FOCUS

INTERNATIONAL BRIDGE TECHNOLOGIES

Lives up to its Name

by Craig A. Shutt

The 2890-ft-long Second Vivekananda Crossing in Calcutta, India, uses the extradose concept, which features precast concrete box girders that work with low-angle stay cables. It provides a new and developing concept for medium-span bridges with clearance issues.
Photos and renderings: International Bridge Technologies.

Focus on new concepts being used around the world keeps IBT growing in its 10th year

International Bridge Technologies (IBT), celebrating its 10th anniversary of operation this year, embodies its name in virtually every project it undertakes. Its record of accomplishments around the globe already has been notable, and it expects its approach to innovation and international work will continue. Some of that work will come via advancements in concrete material and construction techniques, which IBT uses in a high percentage of its projects.

"We've found there's a lot of value in trying to be ahead of the curve of creating new ideas for bridge construction," says Chris Hall, one of IBT's three founders. "We've had considerable success in our 10 years and have seen a lot of growth. We believe it derives from our willingness to be open to new solutions. Everyone wants to be innovative, of course, but we've had many opportunities, especially through the design-build process, to work outside the box with contractors and not be told 'no.' "

The company's expertise with concrete construction techniques has a strong foundation. IBT was founded in San Diego by Daniel Tassin, Michael Smart, and Hall. The three gained experience at Jean Muller International Inc. (JMI), whose founder developed the technique of precast concrete segmental bridge construction. "His focus was always on marrying new construction techniques to efficient designs," Hall says. Muller, in turn, studied under Eugene Freyssinet, the inventor of modern prestressing techniques.

"Our historical relationship with design-build contractors has really created the framework for practical innovation." says Hall. "Being close to construction lets us understand the issues that need to be addressed in our designs. More important are the relationships built over time. Through successful collaborations, we have established the trust that allows our concepts to advance into practice."

Five International Offices

In just one decade, the company has grown to encompass employees working from five offices around the world: San Diego, USA; Bangkok, Thailand; Mexico City, Mexico; Vancouver, Canada; and Abu Dhabi, United Arab Emirates. From those locations, the company has designed projects in Canada, Puerto Rico, India, Abu Dhabi, Mexico, Australia, Jamaica, and the United States.

"Our name was an intentional decision on our part to ensure we focused on technological aspects of construction," Hall explains. "At JMI, our emphasis was specialty projects, and that has carried over." The company's first project, in Taiwan, was in partnership with JMI. The project consisted of a 120-mile-long elevated high-speed rail line, which was constructed with cast-in-place concrete.

The project exemplifies the way IBT approaches its projects, says Hall. "The owners had a prescribed solution using full-span precast concrete box girders," he explains. "We studied the goals and the materials, and we found what we considered a more constructable alternative." They developed a Movable Scaffolding System (MSS) to cast the concrete superstructure. "It made construction of the spans more efficient and eliminated transportation issues of hauling large box girders to the site."

Another notable international project is the Second Vivekananda Crossing in Calcutta, India. A 2890-ft-long precast concrete segmental bridge with typical spans of 361 ft, it represents a relatively new concept: an extradosed bridge, which is described as a combination between a girder and a cable-stayed bridge, using a stiff box-girder that works with low-angle stay cables. "We were one of the first North American firms to have designed this bridge type, and maybe the first to have one open to traffic," Hall says. "Although its application is fairly narrow, it represents a good concept for medium-span bridges that have clearance issues."

North American Projects

One of the most honored of its American projects is the Otay River Bridge in IBT's hometown of San Diego. The 3325-ft-long bridge was constructed 150 ft above grade over an environmentally sensitive river valley. The twin 12-span structures feature precast concrete variable-depth box girders constructed using the balanced-cantilever method, the first such bridge to open to traffic in the state. More details of this project are provided in the Spring 2007 issue of *ASPIRE*.™

"Caltrans was concerned about the performance capabilities of this type of bridge in a high-seismic zone, as there wasn't much history," Hall explains. But tests conducted at the University of California–San Diego showed "precast concrete segmental designs are very desirable for these applications, with very good behavioral characteristics in high-seismic zones." The state now is considering more projects built in this manner.

