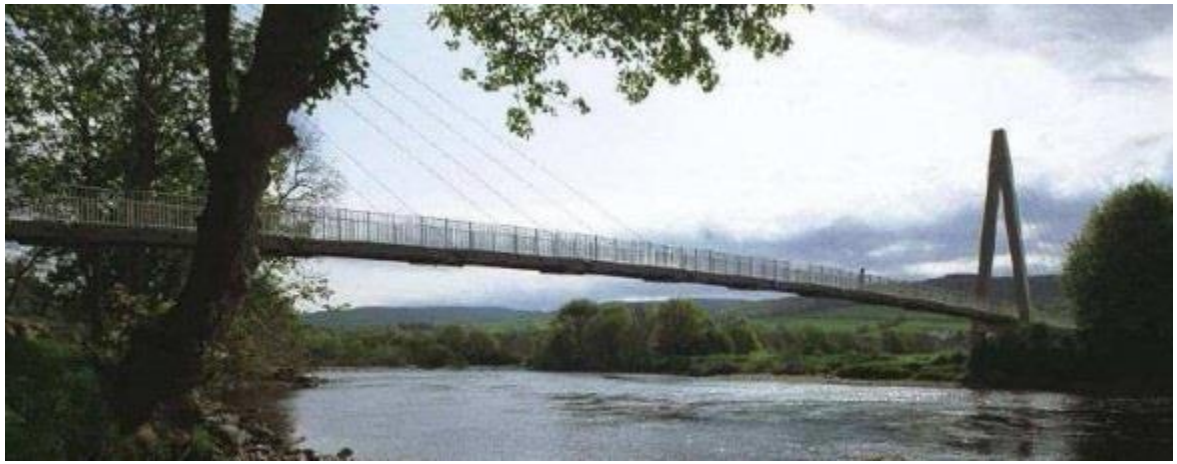
Light Weight FRP Decks for Bridges

Long Lasting
Lightweight
Accelerated Construction

Scott Reeve
Composite Advantage

20+ Years of Success and Lessons Learned

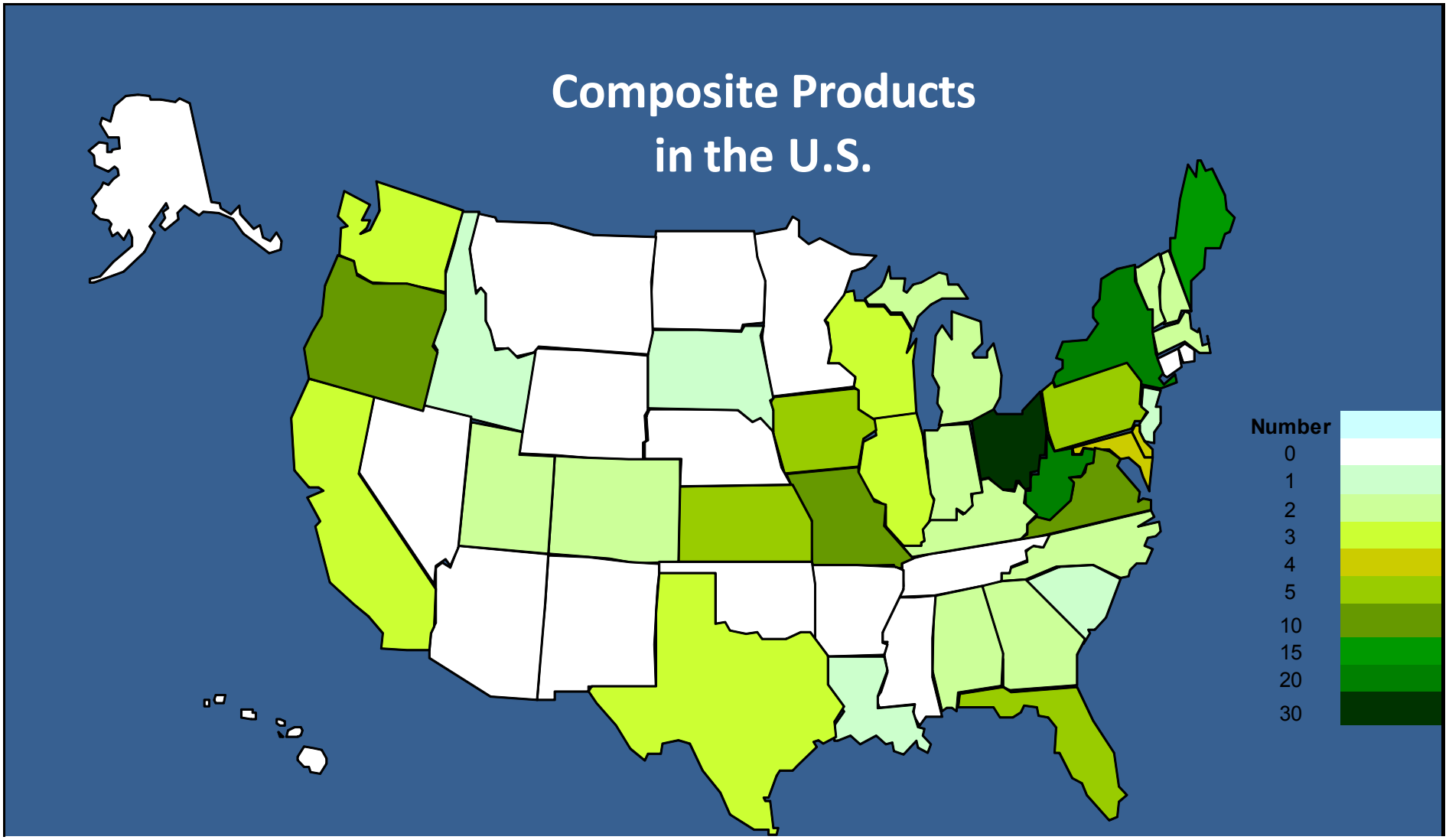
- First FRP bridge decks
  - Pedestrian bridge in Aberfeldy, Scotland (1992)
  - Vehicle bridge in Russell, Kansas (1996)
- FRP Federal and state agencies focused technology funds for FRP applications
  - Kick start
  - Evaluate, improve and disseminate information



