1-1-2007

FRP Deck - Rehabilitation of a Steel Truss Bridge

Purdue ECT Team
Purdue University, ectinfo@ecn.purdue.edu

DOI: 10.5703/1288284315720

EMERGING CONSTRUCTION TECHNOLOGIES

Civil - Composite Materials & Technologies

FRP DECK - REHABILITATION OF A STEEL TRUSS BRIDGE

THE NEED

To avoid a costly bridge replacement project, the New York State Department of Transportation partnered with private industry to rehabilitate a steel truss bridge using lightweight composites. Reducing dead load on the bridge by 265 tons, the application of composite deck technology doubled the load ratings (to a level higher than the original design) and allowed weight restrictions to be removed, while saving $1.4 million. This was the first time this type of rehabilitation was accomplished in the U.S.

FIGURE 1 REHABILITATION OF A STEEL TRUSS BRIDGE

THE TECHNOLOGY

Bentley's Bridge, located near Elmira, New York, was installed in September 1999. Before reconstruction, the structure had a steel reinforced concrete deck cast over steel stringers. Due to deterioration of the bridge, load restrictions were posted. Reconstruction of the bridge with FRP (fiber reinforced polymer) composite deck panels fabricated an AASHTO HS25 design load for the bridge deck. Panels are fabricated using Vacuum Assisted Resin Transfer Molding to produce a lightweight cellular core panels.

FIGURE 2 FRP DECK (A STEEL TRUSS BRIDGE)

http://dx.doi.org/10.5703/1288284315720

The construction included six composite bridge deck panels, with composite curbs and shims, measuring 140' span by 25’ width. Also included in the project was the construction of replacement pedestrian walkways with composite walkway panels. The lightweight deck and walkway replacement enabled New York State Department of Transportation to double the bridge's load ratings while allowing vehicle weight restrictions to be removed. Most important, it avoided a costly bridge replacement project by rehabilitating a steel truss bridge using lightweight composites. Reducing dead load on the bridge by 265 tons, the application of this technology doubled the load ratings to a level higher than the original design and allowed weight restrictions to be removed, while saving $1.4 million in the process. It demonstrates the tremendous savings in time, money and weight to be gained from the use of large composite structures. The total cost of the project was just $800,000, versus a projected $2.2 million for replacing the bridge. As a result of reducing the dead load on the bridge to 32 pounds per square foot from 170 pounds per square foot, contractor was able to raise the load rating on the bridge to a much higher level than the original design and save the original superstructure. And the installation - completed in September, 1999 - was responsible for only one month of downtime for the bridge, instead of several.

Fiberglass rebar may be a suitable alternative to steel reinforcing in:

- Architectural Concrete: cast stone, architectural cladding, balusters, column facades, window lentils, architectural precast elements, hand railing, and statuary and fountains, etc.
- Concrete exposed to de-icing salts in: bridge decks, railroad grade crossings, median barriers, parking garage elements, and salt storage facilities, etc.
- Concrete exposed to marine salts in: seawalls, water breaks, buildings & structures near waterfront, aquaculture operations, and floating marine docks, etc.
- Concrete used near electromagnetic equipment such as: MRI rooms in hospitals, airport radio & compass calibration pads, and concrete near high voltage cables, transformers, substations, etc.

The Benefits

- Allow vehicle weight restrictions to be removed
- Eliminate the need for a costly and time-consuming bridge replacement project along a heavily trafficked road.
- Reduce the deck dead load on the structure by 265 tons.
- Prolong the life of steel truss bridges.

Based on features above, FRP bars appear to be promising alternative to steel reinforcement in concrete structures such as marine structures, parking structures, bridge decks, highway under extreme environments, and structures highly susceptible to corrosion and magnetic fields.

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STATUS

NEW CASTLE, DELAWARE - August 24th, 2000 - Hardcore Composites has been named by the Civil Engineering Research Foundation in this year's Charles Pankow Award, the Foundation's highest award for innovation, for the rehabilitation of an aging steel truss bridge in Wellsburg, New York, using fiber-reinforced composites. Hardcore Composites manufactured the key component in the project - a lightweight but super-strong all-composite deck. Over the past four years, Hardcore Composites has manufactured and installed twenty traffic-bearing bridges or bridge decks.

In addition, FRP Rebar Manufacturers Council (Chairman: Doug Gremel) was formed by the manufacturers listed on the 'Points of Contact' with the objective of fostering quality assurance and other industry standards amongst manufacturers.

The Canadian Highway bridge design code, CSA - S6-06 now includes provisions which allow for the use of GFRP rebar. Consequently, a number of bridges in Canada are being built in on a more routine basis. The largest of these projects to date is the "Floodway Bridge" near Winnipeg. This is a significant bridge structure by any measure but more so due to fact that it was built using the "steel free deck" concept using all GFFRP bars in the concrete above the girders.

BARRIERS

- Limited information on Life cycle costs
- Limited information on Life cycle performance
- Limited information on benefits/cost analysis of replacing conventional materials with composites
- For this particular technology (HCI panels) sometimes a vertical uplift between the panels is noticed. This could be because the thin splice plates that are used to join the two adjacent panels did not provide adequate stiffness to prevent this movement. This problem can be rectified by clamping down the decks. However, the preparation and assembly of the tongue pieces as well as the extra efforts of clamping down the decks could be difficult and time consuming.

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Points of Contact

Mark Ewen
Tel: (302) 442-5900.

References

1. Hardcore Composite Press Release

Reviewers

Peer reviewed as an emerging construction technology

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Publisher

Emerging Construction Technologies, Division of Construction Engineering and Management, Purdue University, West Lafayette, Indiana

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