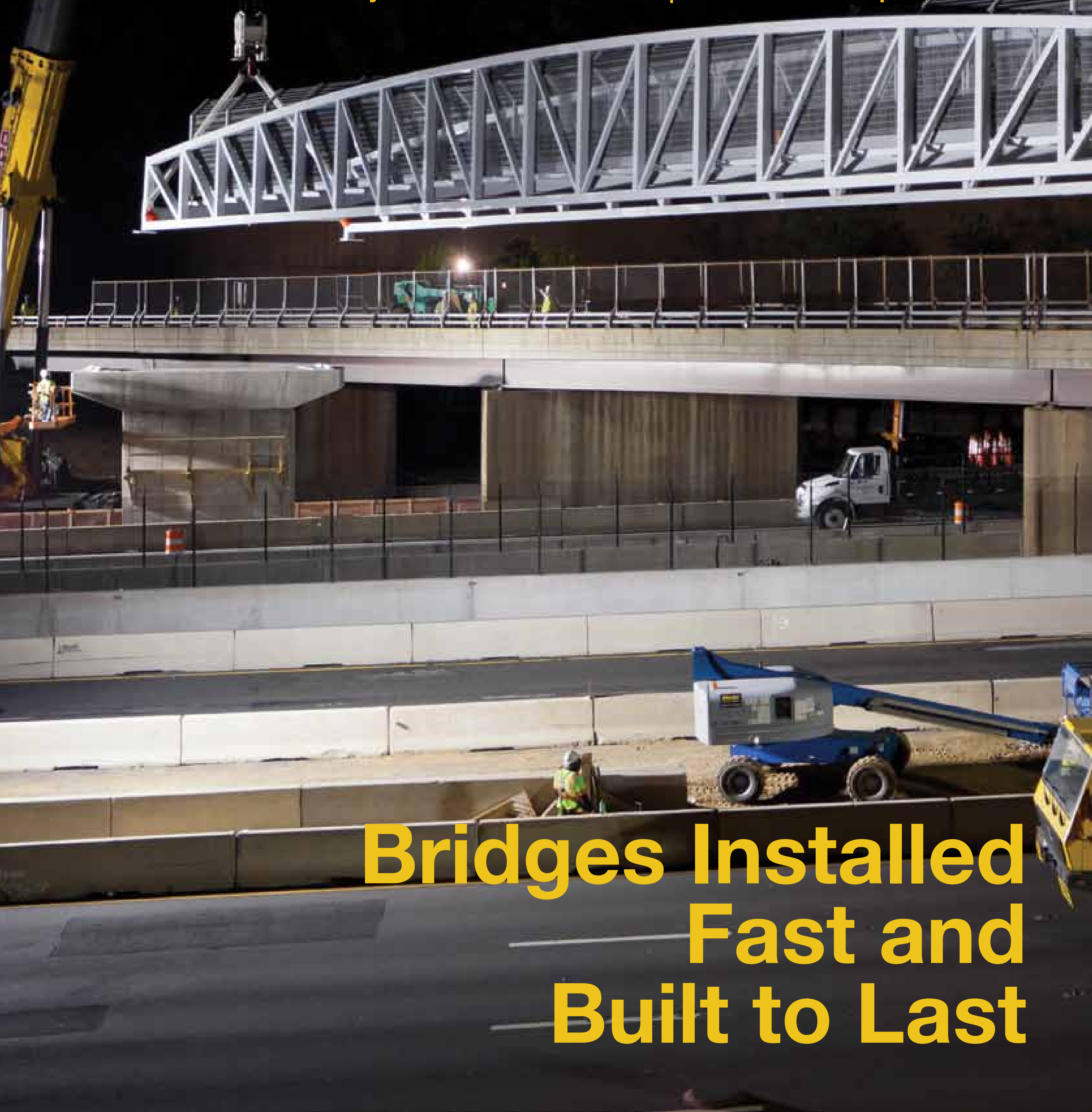
Composites Manufacturing

January/February 2013

The Official Magazine of the American Composites Manufacturers Association

Industry Forecast for 2013

Get Ready for COMPOSITES 2013 | 5 Trade Show Tips



Bridges Installed Fast and Built to Last

A Tale of Two Bridges

How FRP bridge decks solved a pair of construction challenges

By Susan Keen Flynn

Composite Advantage in Dayton, Ohio, has provided FRP bridge decks for seven pedestrian bridges in the past four years. Scott Reeve, president of the company, is upbeat about the outlook for composites in the infrastructure segment. "We're getting to the point where engineers, designers and procurement are letting us go head-to-head against concrete," he says. "In the past, we were either excluded because they only considered traditional options or we had to do a lot of work to be a special demo case."