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.



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

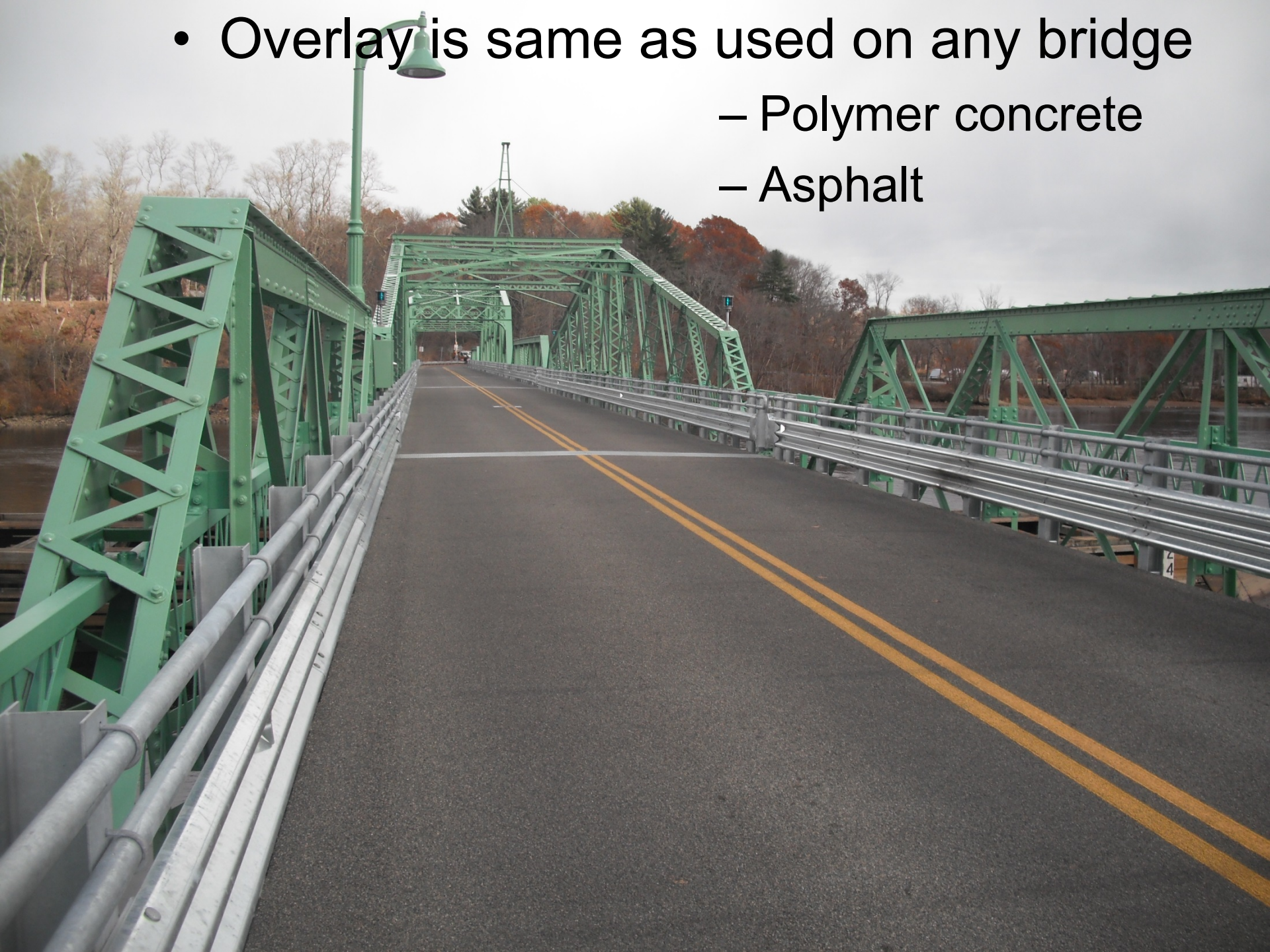
- Prefabricated panels are easy to install
- From one end to the other

