EMERGING APPLICATIONS of FIBER-REINFORCED POLYMER (FRP) COMPOSITES

Louis N. Triandafilou, P.E., FHWA Senior Structural Engineer
FHWA Resource Center, 10 South Howard Street, Suite 4000, Baltimore, Maryland 21201

This presentation will cover recent developments in the use of FRP composites in civil engineering infrastructure applications. After a brief introduction to the national problem of critical bridge conditions, it will focus on a hybrid composite beam (HCB), a carbon fiber tube arch (CFTA), and a thermoplastic (TP) bridge. The engineering properties of these structures have been validated through extensive laboratory testing and field installations.

The HCB was developed by Mr. John Hillman of Teng and Associates. It is a structural member that combines the positive characteristics of three main building materials into one cost-effective element designed to be stronger, lighter and more corrosion resistant than any of the materials used alone. An FRP rectangular shell houses a self-consolidating concrete compression arch along with tension reinforcement consisting of galvanized prestressing strand and fiberglass cloth. Highway bridge installations have been completed in Illinois and New Jersey, with several more pending for the Missouri Department of Transportation (DOT). A railroad bridge built with these beams has been undergoing continuous locomotive loading since 2007.

The CFTA was developed by Dr. Habib Dagher of the University of Maine - Orono. It has also been referred to as the "Bridge-in-a-Backpack because of the means of delivering the carbon FRP tubes to a jobsite. Erected at approximately two-foot centers, the tubes are then filled with self-consolidating concrete. Corrugated CFRP formwork is then attached to the tubes in order to support the earth fill and roadway pavement on top of the arch. The Maine DOT has completed one field installation, and has six more in various stages of design. The TP bridge was developed by Dr. Thomas Nosker of Rutgers University (New Jersey). It consists of recycled structural plastic composites that manufactured into environmentally sound bridge elements. The material has a similar unit weight to timber, is one-fifth the weight of reinforced concrete, and about one-tenth the weight of structural steel. Piling, caps, beams, decks and railings have been installed as a bridge in a State forest and on 3 military bases. Engineering properties of the latter three have been validated through testing with army tanks and railroad locomotives.

These three composites developments fit very well into FHWA's recent emphasis on accelerated bridge construction with prefabricated bridge elements and systems. They are lightweight, corrosion-resistant, innovative, and show great promise as bridges with 100-year service lives.

The presentation concludes with a brief summary of other emerging infrastructure applications of FRP composites, including wrapping aluminum overhead sign structures, lining culverts, other hybrid beams, bridge drains, inspection walkways, pavement dowels, pavement slabs, and prestressing tendons.

References:

Excerpts from presentations on the Hybrid Composite Beam, by Mr. John Hillman, Teng and Associates.

Excerpts from presentations on the Carbon Tube Filled Arch, by Mr. Nathaniel Benoit, Maine DOT

Excerpts from presentations on thermoplastic bridges, by Dr. Thomas Nosker, Rutgers-The State University of New Jersey.