"We were able to install the entire deck in about three days. A traditional concrete deck, given the location, would have taken at least four weeks."

John A. Majane III, senior structural project manager
Shirley Contracting Company, Lorton, Va.

However, Reeve admits that progress is slow. "I tell my employees, 'It took 30 years for steel to replace wood in bridges. It will take longer than we want for composites to replace concrete,'" he says. "You have to keep working at it."

One way that Composite Advantage has made inroads in infrastructure is by providing products that help solve construction challenges and highlight the advantages of composites. That's the case for the two bridge projects presented here: One required accelerated construction, while the other was a highly-engineered bridge. Both utilized prefabricated FRP bridge decks.

The decks were manufactured using the company's FiberSPAN™ molded sandwich construction, which employs fiberglass top and bottom skins and closely-spaced internal webs that function like a series of I-beams. The fibers in the webs are oriented at ± 45° angles and infused with resin to form very strong, stiff shear webs for the sandwich cross-section. The closely-spaced webs provide good crushing resistance to concentrated loads, and there is no local skin deflection since the skins are well supported by the webs.

Bridge Project: North Bank Bridge
Location: Boston
Challenge: Pedestrian bridge had to fit into a tight space amid other structures.

Built in May 2012, the 690-foot long North Bank pedestrian bridge connects two parks on the Charles River across from downtown Boston. The $9.5 million bridge project was funded through the American Recovery and Reinvestment Act. At the grand opening, Massachusetts Governor Deval Patrick called the bridge "an investment for generations to come."

Every detail of the gently sloped S-shaped bridge is designed to be aesthetically pleasing, down to the wear surface – an epoxy aggregate non-slip coating – that matches the color of the steel superstructure and guardrails. While people running and rollerblading along the bridge are sure to admire the views, they aren't likely to appreciate the construction challenges.

"The bridge was built next to a road, under the Zakim Bridge, around a historic building and over a T commuter rail line, a small river and a ramp for Duck tour boats," says Reeve. Composite Advantage supplied 8,280 square feet of FRP bridge deck, including curbs and expansion joints. The FRP deck contributes to superstructure properties, and deck panels were molded in five different shapes to contribute to the curvilinear nature of the bridge.

"In most cases, concrete and FRP decks are there to support people or vehicles. The steel structure really carries the load to the ground," says Reeve. "In the North Bank pedestrian bridge, aside from supporting people the deck actually helped connect all the steel pieces together and transfer load within the superstructure." Composites made this possible: The deck achieves higher structural properties with the addition of more – and thicker – fiberglass skins. Plus, more fibers are oriented at ± 45° angles.

Bridge Project: Wolf Trap National Park
Location: Vienna, Va.
Challenge: Fully-assembled truss bridges needed to be erected rapidly to reduce road closure time.

Wolf Trap National Park for the Performing Arts hosts a variety of shows at its outdoor amphitheaters, ranging from jazz concerts to dance recitals. To walk from one facility to another, thousands of spectators often filed along a narrow curb over a vehicle bridge. The park put an end to this potentially dangerous situation by completing construction of a pedestrian bridge in April 2012.

The bridge, which crosses over a 10-lane highway leading to Dulles International Airport, was designed by the

Balsa Wood at the Core of New Bridge

Last October a century-old, one-lane concrete bridge in Bex, Switzerland, was replaced by a two-lane bridge with a composite deck. Aside from being lighter and corrosion-resistant, the prefabricated bridge deck offered another advantage – quick installation.

"The bridge is located in a mountainous area, on the only road providing access to the valley," says Sébastien Lavanchy, project leader/engineer for 3A Composites. "Therefore, the time of installation was critical." 3A Composites in Switzerland provided the COLEVO composite bridge deck, which was installed in less than three hours.

The new Bex bridge over the Avançon River in southwestern Switzerland has another distinction: It is the first application of a balsa sandwich road bridge in the country. The core of the composite deck is made of a structurally-bonded balsa-based material called BANOVA, developed by 3A Composites. According to Lavanchy, BANOVA has two to three times lower density than traditional construction wood products and offers optimal performance through special orientation of the wood fibers. "It's ideally suited as core material for lightweight and highly-loaded sandwich elements used in construction applications and composite bridges," says Lavanchy.

The sandwich deck elements were produced on a flat mold by vacuum infusion. The 285-millimeter sandwich plate is composed of a 240-millimeter BANOVA core wrapped on all sides and fully sealed into glass fiber and vinyl ester face sheets. "The total thickness is similar to that of a concrete deck for the same application, however with a significantly lower weight of only 160 kg/m2 against 700 kg/m2 for the concrete solution," says Lavanchy.

