The Morrison Bridge, with its minimalist design, turned heads when it was built to cross the Willamette River in Portland, Ore., 54 years ago.

Today the streamlined bridge is experiencing another modern change: The open steel grating on the double-leaf Chicago-type bascule span is being replaced by a prefabricated, pre-engineered fiber-reinforced polymer (FRP) composite bridge deck designed by ZellComp Inc., located in Durham, N.C. The anticipated completion date of the project is spring 2012. This use of FRP in bridge structures is 21st century reality of civil engineering married to green technology. At over 17,000 sq ft, the Morrison FRP bridge deck will be the largest in the U.S. and one of the largest in the world.

The busy six-lane bridge measures 760 ft in length. With over 50,000 vehicles crossing daily, it is a major gateway into downtown Portland. Concrete and steel bridge decks require ongoing and expensive maintenance as a result of cold, wet weather, salt and corrosion. The aging open steel grating on the Morrison Bridge was no exception.
“The Morrison steel grating deck has been a factor in several accidents on the bridge and was in serious need of replacing,” said Ken Huntley, engineer for the Multnomah County Bridge Section.

“The finished surface of an FRP deck is comparable to a typical concrete or asphalt road surface and as such offers a much higher friction value than steel, which greatly improves control and stopping distance,” added Huntley. “Also, a solid deck surface allows for collecting all the rainwater that lands on the deck, which can then be cleaned and treated before releasing into the river. With steel grating, the water passes through the deck, taking with it all the grease and oils deposited on the deck.”

The weight of the deck also was a key factor in the county’s decision to use an FRP deck for this project. If Multnomah County had selected a new open steel deck, more counterweights

Conway Construction Co.’s responsibility has been to remove all the open steel grating on the two bascule spans and two-thirds of the stringers on those spans; replace the stringers with new steel beams of the same size; and replace the open steel grating with FRP decking.
would have been required, and it actually might have required
the replacement of all the machinery.

Balancing work

Conway Construction Co. (CCC), the project’s primary
contractor, is based out of Ridgefield, Wash. CCC’s responsibil-
ity has been to remove all the open steel grating on the two
bascule spans and two-thirds of the stringers on those spans;
replace the stringers with new steel beams of the same size;
and replace the open steel grating with FRP decking. The most
complicated part of this project, according to David Conway,
president of CCC, has been working closely with Multnomah
County to keep each movable bascule span in balance through-
out demolition of the old steel deck and installation of the new
FRP deck.

The development of a counterbalancing plan began with a
careful calculation of the weights and the sequence for every
component that would be temporarily or permanently added
to or removed from the operable bascule span. The next step
was to install strain gauges and perform drift testing to verify
the pre-construction balancing condition of the spans.

“As the work progresses, the counterbalancing weights are
strategically placed and removed so as to keep the span in
balance,” explained Conway. “Actual weights of removed and
installed materials are compiled and compared to original
estimates. The plan is regularly reviewed and revised as needed.
The goal is to keep the span in a slightly ‘toe-heavy’ condition
and avoid a ‘toe-light’ situation.

“Once the FRP deck has been completed, additional
strain-gauge readings will be taken and drift testing will be
performed. The final result will determine the amount of
permanent ballast to be installed in or removed from the
weight rooms located behind the ‘heel,’ which are the weights
that permanently counterbalance the cantilevered lift span.”

In addition, CCC has been required to keep the bridge
open to both car and truck traffic on the bridge and watercraft
traffic beneath it. For traffic on the bridge, CCC and the
county devised a staged construction plan to ensure that two
lanes were always kept open. For Stage 1 of the project, which
was completed last fall, temporary traffic control included
the installation of a temporary thrie-beam rail and a truck-
mounted impact attenuator. Both served to protect the work
area from adjacent traffic.

“Stage 2 temporary traffic control includes a combination of
a thrie-beam rail, four truck-mounted impact attenuators and a
concrete traffic barrier,” added Conway.

For watercraft, vertical clearance of the closed bascule span
is sufficient for the majority of bridge traffic, but openings are
necessary on average about 30 times per month.

