FOCUS

Bridge and Transit Firms Combine as International Powerhouse

An international presence and innovations in segmental bridge design enable SYSTRA-IBT to carry on as a leader in transportation systems

by Monica Schultes

After a decade of study, community meetings, public outreach, environmental clearance, and utility coordination, the Mosquito Road Bridge Replacement Project in El Dorado County, Calif., is scheduled to break ground in 2022. This rendering shows the replacement bridge approximately 400 ft above the river; the original structure, visible at the bottom of the photo, will be retained for bicycles and pedestrians. Rendering: SYSTRA-IBT Viz Team.

In 2017, the world-renowned bridge-design firm International Bridge Technologies (IBT) joined the SYSTRA family. SYSTRA-IBT, as the wholly owned subsidiary is now called, is a top international bridge specialist. By joining forces with IBT, the SYSTRA Group extended its reach in North America, complementing existing bridge-design centers in France, South Korea, and India.

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SYSTRA recognizes that bridges are a vital component of transportation infrastructure, their core business. "SYSTRA at its core is a rail and transit company, but we have very strong bridge centers," says Ben Soule, technical director of SYSTRA-IBT.

With more than 7000 employees located around the world, SYSTRA has grown through a combination of acquisitions and organic growth over the last decade. "Part of their global strategy was to bring IBT into the fold to enhance their bridge-design capabilities as well as their presence in North America," notes Soule. "Transit was a subspecialty of ours at IBT, so it was a good fit when we joined the SYSTRA family. There is a synergistic connection with our sister companies."

Shared Expertise

As a global organization, SYSTRA provides solutions via 350 dedicated bridge group specialists based in design centers in the United States, Canada, France, the United Arab Emirates, India, and South Korea. "The ability to trade expertise around the world and utilize all of the firm's specialties has provided us with more opportunities," explains Soule. When pursuing future work, it is especially beneficial to have technical proficiency and support, for example, with transit interfaces or subspecialties a bridge engineer might not be familiar with, such as power, signals, and stray

Phase 1 of the Chicago Transit Authority's Red-Purple Modernization project challenged design-build teams to develop concepts that could be constructed while service was maintained on portions of the existing 'L' train lines. The new precast concrete segmental box-girder solution reduced costs and offered a compressed schedule. Renderings: SYSTRA-IBT Viz Team.

Precast concrete segments for the Red-Purple Modernization project in Chicago, Ill. Although this is the first use of precast concrete segmental construction for the Chicago Transit Authority, the technology has been widely used around the world since Jean M. Muller, the famous French bridge designer and inventor, transformed segmental concrete bridge design. Several bridge engineers at International Bridge Technologies worked directly with Muller. Photo: SYSTRA-IBT.

current. "That is when the shared expertise has been really helpful," Soule adds.

Full Service

SYSTRA is known for offering a complete array of project services from concept to completion. That has its pluses and minuses, according to Soule. "The downside is that you have a short resume—you might be involved in just one project for years, from planning through commissioning," he says. "The upside is that we understand the nuances of every aspect of the project life cycle. You become a better consultant because you understand what is valuable to your client, whether it is an agency or contractor, and you can anticipate their needs."

The use of bridge information modeling (BrIM) helps SYSTRA-IBT integrate all facets of a project. "In the United States, we are still signing and sealing paper drawings as official documents, and 3-D [three-dimensional] models are not always part of the bidding process," says Soule. "However, the industry is moving toward digital delivery systems. We see it more often overseas, where other countries are ahead of us in that respect. SYSTRA colleagues working on the high-speed rail line in Great Britain are delivering final documents entirely as a digital model."

"Right now, BrIM is a great tool to generate 2-D plans, and we can see how it can lend itself to asset management for our clients," says Soule. "We were reluctant to embrace digital models as official construction deliverables, but the interface-heavy Chicago 'L' project has made us converts," he adds.

Using their experience in transit and segmental guideways, the design team of SYSTRA-IBT, SNC-Lavalin, and AECOM is adding more than 13 miles of new, fully automated and electric light rail to the Réseau express métropolitain transit system in Montreal, Quebec. The 4550 precast concrete segments, some weighing up to 58 tons, are being assembled by two launching gantries. Photo: *Réseau express métropolitain*.

Chicago's "L" Train

The Chicago Transit Authority (CTA) Red-Purple Modernization project includes a precast concrete segmental superstructure along an elevated section of the Chicago rail transit system. Working with lead design consultant Stantec, SYSTRA-IBT is responsible for both bridge design and the electrical grounding and stray current protection system for the segmental superstructure. The design-build joint venture of Walsh Construction and Fluor Corporation are currently constructing the project located in a congested part of Chicago. The segmental concrete solution was selected where practical for its construction efficiencies, and it reduced total cost of ownership over a traditional steel design, for which the CTA is well known.

Soule commented, "Our team developed an alternative technical concept, then communicated the advantages to CTA. This project demonstrated the benefits of BrIM for communicating information quickly and efficiently, and ultimately for CTA asset management."

