'We Embrace New Technology'

At the forefront of new techniques for bridge construction, CME sees changes ahead for the industry and the growth of new delivery methods

by Craig A. Shutt

Rehabilitating a 110-ft-long concrete arch bridge in Chester, Mass., which had a 30-degree skew, required using an adjustable forming system to widen the existing arch structure without adding load. All Photos: CME Associates.

Engineering design firm CME Associates has taken a lead role in a variety of new technologies and techniques gaining attention in the bridge construction industry. It has helped test new ideas and worked with organizations to develop standards. Those efforts pay off when projects need innovative solutions to more-complex challenges.

"We're involved at the national level with a number of organizations, such as the Precast/Prestressed Concrete Institute and the Federal Highway Administration, so we know what's going on around the country," explains Michael P. Culmo, vice president of transportation and structures at the East Hartford, Conn.-based firm. "We've made a big investment in actively participating in these programs to stay ahead of the curve and be prepared for new challenges, such as ground-breaking accelerated bridge construction programs taking hold in states all over the country. This ongoing effort to learn and share new advancements allows us to bring those valuable technologies to our clients when the need and opportunity arises."

An example is the work CME now provides to the Connecticut Department of Transportation (ConnDOT), which consists of managing part of its bridge program, to inject new technologies where possible. "We've worked with them regularly in the past, but now we can bring them a variety of ideas that allow them to decide whether to move forward with new techniques," he says. "We're not overly conservative. We embrace new technology."

Thriving on Challenges

The firm's interest and experience in emerging technologies has led the company to take on more complex and challenging projects. A number of those projects recently have been with the Massachusetts Department of Transportation (MassDOT), such as the "93 Fast 14." The 93 Fast 14 project used accelerated bridge construction (ABC) techniques and materials to replace 14 bridge superstructures on I-93 in Medford, near Boston, over 10 weekends during the summer of 2011.

CME developed the project concept for this $98-million design-build project. It used precast concrete superstructure components and rapid-setting, cast-in-place concrete, which cut 3 years from the conventional construction schedule. The work was part of MassDOT's Accelerated Bridge Program, which seeks to use ABC techniques and other innovations to speed project delivery and construction.

Another complex project that is currently underway is the I-91 deck replacement in Springfield, Mass., where 750,000 ft^2 of bridge deck is being replaced with precast concrete deck panels in 156 spans. The $200-million project was designed in

less than 1 year, finishing in September 2014. "We are very proud of our team," Culmo says. "That project required hundreds of drawings, and we completed it on a very tight timeframe." These two MassDOT projects show what can be accomplished as bridge owners embrace new ideas, and more are seeing the benefits, he says. "Departments of transportation recognize that customer service is important and are willing to use new techniques to reduce road-user impacts. Our work with ConnDOT is letting them develop new decision tools, which has resulted in about 25% of the sites using ABC techniques, so the options are growing. The Federal Highway Administration has done a lot of engineering and marketing work to promote it, and it's begun to take hold."

The Worthington Bridge in Massachusetts was completed by a relatively small-sized contractor on a 60-day schedule.

Making ABC Standard

ABC is not necessarily a new technology, he notes. "Transportation agencies have been using ABC on critical projects for many years." CME was one of the first firms to make ABC techniques standard practice, he says, starting with work done for the Utah Department of Transportation (UDOT) during its infrastructure programs. These programs were fueled by the success of the accelerated infrastructure work completed in preparation for the 2002 Winter Olympics.

Even before that work, CME used self-propelled modular transports (SPMTs) to move gas-fired equipment on local roads for power-plant construction projects. Designers also had seen railroad companies sliding trestle bridges into place to minimize construction time for railway tracks that had no detours.

These two photographs of the Worthington Bridge in Massachusetts show the first use curved and skewed Northeast Extreme Tee (NEXT) precast concrete beams. One side of the top flange of the NEXT beam was blocked out to form the curve.