Precast concrete segmental designs offer good behavioral characteristics in high-seismic zones.

Another project featuring precast concrete segmental box girders was completed at nearly the same time. The Sound Transit Central Link Light Rail System in Seattle, Wash., featured in the Fall 2007 issue of *ASPIRE*, contains 4.2 miles of elevated guideway carrying twin tracks with continuously welded rails fastened to the top of the structure. Two stations are located along the alignment, which passes through environmentally sensitive areas.

The precast concrete girders feature a unique V-shaped triangular cross section developed specifically for this project, Hall notes. The design optimized superstructure quantities and reduced the visual impact when observed from ground level.

"Precast concrete segmental construction is commonly used for elevated transit, especially overseas, because these projects often are constructed in congested corridors, where delivering precast components alleviates site disruption," he explains. "But we realized that these designs use box sections that waste a lot of material in the bottom half of the section. The V-shape design thinned down the concrete quantities significantly and improved the visual appearance. It was a good solution, both technically and aesthetically."

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Several Vancouver Projects

The firm also has done considerable international work in Vancouver, Canada, where it opened its newest office. The city, which hosted the 2010 Winter Olympics, committed to a number of large bridge and infrastructure projects as part of British Columbia's Gateway Program. Begun in 2003, its aim is to facilitate movement of people, goods, and transit through the city. "Vancouver wants to become a key international port city, and they used the Olympics as a catalyst," Hall says.

Tassin and other IBT engineers, while at JMI, worked with Canadian officials on projects such as the Confederation Bridge to Prince Edward Island, a landmark precast concrete segmental bridge and the Millennium Line extension to Vancouver's light rail system. "We had a good presence in Canada, and a lot of good engineering work comes out of good relationships."

A project currently underway is the 6801-ft-long Port Mann Bridge carrying the 10-lane Trans Canada Highway across the Fraser River, which IBT is designing in collaboration with T.Y. Lin International. The crossing includes a 2789-ft-long, cable-stayed bridge with a main span of 1542 ft and 4012-ft-long

The 3325-ft-long Otay River Bridge in San Diego, Calif., features twin variable-depth box girders connected by a transverse diaphragm at the piers and cast-in-place slab along the bridge's centerline. The 640 trapezoidal box girder segments, erected via the balanced-cantilever method, used a self-launching overhead gantry to minimize site disruptions.

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precast concrete segmental box girder approaches built using balanced cantilever construction above the water and span-by-span construction over land.

Cable-Stayed Bridges Grow

IBT has completed two other cable-stayed projects using this same combination of materials in the city, the Coast Meridian Overpass and the Pitt River Bridge. "These are often called 'steel' cable-stayed bridges because the main bridge structure has steel girders, but there's a large amount of concrete included in them, with precast concrete deck panels and cast-in-place concrete pylons and foundations," Hall notes. "It's a bit of a misnomer to call them 'steel' when concrete plays such a critical role. You really can't beat concrete, particularly for compression elements."

Together with AECOM, the company recently completed the design of an all-concrete cable-stayed structure for the 2600-ft-long Indian River Inlet replacement bridge near Delaware Seashore State Park. The design features two 240-ft-tall concrete pylons on either side of the deck, each supporting a single plane of stays. It will provide a 950-ft-long main span over the inlet with 1650 ft of bridge deck over the land. All supports will be placed out of the water, due to the extreme scour experienced by the existing bridge. The bridge will be supported by 36-in.-square precast concrete piles.

The design provides a minimum 100-year service life, a critical component for officials and the key reason for the all-concrete design. Achieving this goal required adding several features, including epoxy-coated steel reinforcement, stainless-steel embedments, low-permeability concrete, and a latex-modified overlay. In addition, the superstructure was designed for zero tensile stress under service loads.

"Long-term maintenance costs were a major concern, and the owner decided upfront that maintaining a steel structure would be too costly." The design incorporates innovative construction methods, with the deck sections above land supported on falsework, and a traveler used over the water. The floor beams are cast-in-place over the water whereas precast beams are used over land.