Design-Build Project Delivery

"I would estimate that 80% to 90% of our projects are design-build, which plays into the SYSTRA-IBT experience very well," says Soule. The firm's vast experience lends itself to integrated project delivery methods. By considering life-cycle costs during each stage of design development, the company has achieved a reputation for identifying innovative designs that reduce operational costs.

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The now completed 1.91-mile-long Atlantic Bridge across the Panama Canal has a 1740 ft main span, which was built using the balanced-cantilever method with traveling forms. The concrete superstructure for the cable-stayed spans consists of longitudinal concrete boxes connected with transverse diaphragms. The deck is supported by two planes of stay cables anchored along the edges. During bridge construction, the Panama Canal could not be closed to shipping or used for construction access. Photo: VINCI Photo Library.

"The selection of teams based on qualifications instead of pure low bid is still evolving. On complex projects, designer-contractor collaboration is here to stay," says Soule.

Third Panama Canal Crossing

SYSTRA-IBT recently played a key part in designing the world's longest all-concrete cable-stayed main span bridge, which crosses the Panama Canal near the port city of Colón. The Atlantic Bridge was a design-bid-build project for the Panama Canal Authority, and SYSTRA-IBT was retained in an engineering role by the winning contractor, VINCI Construction. As the project progressed, the design was modified to improve constructability while retaining aesthetic features from the original design. This led to a reengineering of the entire structure to better align the structural elements with the preferred construction methods. SYSTRA-IBT led those design efforts for the main span in partnership with the engineering group from VINCI. The result is a concrete cable-stayed bridge with a main span of 1740 ft. The 26-ft-long segments were cast in place with a customized form traveler that could accommodate the complex deck cross section.

Mosquito Road Bridge

SYSTRA-IBT targets large, unconventional bridge projects such as cable-stayed,

Mentorship and Technical Contributions

SYSTRA-IBT's design philosophies and culture are deeply rooted in a mentor-apprentice tradition that continues to this day. Several bridge engineers at International Bridge Technologies (IBT) worked directly with the late Jean M. Muller, the famous French bridge designer and inventor who transformed segmental concrete bridge design. Muller is credited with the development of the match-casting technique widely used in modern precast concrete segmental construction. His design for the Brotonne Bridge in Normandy, France, with its 1050-ft main span, was the first example of a concrete box girder supported by a single plane of cable stays. He also invented the delta frame concept, a unique way to make long segmental cable-stayed bridges wider to accommodate more traffic lanes.

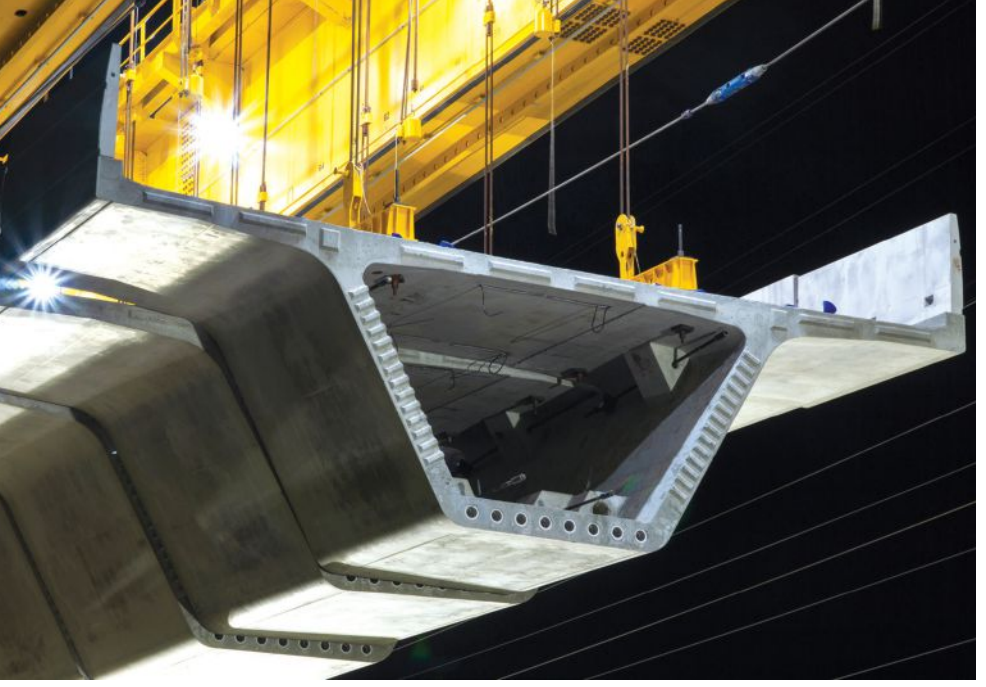
As a young engineer, IBT cofounder Daniel Tassin was sent to the Florida Keys to supervise construction of Muller's segmental designs, which included several other revolutionary ideas, such as external post-tensioning and span-by-span erection. These technologies are taken for granted in segmental design and construction today.