- 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)

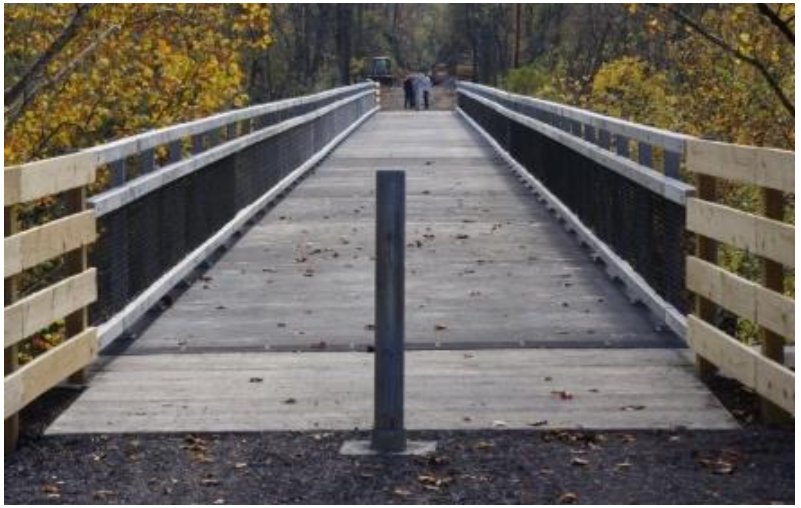
Floating Bridge

- 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

Key Applications

- Signature bridges
- Rails to Trails
- Architectural designs (aesthetics, shapes, colors)
- Light weight for erection of fully assembled bridges

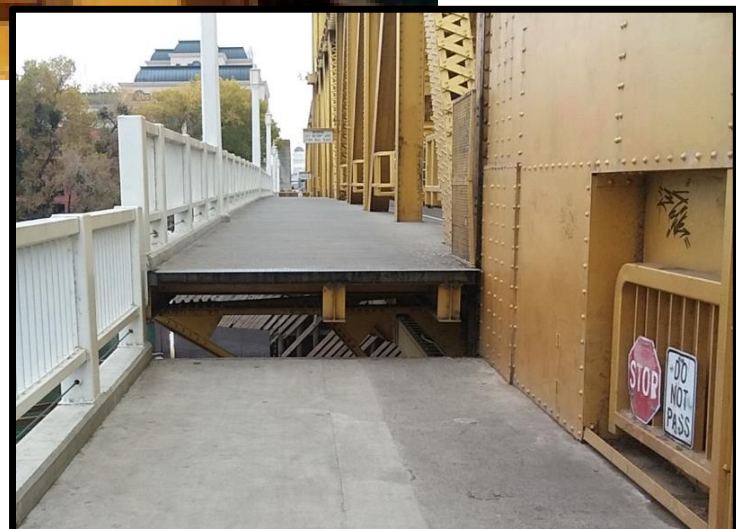
FRP Deck Enables Accelerated Construction of Truss Bridges

- 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