"Using concrete for all of the components produces a slight premium on initial costs," Hall says. "But when owners are looking at the total life-cycle costs, then concrete cable-stayed designs are very competitive." Owners, unfortunately, are forced to put a premium on initial costs instead of being able to factor costs over a longer horizon. "It's hard to get past the initial cost," he says. "But there's an evolution occurring, and owners are becoming more aware of the positive impact that cable-stayed designs can have." They're still gaining a foothold in the United States though, so

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The 2600-ft-long Indian River Inlet replacement bridge features an all-precast concrete cable-stayed superstructure with a projected 100-year minimum service life. Owners required concrete to ensure low long-term maintenance costs throughout the structure's life.

states are still hesitant to consider them. Cable-stayed designs also must fight their reputation. "They're often considered 'landmark' designs, which equates to being fancy—which means expensive." In fact, the concept was developed in post-war Germany to exploit material efficiencies. "The market for stays and stay hardware is robust, and increasingly competitive, which can create a very cost-effective and efficient design, especially for spans longer than 500 ft. This has added advantages where slightly longer spans can help mitigate impacts to a sensitive environment."

Owners Demand Speed

Owners are studying options more closely as designs are proven in the field and costs are reconsidered. They also are demanding one other element: faster construction. "Speed has taken a huge leap forward," Hall says. In part, the design-build delivery approach has been a factor. "Design-build teams have proven the process can be sped up and demonstrates that schedules can be compressed," he explains. "Now, owners are seeing that high-quality bridges can be safely constructed a lot quicker than they realized—and they want that compressed time."

That expectation leaves little room for maneuvering. "It's reaching a point of equilibrium, where the push for speed has begun to obscure potential cost efficiencies," he notes. "There is a sweet spot between cost and speed that has to be acknowledged, and squeezing too tightly can have an impact on cost that isn't worth the time gained. It's a judgment call on each project."

The motivation to finish bridges quickly is easy to understand, he adds. Much of America's aging infrastructure—built in the 1950s with a 50-year life span—is reaching the end of its service life. But swapping old for new can be difficult with communities built around these access points. "Bridges, especially concrete ones, have shown a lot of resilience to date, but you can squeeze out extra service life for only so long."

New Designs Tested

IBT is currently testing a technology in Massachusetts, where the 248-ft-long Randolph Department of Conservation and Recreation (DCR) Access Road channel bridge is being designed with precast concrete components to replace a four-span steel girder structure. The short-span bridge features two large edge girders that will serve as the roadway barriers, reducing material and increasing vertical clearance. The bridge's total depth will be 5 ft 4 in., including barriers. "It offers an opportunity for a quick replacement on a small span by bringing in a few precast concrete components and assembling them quickly on site," he explains.

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New concrete technologies are aiding new designs. "Concrete is both science and art," Hall says. "More and more is being done to improve its capabilities." For instance, significant efforts are underway to enhance performance of concrete decks by expanding and refining concrete properties to create more durable structures with lower concrete permeability.

"The condition of decks is the most visible aspect of the bridge's condition to users, and it's the first part to go because of the wear and exposure," he says. "Modifications to the mix designs can really aid that aspect and provide better concrete products." Self-consolidating concrete also is producing new solutions and its use will continue to grow, he adds.

Hall expects more concrete technologies to arrive in the future. "Concrete segmental bridge projects have seen a lot of success," he notes. "The DOTs and bridge owners are still building their level of comfort with the capabilities of segmental construction as more are built and a record of their service life grows. We believe precast segmental designs still have a lot of potential for expanding even further."

"There is still a lot of opportunity to innovate and explore new design and construction options," Hall says. "We honestly didn't know for certain how true that would be when we started out 10 years ago. But we found there are definitely ways to take bridge concepts to the next generation so that owners benefit, time is saved, and projects are delivered at a lower cost."

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The DCR Access Road over Route 24 Bridge in Randolph, Mass., now underway, uses two large edge girders as roadway barriers, reducing materials and increasing vertical clearance. The low profile adds 2.5 ft to the vertical clearance without altering the approach grade.