



New products using advanced composites are offering bridge engineers more options for maintenance-free structures

“It’s hard to beat the lifecycle cost benefits of a fibre-reinforced polymer composite bridge superstructure,” says Steve Mary, engineer for Cincinnati, Ohio’s Hamilton County in the USA. While raw material costs and factors like low volume still give FRP composites a higher premium than traditional materials, Hamilton County is considering using the FRP superstructure on longer span bridges in the future.

A recent inspection of a bridge that Hamilton County replaced two years ago using this technology showed that the structure was corrosion-free, and maintenance had been minimal. “The traffic rate for Eight Mile Bridge Road is about 2,000 cars per day,” Mary says. “We’re very happy with the bridge’s performance and have had no issues to date.” According to Mary, Hamilton County is negotiating an agreement with the University of Cincinnati to perform testing on factors like deflection under load this winter and during the summer. These tests will provide important data on bridge performance in varying temperatures and weather conditions.

Mary cites minimal maintenance, light weight, speed of construction and installation and lack of corrosion as the features that led engineers to seek an FRP superstructure for the county’s Eight Mile Road Bridge in 2008 - a product that at the time didn’t exist.

When Composite Advantage got wind of the project, the team had an idea. “We had developed an FRP composite floor for a tractor trailer application,” says Composite Advantage president Scott Reeve. “We were able to take our trailer floor concept and modify it to meet the design and size requirements for the bridge. CA created Superfiberspan using Tycor fibre-reinforced composite core material and then prefabricated the bridge superstructure with integrally moulded beams and deck.

The short span concrete bridge deck slab, built in 1940, was replaced with a new

FRP superstructure in June 2008. The abutments were also rehabilitated to extend the life of the structure. Bridge parameters called for a 6.7m-long span and a width of almost 19m. Other specifications included the standard AASHTO HS 20 loading, an alternative military truck loading; L/800 deflection criteria; an integral concrete diaphragm; skew, cross-slope kick across the bridge to control asphalt thickness and an asphalt wearing surface.

Composite Advantage used its infusion process to mould eight panels, each spanning the full 6.7m length and just under 2.4m wide. Tycor’s infusion grooves allowed the resin to move quickly through each panel. “Tycor works very well with our resin infusion process,” says Reeve. “When we were first introduced to Tycor by the Webcore technical staff, we saw the advantage of using a core material that can deliver the resin in a controlled manner. With Tycor, we designed the manufacturing layout of some of our parts around this feature. It is the best way to ensure high quality infusion of the internal structure of sandwich panels.”

Once panel infusion was complete, a joint beam was bonded and bolted to join adjacent panels. Beams and deck were integrally moulded together. The deck facings, beam shear webs and beam caps consisted of multi-axial fibreglass fabrics. The entire lay-up of beams and deck was infused with a corrosion resistant vinyl ester resin with pigment and UV inhibitor. A test programme was conducted to validate the design.

After the old bridge was removed, new abutments were poured. Bearing pads were located on the abutments at each FRP beam location. All eight panels were dropped in place in one day, starting with the east side of the bridge (pictured above).

“For this project in particular, the goal was to construct a total superstructure out of composites that could deliver a service life capable of exceeding 100 years,” says Mary. “In addition to a long life cycle, the non-corrosive nature of composites greatly

reduces maintenance costs." One month after installation an inspection revealed minor longitudinal cracks over the deck joints – these were sealed. A recent inspection, more than two years after installation showed the structure to be corrosion-free. The asphalt cracks had not worsened and maintenance has been minimal.

In developing manufacturing processes and techniques for Superfiberspan, CA chose Tycor over balsa and PVC foam for its strength and stiffness properties. "We had stringent deflection requirements to meet with this project," explains Reeve. "PVC foam lacked the crushing strength and shear properties needed. Balsa was also an unsuitable core material choice because of its tendency to absorb water and the extra effort it requires when it is used for infusion molding."

The composite superstructure also had to support high load concentration. "Tycor had the structural properties to support the crushing loads and high shear loads from the tyres of a fully-loaded tractor trailer," says Reeve. "Regular foam core products just can't handle these types of requirements."

Because the integrated system prefabricates more components in a single piece, the cost premium for using high performance composite material is reduced. The overall cost is less than a conventional FRP bridge deck and separate beams because fabrication and assembly of the panels takes place under one roof. The ability to receive Tycor material on a just-in-time delivery basis was also an essential element.

Composite Advantage is currently working to replace a structurally deficient bridge on Dodson Road in Dayton, Ohio's Montgomery County with its FRP superstructure bridge system. The project will involve rapid replacement of the existing bridge with precast concrete abutments. "We anticipate that once the existing structure is removed and subgrade preparation complete, the bridge abutments and FRP super-

structure components can be installed in a single day," Reeve explains.

The existing bridge is a jack-arch construction with a single span steel superstructure and concrete deck 5.5m long and 8.5m wide. The replacement will consist of three FRP panels which each have a longer span of 6.4m, a width of 2.8m and depth of 500mm on a 10.5° skew. Total depth includes the deck section at 140mm deep and the beam at 370mm deep; each panel weighs 1,770kg. UHMW sheets sandwiched between the deck and abutments will allow the deck to move with thermal expansion.

Montgomery County selected the FRP superstructure to meet project goals that include using cost-effective, innovative highway bridge applications, developing techniques to reduce construction time, and maintenance and life cycle costs.

"The project draws on previous FRP bridge work experience and lessons learned while using innovative design features capable of moving the technology forward," Reeve says. The deck and beams will be moulded in one piece to reduce structural joints where performance issues often occur. The deck transfers vehicle loads to the beams which in turn transfer loads to the abutment. When compared to reinforced concrete, FRP offers high strength with reduced stiffness. This means the advanced material can meet the driving design requirement for deflection criteria of $L/D=800$. Tapered beams built to provide a flat surface as they approach the abutment is another new feature. The joints will also provide splice plates to ensure panels work together and minimise reflective cracking in the wear surface due to panel separation. A rough top coat surface will be applied followed with the asphalt wearing surface.

The project is intended to demonstrate accelerated construction with prefabricated composite components and help to standardise the FRP panel and connection details for future projects ■

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