An example of its ABC projects is the Worthington Bridge in Worthington, Mass., where the newly developed Northeast Extreme Tee (NEXT) beams were used for the first time on a curved and skewed roadway. "The construction schedule was set at 60 days, which was fast but not excessively fast," Culmo says. "We have found that taking your foot off the accelerator a little bit can lead to significant cost savings when compared to very fast construction methods."

The project showed that ABC can be undertaken by small contractors, he says. "The project also led the design team to develop a very simple and cost-effective method of building precast concrete stub abutments on spread footings." The project received the award for Best All-Precast Concrete Solution in the 2013 design awards competition sponsored by the Precast/Prestressed Concrete Institute (PCI).

"We're very hopeful that the use of ABC will continue to grow," he says. "The benefits are so significant, both politically and for the public. It's taking hold in almost all departments of transportation." Projects in Vermont show that its benefits extend beyond highly trafficked, urban areas, he adds. "It's important for rural, less-congested areas because detours can be so long and have so much impact on communities."

CME participated in the creation of the NEXT beam, which has been a key component in some of its ABC projects. It was designed in conjunction with PCI Northeast's (PCINE's) Bridge Technical Committee, of which Culmo has been a member for 25 years. As such, he helped develop the NEXT beam as well as the Northeast Bulb Tee, guidelines for several precast concrete components (such as full-depth deck panels and

The integral abutment details used to construct this bridge in Charlemont, Mass., were adopted by PCI Northeast's Bridge Technical Committee for its Northeast Extreme Tee (NEXT) beam guidelines. Strands extending from the end of the beam have been bent up as part of the integral connection.

substructure elements), and ABC techniques.

"We had a double-tee design for train-station platforms and thought it would make a good profile," Culmo says. "We decided to make it a variable-width beam, because bridge widths vary so much in the Northeast, where the roads are so old and different. There is no such thing as a 'typical' bridge in the Northeast."

The committee expected the beam to be used primarily for short-span bridges with utilities running beneath the bridge, a common design in the Northeast, he explains. But it's being used for other locations too. "It's remarkable how often it's being used today. It looks inefficient and heavy, but it's actually very cost-effective." Many times, costs run 30 to 40% less than other short-span bridge types, he notes. It's now being used in Pennsylvania and New Jersey and continues to expand into other east coast states.

CME has used the NEXT beam on several projects, including the Worthington project and a bridge in Charlemont, Mass. That project used precast concrete integral abutment stems featuring details recommended by PCINE. The construction time on this project also was set at 60 days, which was met.

More Concrete Used

CME designed a pilot project for MassDOT focusing on ABC techniques for a three-span bridge in Holyoke, Mass. It integrated a variety of precast concrete components, including spread footings, railroad crash walls, columns, pier caps, integral abutment stems, approach slabs, and full-depth deck panels with longitudinal post-tensioning. The bridge was built in two stages in one construction season, while a similar adjacent bridge built earlier using traditional construction methods took 2 years.

"We used all the precast concrete elements we could," Culmo says.

A bridge in Charlemont, Mass., was one of the first to use Northeast Extreme Tee (NEXT) precast concrete beams for an integral-abutment bridge.

'ABC using precast concrete elements has the potential to fundamentally change the way we build bridges.'

"Precast and prestressed concrete can play a significant role in the deployment of ABC. ABC using precast concrete elements has the potential to fundamentally change the way we build bridges. The revolution in precasting beams in the 1960s might end up being the roadmap for the development of precasting all bridge elements in the future."

Even when steel girders are used, he adds, concrete plays a key role in the construction. "Virtually every bridge has a concrete substructure," he points out. "Precast concrete can be used in almost every replacement project today. We're seeing more precast concrete being used for everything. It makes economic sense to use it for pier caps, abutments, and other components."

A key obstacle to convincing clients of the benefits of designing in precast concrete comes from the mindset that detailing in concrete remains the same regardless of the format. "Owners who convert cast-in-place details to precast concrete don't always get good results because they need to adapt the design," Culmo explains. "The detailing needs to be somewhat different—and sometimes, the precast concrete detailing is better."

