist of 125- and 140-ft-long spans in four-span continuous structural units. Among the awards the design won was the Harry H. Edwards Award for Innovation from the Precast/Prestressed Concrete Institute.

## Durability Needs Grow

The need for durability has continued to increase in the time since that design was completed. "Especially on design-build and P3 projects, there is a much more stringent focus on durability today," explains Loizias. "The goal is to design for a 100-year service life in many cases, which requires a thorough corrosion-protection plan. Our overall approach combines a high-quality design with strategies to achieve high durability and elimination of non-durable details, the use of highly durable materials, a thorough quality-control program during construction, and a detailed inspection and maintenance manual."

These needs often lead owners and engineers to concrete components. "Concrete offers more durability and less maintenance, creating an economical design in many cases. We can adjust the concrete to meet specific requirements to achieve reduced permeability and greater corrosion resistance. Concrete components of the bridge are designed to achieve the specified service life with a target confidence level of 90%. Typically, we provide several options of mixture proportions for the contractor to choose from."

## Speed Increases

Owners also are looking for faster schedules, a requirement that plays to Jacobs' strengths. "We have been using accelerated bridge construction [ABC] methods since the early



1960s,” says Loizias, pointing to work on the Chesapeake Bay Bridge and Tunnel Crossing in Norfolk, Va. Built in 1964, it included 12 miles of prestressed concrete low-level trestles with full-span, precast, prestressed concrete girder/deck modules and precast concrete pier caps. Pier caps were supported on three 54-in.-diameter precast concrete cylindrical piles designed to withstand 20-ft-high waves and 10-ft-high storm surges. Proving the cost effectiveness, ease of construction, and low maintenance of this design, 35 years later similar trestle structures were used on the Parallel Crossing, which opened in 1999.

Loizias points out that owners are emphasizing shorter construction-schedule times, as well as maintenance of traffic lanes, staged construction, and increased constructability, to mitigate the economic impacts of congestion and inconvenience to the traveling public during construction.

Many of these challenges are addressed by ABC techniques. “The use of ABC is being considered in more and more projects, including smaller, conventional projects,” he says. “We believe the use of precast components has a lot of potential. They can accelerate construction on-site economically. Precasting results in a better product, but often the decision to use precast or not is driven by the availability of local suppliers.”

Jacobs incorporated ABC into the I-15 Corridor Expansion (CORE) design-build project in Utah County, Utah, the largest road-construction project ever undertaken by the Utah Department of Transportation. The \$1.1-billion project included 24 miles of reconstruction impacting 55 bridges on 29 new and modified interchanges. At the new three-span Proctor Lane Bridge, two



For the three-span Proctor Lane Bridge on Utah’s \$1.1-billion, I-15 Corridor Expansion project, two 126-ft spans of precast concrete girders were moved into position using self-propelled modular transporters.

126-ft-long spans consisting of BT58 precast, prestressed concrete girders were moved into position using self-propelled modular transporters (SPMTs) requiring a single 6.5-hour overnight closure. It marked the first time two spans were moved with SPMTs in a single-night closure.

“From our experience, the use of prefabrication and precasting offers numerous benefits beyond ABC,” notes Loizias. “It also improves the quality of bridge elements, since they are constructed in a plant-controlled environment using high-quality materials and standardized production processes. This improved quality leads to extended bridge service life and reduced life-cycle costs. Other advantages include reduced on-site construction time, which offers key benefits with regards to traffic impacts, safety, environmental, and weather impacts.”

### New Concrete Designs

Many of the design challenges arising today can be met with new concrete designs, Loizias says. “Precast concrete beams are extending their length,

pushing from 150 ft a few years ago to 300 ft or more,” he says. “That allows us to eliminate piers in the navigational channels and work from above to minimize disruption to the environment.”

Balanced-cantilever methods and overhead gantries or travelers are gaining popularity as environmental issues become more prominent, he notes. An example is the Route 364 Creve Coeur Lake Memorial Park Bridge between St. Louis and St. Charles counties in Missouri, constructed over an environmentally sensitive lake.

The dual five-lane, side-by-side segmental structures feature cast-in-place, post-tensioned box girders with sloping, variable-depth webs. The 2675-ft-long structure consists of nine spans constructed by the balanced-cantilever method with form travelers. This approach was used to construct the bridge entirely from above and minimize environmental impacts. The project won a variety of awards, including the American Segmental

The Route 364 Creve Coeur Lake Memorial Park Bridge between St. Louis and St. Charles counties in Missouri, constructed over an environmentally sensitive lake, features cast-in-place, post-tensioned box girders with sloping, variable-depth webs. The nine-span project was constructed by the balanced-cantilever method with form travelers and was the first segmental bridge built in the state.