With these accomplishments and those carried out by Tassin and others he mentored, Muller left a rich legacy of technical achievement as well as elegant structures that are admired for both their lasting engineering excellence and their appealing aesthetics.

"Credit for our success goes to our mentors," says Mike Smart, SYSTRA-IBT president, who cofounded IBT in 2000. "Most of the precast [concrete] segmental concepts that we use in the U.S. were introduced by Muller decades ago. Although segmental construction is now common, it is still complex. Thankfully, we've had access to the Muller-Tassin answer key all this time to help guide us through most of the same challenges that were faced when it was all considered 'unproven' technology."

Recently inducted into the National Academy of Engineering in recognition of his unique contributions to the profession, Tassin continues to mentor SYSTRA-IBT engineers. "We continue to learn from the winning bridge concepts that he envisions and sketches on sheets of paper," notes Smart.

Notably, several of SYSTRA's leading bridge engineers were also apprentices of Muller, and Muller himself worked for the legendary engineer Eugène Freyssinet, who is considered the inventor of modern prestressed concrete. Given this mentoring pedigree, it is no wonder that SYSTRA-IBT is synonymous with attractive, efficient concrete structures.



A 5.2-mile-long precast concrete segmental elevated guideway in Honolulu, Hawaii, is currently under construction. The structure, designed by Parsons and SYSTRA-IBT, is the third in a series of projects for the Honolulu Rail Transit Project, a 20-mile-long grade-separated, fixed-guideway transit system. Photo: SYSTRA-IBT.

launched, transit, and segmental bridges. "We look for those particular projects wherever they may be. But the larger, more complex projects are of particular interest to us," says Soule.

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A recent example is the Mosquito Road Bridge spanning the South Fork of the American River in El Dorado County, Calif. The three-span, post-tensioned concrete box-girder bridge has a 536 ft main span with 322 ft end spans. Starting in 2022, the segmental concrete bridge will be constructed using the cast-in-place balanced-cantilever method. Working with design partner Quincy Engineering for the El Dorado County Transportation Division, SYSTRA-IBT is responsible for detailed design calculations and drawings of the superstructure as well as review of the foundation design.

Bridging Challenges

While SYSTRA-IBT has been fortunate with acquiring and retaining talent, finding bridges to design has been a challenge recently. "Over the last five years, there has been a dearth of funding in the United States. Most large bridge projects require federal dollars, so we are optimistic about the transportation bill gaining momentum in Washington. Also, while it hasn't reached us yet, we will certainly feel the effects of material price increases and labor shortages in construction. More than anything else, the challenge will be getting these projects off the ground," predicts Soule.

Transit has not been a priority in the United States, other than in a few major metropolitan areas. This trend may be changing. but transit design is still challenging. Much of the United States has aging infrastructure, which often limits design options. This is where segmental technology often makes sense.

Light-Rail Upgrades

A current example of segmental technology is underway in Honolulu, Hawaii. In partnership with Parsons, SYSTRA-IBT recently designed a 5-mile elevated guideway for a new light-rail system for the Honolulu Authority for Rapid Transit (HART). Designed for the high-seismic area, the substructure consists of single reinforced concrete piers on monoshaft supports. The precast concrete segmental superstructure is being erected span by span with a self-launching overhead gantry. The airport segment will be the third section of the route to be completed; it is currently being constructed by a joint venture of Shimmick/Traylor/Granite.

In several other countries, transit is a much greater infrastructure priority, as public transportation is part of everyday life and supports a substantial user base that is often lacking in many U.S. cities. For example, in Montreal, Quebec, a new public transit project, Réseau express métropolitain, is underway for the Caisse de dépôt et placement du Québec (Quebec Deposit and Investment Fund). Working with design partners SNC-Lavalin and AECOM, SYSTRA-IBT is responsible for design of the elevated-guideway structure for a portion of the new, fully automated electric light-rail network. The precast concrete segmental guideway, which includes 4550 precast concrete segments assembled by two launching gantries, is currently under construction by NouvLR, a consortium that includes SNC-Lavalin Grands Projets, Dragados, Pomerleau, EBC, and Groupe Aecon Québec Ltée.

High-Speed Solutions

In addition to its light-rail experience, SYSTRA-IBT is a world leader in the design of high-speed elevated guideways. Though such guideways are not currently found in the United States, the need is there, and this trend may be changing, too. The California High-Speed Rail project continues, despite several cost, schedule, and funding challenges. Another high-speed rail route between Dallas and Houston was initiated recently in Texas, and several other high-speed rail routes have been envisioned by the U.S. Department of Transportation Federal Railroad Administration as part of its High-Speed Intercity Passenger Rail Program. Still, the United States lags far behind Europe and Asia in high-speed rail development. "The U.S. won't generate any excitement until there are riders," says Soule. "Once we see some benefits and move people quickly, it will happen in other areas of the country," he predicts.

With decades of transportation experience, SYSTRA-IBT successfully tailors solutions to specific client needs and local stakeholders. The company seeks out complex and challenging projects to solidify their role as the go-to engineering consultants for transportation system design and development.