Abutments are the key challenge and often the most difficult part of a bridge detail, he says. "Abutment joints are the most complicated pieces, especially at corners. Integral abutments are the answer, as are semi-integral ones."

CME's expertise has led to work with clients outside of the Northeast. Precast concrete elements, including beams, were used on the White Boulevard Bridge in Collier County, Fla., a project CME developed with Collier County to create a standard bridge for a number of canal crossings in the county road

CME's 40+ Years of Service

CME was founded in 1973 as an environmental consulting firm focused on natural resource management. In the years since, CME has grown steadily and expanded the services offered to clients, branching out into civil engineering, land surveying, and architecture. In the late 1990s, CME began to develop a structural and transportation division.

Building on early successes, CME made steady investments in learning about and developing emerging technologies. This focus, coupled with a dedication to providing responsible and unique design solutions to private and governmental clients, led to rapid growth in recent years.

Today, CME is a multi-disciplined engineering firm of more than 60 professionals working in the Northeast that strives to practically apply innovative solutions to design challenges for all its clients.

network. The three-span bridge was designed with the Florida DOT bridge double-tee section, which was modified to mimic the NEXT D beam. Precast concrete pile caps supported on prestressed concrete piles were used, as was a similar pile cap for the abutments. Precast concrete parapet sections were used and connected to the deck beams using the cast-in-place concrete sidewalks as the structural connection.

Rehab Work Grows

Unique challenges also arise with rehabilitation work, which CME is seeing more often. "Transportation agencies are putting more money into maintenance and rehabilitation rather than replacement. It makes a lot of sense to spend a little money and get more years of service life from a structure." Preserving older bridges that feature dramatic aesthetic components or used older techniques can create challenges, Culmo notes. "Communities have a desire to retain bridges that are historic, but they can become very challenging to design and detail."

'It makes a lot of sense to spend a little money and get more years of service life from a structure.'

An example is the rehabilitation and widening work done for a 100-year-old concrete arch bridge in Chester, Mass. The 110-ft-long bridge had an unusual 30-degree skew. The design team retained the structure type but replaced the spandrel walls and wingwalls with minor widening to each side. They also detailed an adjustable forming system supported on temporary shoring from above. This allowed widening of the arch without imposing additional dead load on the existing arch structure. The contractor made use of the recommended forming system for the construction, which eliminated impacts to the scenic river below.

Forms were hung from temporary support girders to prevent any interruption of the river during rehabilitation of this 110-ft-long concrete arch bridge in Chester, Mass.

Delivery Options Expand

Design-build is becoming more prevalent in the United States, Culmo notes. "It provides a good contracting mechanism that can encourage innovation." It can create challenges for engineering teams, though, due to the accelerated design schedules during procurement and after award.

CME has high hopes for the Construction Manager/General Contractor (CM/GC) form. "I'm a big fan of CM/GC, which is similar to design-build, but it keeps the owner involved in all aspects of the design," he says. It allows agencies to explore new technologies with the assistance of a general contractor during the design process. "It's getting more legs, but state departments of transportation remain wary due to lack of competitive bidding. It's a great system, because the contractor adds a lot by being at the table from the beginning."

Whatever format is used, CME will continue to look for new solutions to ever more complicated challenges. It currently is helping PCINE develop a Northeast Decked Bulb-Tee beam, and is working with ConnDOT on two large railroad-bridge replacement projects using the CM/GC delivery format.

"As we move into the next generation of transportation and preservation of the highway network, we need to find ways to sustain the system without impacting our way of life," Culmo says. "ABC is a fundamental tool that can be used to reach this lofty goal. We're excited to see how we can aid that process."

EDITOR'S NOTE

For more information and details about the NEXT Beam and ABC details, see the website for PCI Northeast: www.pcine.org.