Material and structural testing were key to the success of this novel project. 3A Composites worked in close collaboration with many partners, including Suisse Technology Partners in Neuhausen, Switzerland, and the Composite Construction Lab (CCLab) at Ecole Polytechnique Fédérale de Lausanne (EPFL). For instance, Suisse Technology Partners tested the complete set of material properties, with special attention on the balsa wood's thick core dimension. The CCLab performed fatigue and ultimate strength tests on full-scale samples. In addition, construction details such as panel joints and the integration of guardrail posts were tested at full scale prior to implementing them on the bridge.

"We may not have 100 years of experience working with this material," says Lavanchy, "but drawing on 50 years of use in maritime construction as well as extensive accelerated aging tests, we are confident that these structures perform just as well as concrete ones."

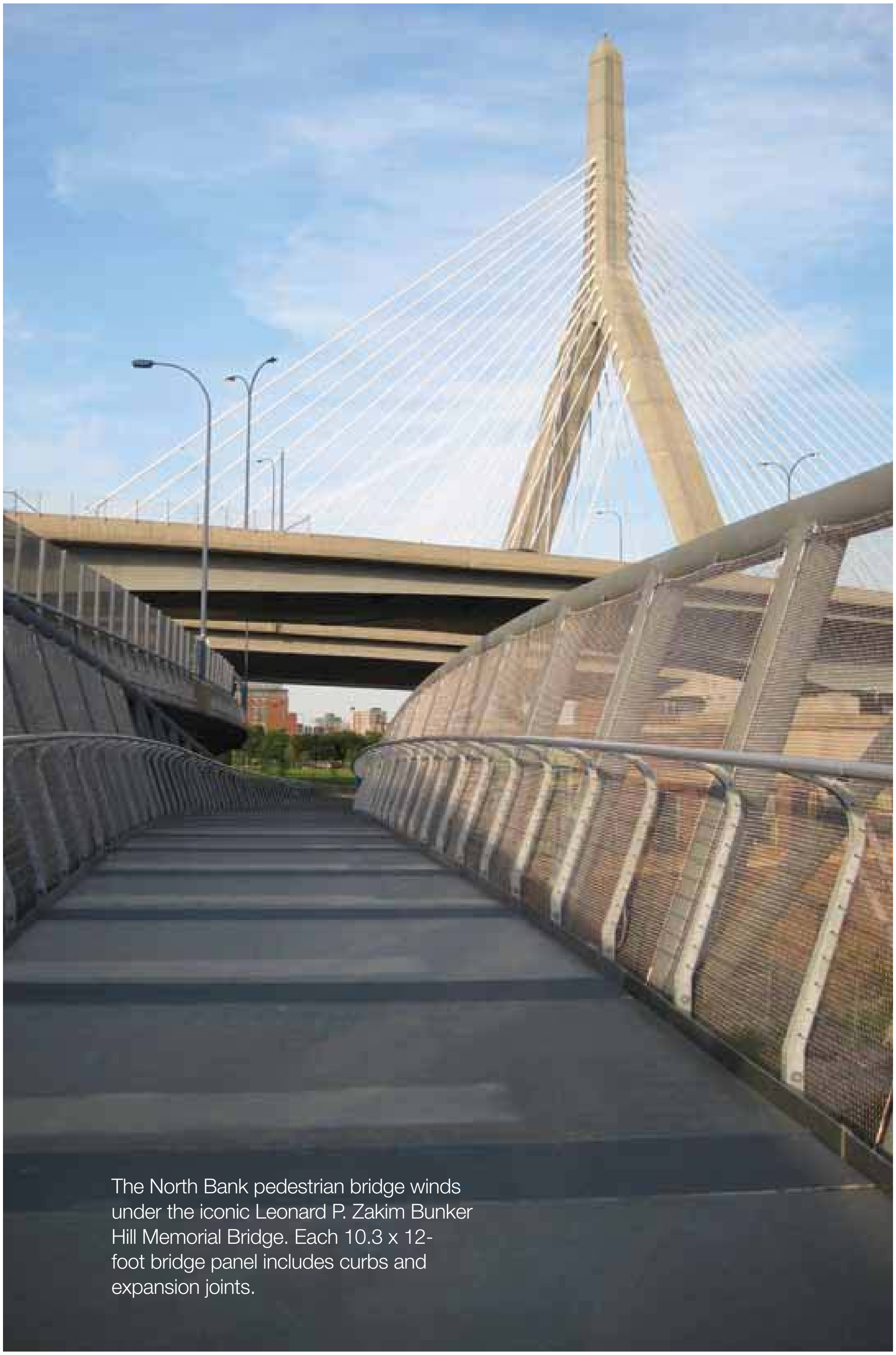
The composite deck was prefabricated in three 40-square-meter pieces by 3A Composites in Altenrhein, Switzerland, then transported across country by truck. Next, the pieces were pre-assembled on the side of the construction site by adhesively bonding the sandwich deck on the upper flanges of two galvanized steel girders. Then the whole bridge was installed in one single piece with a crane. "This would not have been possible with standard construction materials at this location as access of a suitable crane was not possible," says Lavanchy.