An all-precast concrete system was specified for the Boston-Logan Airport design, including piles, pile caps, and New England Extreme Tee beams to support the 141,000-ft<sup>2</sup> engineered-materials arresting system deck.

Bridge Institute's 2005 Bridge Award of Excellence.

Jacobs' designers are also seeing great potential in new girder designs, such as the New England Extreme Tee (NEXT) developed in conjunction with the Precast/Prestressed Concrete Institute's New England regional arm. The firm made extensive use of the girders in its design for the 600-ft-long Runway Safety Area at Boston-Logan International Airport, which included an engineered-materials arresting system (EMAS) placed on a 303-ft-wide, pile-supported deck that extended 470 ft into Boston Harbor.

The Massachusetts Port Authority required the deck to handle the structural design-load capacity of a fully loaded Boeing 747 aircraft, provide a minimum 75-year service life, and be completed "on an extremely aggressive schedule with limited construction windows," he explains. That led the design-build team to specify an all-precast concrete system, including piles, pile caps, and NEXT beams to support the approximately 141,000 ft<sup>2</sup> EMAS deck. It was one of the largest uses of the NEXT beams.

Segmental concrete construction also offers great potential, he notes. "Segmental girders, especially with high-performance concrete, give us much more flexibility today." An example is the Route 36 Highlands Bridge over the Shrewsbury River in Sandy Hook, N.J. The twin 1610-ft-long precast concrete segmental box-girder bridges were built with the balanced-cantilever method maintaining traffic uninterrupted throughout construction.

The bridges were constructed in stages to replace the existing historic double-leaf bascule bridge. The substructure

for each box-girder structure featured single-column, precast concrete, post-tensioned, hollow-box-section piers, along with prestressed concrete piles and precast concrete cofferdam cells. Each bridge was constructed in only 15 months. "Precasting the bridge from the footings up provided not only for rapid construction but also for long-term performance and durability." See *ASPIRE*<sup>TM</sup> Summer 2010 for more details.

### Future Options

Successes like these have states looking to designers and contractors for innovative approaches. That's especially true with changes to concrete techniques and new materials. "Trends that we've witnessed include an increased use of higher strength concrete mixes in precast elements, to 8 to 10 ksi, self-consolidating concrete, high-slump concrete, and occasionally lightweight concrete, especially for bridge decks on existing trusses to reduce weight and increase load capacity," says Loizias. "As states become more familiar with lightweight concrete, I expect there will be greater use in precast girders, deck slabs, and segmental bridges."

Extradosed bridges are also gaining attention. These bridges feature post-tensioning outside the box section serving much like the cables in a cable-stayed bridge but at shallower inclination and with shorter towers. Several have been built in North America already. "The efficiency of concrete extradosed bridges is expanding to fill the gap in the 500- to 700-ft range where steel trusses or arches are more cost effective than cable-stayed bridges," Loizias says. "Extradosed bridges offer another way to use concrete as a solution for creating economical designs. I see more of them being used in the future."

## Jacobs' Past Fuels the Future

Since opening in 1947, Jacobs has evolved from a one-man, engineering-consultant firm to a publicly traded Fortune 500 company and the second largest design firm in the world in 2015, according to *Engineering News Record*.

Its primary markets are aerospace and defense; automotive and industrial; buildings; chemicals; food, beverage, forest and consumer products; infrastructure; mining and minerals; mission-critical and high-tech facilities; nuclear; oil and gas; pharmaceuticals and biotechnology; power and utilities; refining and petrochemicals; telecommunications; transportation; and water and wastewater.

Headquartered in Pasadena, Calif., the firm has 66,000 employees in 250 offices located in 35 countries around the world. Its 2014 revenue was \$12.7 billion.

As new designs develop, Jacobs will remain on the cutting edge, Loizias says. "We have been at the forefront of many technical innovations and have the expertise necessary to design all types of bridges. Working closely with contractors in a diverse number of design projects allows us to further enhance construction methods and integrate them into our designs."

**'Concrete as a whole continues to be the material of choice for most bridges.'**

Those designs will no doubt include new concrete techniques, he adds. "Concrete as a whole continues to be the material of choice for most bridges. Precasting methods, segmental construction, ABC methods, and advances in concrete mixture proportions and higher strengths will result in more economical and durable structures with low maintenance." 

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