“At any given time, one span is allowed to be inoperable
while the other must remain operable,” said Conway. “CCC is
on-call 24 hours a day, seven days a week to accommodate any
maritime traffic request for a bridge opening.”

Conway explained that there were additional challenges due
to the age of the bridge. The stringers were originally connected
to the floor beams with rivets. The age of the structure and the
nature of the riveting caused the location of existing holes in
the floor beams to vary from one stringer to the next.

“We concluded that it would be best to field-drill the vast
majority of holes in the new stringers, holes through which

As demonstrated by Portland’s use of FRP on two major bridges, FRP decks are increasingly being viewed as an excellent alternative to
open steel grating decks on movable bridges. Is the FRP industry here to stay? “Definitely yes,” said Richards.
¾-in. bolts are being placed to fasten them to the existing floor beams.”

A two-part series

Although this is the first project for which CCC has installed FRP bridge decking, David Conway emphasized, “The FRP is simple and straightforward to work with.”

The work is being completed in quads. For each quad, after the new stringers have been installed, CCC installs the base section of the FRP deck. Next they drill holes through both the FRP and the steel stringers. Once the two are bolted together, the FRP top sheet of the FRP deck is attached with mechanical fasteners. After that, a wear surface is applied.

“The two-part FRP deck is open and gives easy access to connecting the deck to the stringers. The contractors can ‘see’ the connection system inside the deck,” said Dan Richards, president and CEO of ZellComp. “They know what they are working with, and they are confident of the strength of the deck and the connection systems. The deck allows for easy adjustments, which are almost always needed. With one-part panel systems, the contractor is ‘blind,’ making it very difficult to make these attachments. Mechanical fasteners are used to attach the top section to the bottom section. There is no need for on-site structural adhesives or resins.”
FRP decks can be attached to stringers with either shear studs and grout or structural bolts and neoprene. Because of weight constraints with the bascule spans, Multnomah County elected to go with bolts and neoprene for the connection system. CCC decided to use a portable magnetic drill to cut through the FRP deck and the steel stringer in one step—a cost- and time-saving step.

And FRP decks are no stranger to Portland. In 2004, Portland used another company’s FRP decking product to replace the steel grating on the historic movable Broadway Bridge. In 2010, portions of this deck were replaced with another FRP deck as part of the Portland Streetcar Loop Project.

As demonstrated by Portland’s use of FRP on two major bridges, FRP decks are increasingly being viewed as an excellent alternative to open steel grating decks on movable bridges. Installing a deck that is approximately the same depth as a typical open steel grating deck and that weighs the same or less than an existing steel deck can be a critical factor—allowing for a quick deck-replacement project without the need to modify or upgrade the lifting machinery.

Perfect compromise

Is the FRP industry here to stay? “Definitely yes,” said Richards, who has been involved with FRP structural products for over 25 years. The FRP infrastructure industry has matured by learning to listen to contractors and bridge owners—the true experts—and tailoring products to the most compelling needs. For example, in the early years of FRP decks, most industry participants designed FRP bridge decks as large, complete panels, thinking that having fewer sections (being even more prefabricated) would be a good idea.

“We’ve learned that bridge structures are seldom ‘perfect’—so being able to make modifications on-site is important, and making those modifications is more difficult with a closed panel system,” explained Richards.

John Busel, director of the Composites Growth Initiative for the American Composites Manufacturers Association (ACMA), said that FRP composite products have now been successfully used for over 20 years in bridge construction and rehabilitation. In addition to FRP decks, member companies of the ACMA supply other innovative structural products, including FRP rebar, girders and hybrid products such as the Hybrid Composite Beam (HCB). Given this growing acceptance of FRP structural products, Busel reflected, “FRP structural products use green construction materials, work well with the Federal Highway Administration’s goals of using prefabricated components and accelerated construction and ensure that bridges built or rehabilitated with FRP composites will last for future generations.”

Bridge owners like Multnomah County, who are embracing the use of FRP products on major projects, prove that FRP solutions are now becoming mainstream in the movement to restore America’s crumbling infrastructure.

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For more information about this topic, check out the Bridge Channel at www.roadsbridges.com.