Light Weight FRP Decks for Bridges

Long Lasting
Lightweight
Accelerated Construction

Scott Reeve
Composite Advantage
20+ Years of Success and Lessons Learned

- First FRP bridge decks
  - Pedestrian bridge in Aberfeldy, Scotland (1992)
  - Vehicle bridge in Russell, Kansas (1996)

- FRP Federal and state agencies focused technology funds for FRP applications
  - Kick start
  - Evaluate, improve and disseminate information
Fiber Reinforced Polymer (FRP) Composite Benefits

• Light Weight
  – Only 20% of reinforced concrete panels
  – For vehicle decks, FRP is 20 psf; concrete is 100 psf
  – Valuable for movable bridges; truss bridges
  – Quick installation

• Prefabricated Bridge Elements
  – Accelerated construction
  – Incorporate features in shop fabrication
  – Lower cost; higher quality

• Long Lasting and Low Maintenance
  – Corrosion resistant to chemicals and water
Bridge Applications in U.S.

Composite Products in the U.S.
Vehicle Bridge Deck Installations

- Over 100 in US
- Largest is almost 19,000 sf
  - Haverhill, Massachusetts
  - Six spans; one is swing span
  - Prefabricated with crown; rail post connections; and expansion joints
Deck Panels with molded-in crown
Deck Panel Features

• **Expansion Joints**
  – Galvanized steel plates
  – At end of deck spans for impact resistance
  – Attached in the shop
  – Includes rail for neoprene seal

• **Rail Posts**
  – Attached to internal steel reinforcement

• **Wear Surface**
  – Polymer Concrete
• Lightweight
  – Efficient transportation; many panels per truck
  – Only need small equipment
• After steel is rehabilitated or replaced, the deck is connected
• Prefabricated panels are easy to install
• From one end to the other
• Quick installation
  – One to five days; not 28 days for concrete to cure
Design Flexibility and Prefabrication Benefits are evident in Swing Span end panels.
Installed Panels at Expansion Joint

- Upfront design work makes installation go faster and final structure is higher quality

- Coordinate with contractor for as-built dimensions and construction tolerance

- Account for temperature during installation
• Overlay is same as used on any bridge
  – Polymer concrete
  – Asphalt
FRP Market Fit

• NOW Value is
  – Installation savings using Prefabricated Bridge Elements
  – Light Weight

• Movable bridges
  – Deck weight has direct effect on mechanical equipment and operational costs

• Historic steel truss
  – Remove load ratings
  – Meet local community desires

• Steel grate replacement
  – Solid surface protects superstructure
  – Lower noise
Special Applications

• Light weight fairings to eliminate dynamic response under wind conditions
  – Sarah Long lift bridge between NH and Maine
  – 2017 installation

• Light weight ballistic protection of critical bridge elements (cables)
Floating Bridge

- FRP provides structural capability, corrosion resistance and flotation
- Brookfield, Vermont
Challenges

• Installations dropped off after Innovative Bridge Research funding ended
• Some failures
  – Certain suppliers (others have no issues)
  – Lessons learned have been incorporated
• Lack of standards
  – Harder for some agencies/designers to specify FRP
  – Need suppliers to prove qualification
  – Special provisions in specs are used to address this
• Price premium
• Most procurements are acquisition based
  – Slow movement to Life Cycle analysis
Pedestrian Bridges & Decks

- Long lasting
- Design flexibility in prefabricated product
Market Successes

• Structural capability accepted
• Accelerated construction
• Some customers buying for low maintenance and life cycle savings
• AASHTO Guide Specification in place
Design Flexibility: Functional Features in Prefabricated Product

- Crown
- Drainage scupper with grating
- Curbs
- Railing Attachments
- Expansion joint cover plate and curb cover
Key Applications

- Signature bridges
- Rails to Trails
- Architectural designs (aesthetics, shapes, colors)
- Light weight for erection of fully assembled bridges
FRP Deck Enables Accelerated Construction of Truss Bridges

• Truss is fully assembled near highway
  – Steel, FRP deck, fencing
  – No deck installation over the road
• 57 deck panels installed in 1.5 days
FRP Deck Enables Accelerated Construction of Truss Bridges

- Spans towed to position on vehicle bridge
- Largest lift was 132,000 lb
  - Precast concrete would have added 74,000 lb
- Road closure of 15 minutes per span!
Cantilever Sidewalks

- Shared use paths
- Safe separation from traffic
- Lower cost than separate bridge
• Add or widen sidewalks
• No increase in dead load
Current Efforts

• Information Sharing
  – Case studies so owners and designers know how FRP can benefit their projects
  – FAST Act has provision for FHWA / TRB to report on IBRC results for FRP and other technologies

• Education
  – Presentations at conferences, agencies and design consultants, universities

• Finding proponents in many places
  – Architects: aesthetics
  – Designers: prefab carries out design best
  – Maintenance Departments – less work
FRP Bridge Decks

• Providing innovation and options
• Design flexibility of an engineered product
• Right market fit
  – Light weight
  – Prefabricated with design features
  – Accelerated construction
  – Very low maintenance
• Vehicle
  – Movable, Steel Truss, Specialty Solutions
• Pedestrian