Polymer grid technology a boon for bridges

May 24 2005

When the long-awaited Highway 151 bypass around Fond du Lac, Wisconsin, opens later this year, vehicles traveling northbound will cross DeNeveu Creek on a bridge like no other in the country.
Externally, the bridge looks identical to its adjacent twin. However, internally, the concrete deck reinforced with a novel fiber-reinforced polymer (FRP) grid system that could replace conventional epoxy-coated reinforcing bars (rebars) inside future bridges.

Professor of Civil and Environmental Engineering Larry Bank, Associate Professor Mike Oliva and graduate students David Jacoboson and Mack Conachen developed the system, which boasts several advantages over the steel rebars bridge-builders currently use. "The steel reinforcing bar in the concrete deck corrodes," explains Bank. "That corrosion causes cracking of the concrete, the concrete then chips off and you get potholes and all of those problems that people don't like on bridges."

Because it is non-metallic, the fiber-reinforced polymer material won't corrode, giving it the durability to last at least 75 years, says Bank. "Most bridge decks will only last somewhere between 30 and 40 years before they have to be replaced," he says.

While durability is one benefit of FRP technology, Bank and his students took their system a giant step farther. Traditionally, both steel and FRP reinforcing elements have been long bar shapes, which workers then have to secure together. But working with Strongwell, a Chatfield, Minnesota, manufacturer, Bank's group designed prefabricated, three-

dimensional FRP grids that cranes can rapidly lay into place, eliminating weeks of labor-intensive work.

That means workers can pour concrete more quickly, speeding up bridge construction or deck replacement. "The idea is, if you have to do a deck replacement on a busy road like I-90, you want to do it as quickly as possible so you don't have bypasses that are dangerous, or detours, which are even worse," says Bank.

The FRP grid system is the first of its kind installed anywhere, thanks to funding from a Federal Highway Administration program called Innovative Bridge Research and Construction, and cooperation from partners at the Wisconsin Department of Transportation (DOT).

Mark Klipstein is the DOT project manager overseeing the Highway 151 bypass project, and "volunteered" the DeNeveu Creek pair of bridges for this unique research experiment. "We had two structures that were right next to each other with similar lengths and similar widths," he says. "Because of that, it gave us an opportunity to build a conventional structure using materials that presently go in pretty much all the structures around the state, and the new fiber-reinforced structure."

Doing that, he says, enabled the researchers, DOT personnel and Alfred Benesch and Co., the professional engineering company of record, to compare construction time and cost, and to study each bridge's performance over time.

Pre-construction, Bank and his students developed computer models and conducted actual tests of concrete reinforced with FRP grids in the Wisconsin Structures and Materials Testing Laboratory on campus. But perhaps the most telling test of the FRP bridge's strength came in late-summer 2004, when Bank and his students watched workers drive six dump trucks totaling 300,000 pounds across it.

Gerald Anderson, DOT chief of structures who oversaw the department's bridge-design program, says recent advances in FRP production and material properties have made FRP bridge-deck designs a reality in Wisconsin. "Wisconsin DOT is looking at this FRP research as a promising potential investment for the future for the design of reinforced concrete that is exposed to chlorides," he says. "Wisconsin DOT may eventually be able to design concrete reinforced with a non-corrosive FRP material that by far outperforms the conventional epoxy-coated rebar decks. There will be a savings in construction to offset the FRP materials cost, as well as savings in both routine deck maintenance longer service life before deck replacement is required."

Although the cost of building this first FRP grid bridge was higher than that of a traditional bridge, Bank says that mass-produced, rather than custom-designed FRP grids, as well as their extended durability, will make the system cost-competitive. "The FRP reinforcement system costs around $20 a square foot, which given the time and labor savings obtained in construction, is competitive with a conventional steel rebar-reinforced bridge," he says.

Now his group is working with Strongwell to develop a next-generation system that's even better and more cost-effective. And though at the moment there aren't plans for additional FRP-grid bridges in Wisconsin, the technology is catching on: In June, workers will use a variation of the system in Green County, Missouri.

Source: University of Wisconsin