Overall, the road was closed for 10 days: It took two days to remove the old bridge and only a few hours for installation. The remaining road closure was necessary for casting the transition slabs and standard road reconstruction on both sides of the bridge. By comparison, a cast-in-place concrete solution would have required closing the road for six to eight weeks, says Lavanchy.

While critics argue that sandwich composite materials cost more than traditional construction materials, composites may be the most economical solution where lightweight, durability and longevity are critical. "For the road bridge project in Bex, taking into account the full project cost, the sandwich composite deck is a technically and economically competitive solution," says Lavanchy.

Photo credit: ©Alain Herzog, EPFL

This 11.4-meter long bridge in Bex, Switzerland, featuring a balsa wood core, was installed as a single piece in less than three hours.



The North Bank pedestrian bridge winds under the iconic Leonard P. Zakim Bunker Hill Memorial Bridge. Each 10.3 x 12-foot bridge panel includes curbs and expansion joints.

Federal Highway Administration (FHWA). The FHWA required accelerated construction to reduce lane closures that would hamper access to the busy airport. Composite Advantage's FRP bridge decks offered the ideal solution. The deck panels were prefabricated, including the wear surface, curbs and expansion joints. This reduced on-site construction time. More importantly, the FRP bridge deck is 80 percent lighter than a concrete deck, making it faster to lift, move and place by crane.

Composite Advantage supplied 57 prefabricated deck panels measuring 15.5 x 8.3 feet. Each panel weighed only 880 pounds. The panels were assembled on three spans ranging from 138 to 170 feet long alongside the highway. Installation took place on three consecutive nights at 1 a.m., when traffic was light. Each assembled truss – including the steel, FRP deck and fencing – was towed to its position on the adjacent vehicle bridge. Then the contractors stopped traffic and two cranes lifted the truss into place, where it was bolted down. The highway was only closed for 15 minutes each evening. For two weeks following installation, construction workers finished the detail work, such as sealing joints, completing the railing and finishing the ends of the fencing.

The contractor on the project, Shirley Contracting Company LLC, Lorton, Va., never worked with composite decks before. It experienced some hiccups, such as matching the curbs and filling the joints, but was able to correct those issues after the bridge was in place. But the benefits outweighed the glitches.

Learn More About FRP Bridges

COMPOSITES 2013, held Jan. 29-31 in Orlando, Fla., features two education sessions on FRP bridges. Scott Reeve of Composite Advantage will delve into how FRP composite decking contributes to the Accelerated Bridge Construction (ABC) Initiative. Dan Richards of Zellcomp will present a case study about replacing an old steel grid deck with a lightweight FRP deck.

In addition, two other sessions will feature input about ABC from representatives of the Federal Highway Administration and the insurance industry. Visit *compositesshow.org* today to sign up for COMPOSITES 2013.

Nighttime construction has become commonplace to minimize the impact of lane and road closures. Composite Advantage supplied FRP bridge decks for a 3-span steel superstructure at Wolf Trap National Park. Here, the third span is lifted into place. The road was only closed for 15 minutes on three consecutive nights to accommodate the installation of each span.

"We were able to install the entire deck in about three days. A traditional concrete deck, given the location, would have taken at least four weeks," says John A. Majane III, senior structural project manager for Shirley Contracting Company. "[Another benefit] was the ability to assemble the deck off site, which reduced costs and the risk associated with working over traffic."

Majane admits that cost is a factor when it comes to using FRP bridge decks. But he would consider composites for future projects. "This pedestrian truss bridge over traffic was a perfect application for the product," he says.

Susan Keen Flynn is managing editor of *Composites Manufacturing* magazine. Email comments to *sflynn@keenconcepts.net.*

Visit *compositesmanufacturingblog.com* and click on "CM Interviews" for an online exclusive interview with Benjamin Oltmann, P.E., from the Federal Highway Administration, who helped design the Wolf Trap National Park pedestrian bridge.

The superstructure of the Wolf Trap pedestrian bridge was a steel truss with longitudinal beams spaced 4.25 feet apart. Mechanical fasteners and Z clips provided the deck-to-beam connection.