Design, Fabrication, and Construction of FRP Girder/Beam Type highway Bridges

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AIT Bridges

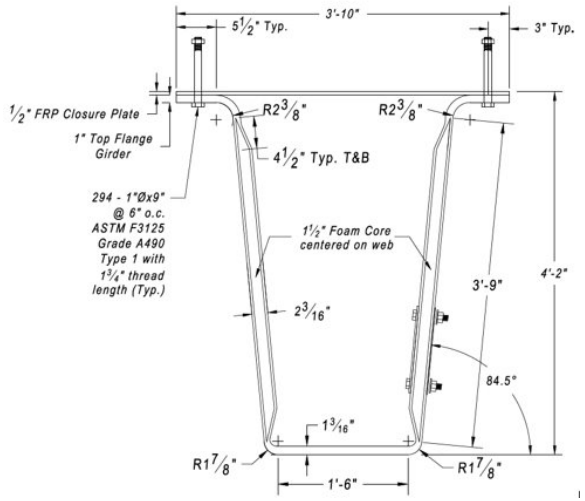
Composites
AN INFINITE WORLD OF POSSIBILITIES

Presentation Outline

- Overview of FRP GBeam
- Grist Mill Bridge replacement case study
- Creep and deflection considerations
- Grist Mill load test data
- Sun Island Bridge replacement case study
- Twin Bridge replacement case study

GBeam System & Key Benefits

- Composite tub beams that require no concrete fill.
- Cast-in-place, precast transverse, and precast longitudinal deck options.
- Can be designed at different depth and camber depending on project scope.
- Spans up to 120' and is best suited for replacing steel and concrete beam bridges.



- Non-corrosive
- Non-conductive
- Seismic reduction
- 100+ year life cycle
- Thermally non-conductive
- Lighter than steel and concrete
- Accelerated-Bridge-Construction ready
- AASHTO approved

Grist Mill Bridge Replacement (Hampden, ME)

75' Single Span FRP Girders

Grist Mill Bridge

Year : 2020

Span: 75'

Depth: 4' 2"

Width: 40' 4"

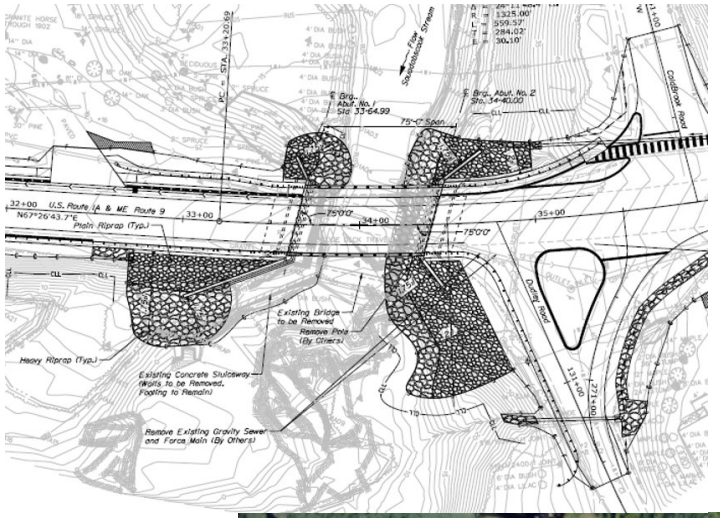
Skew: 75

Girders: 5 FRP GBeams

Owner: Maine DOT

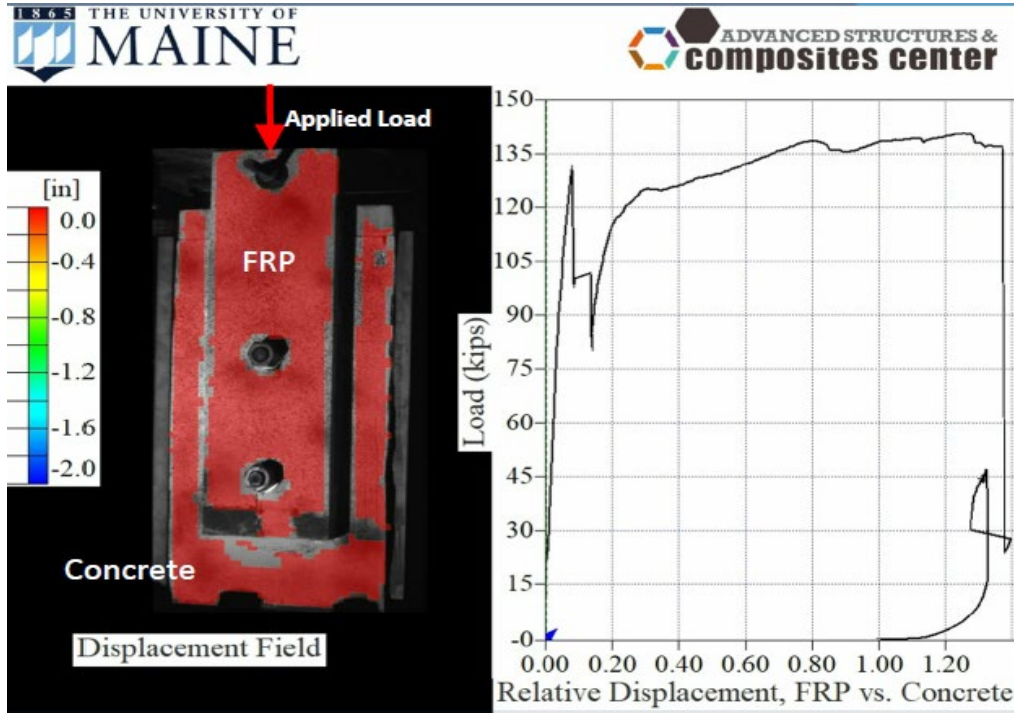
Engineer: AIT Bridges, T.Y. Lin

Contractor: T-Buck Construction



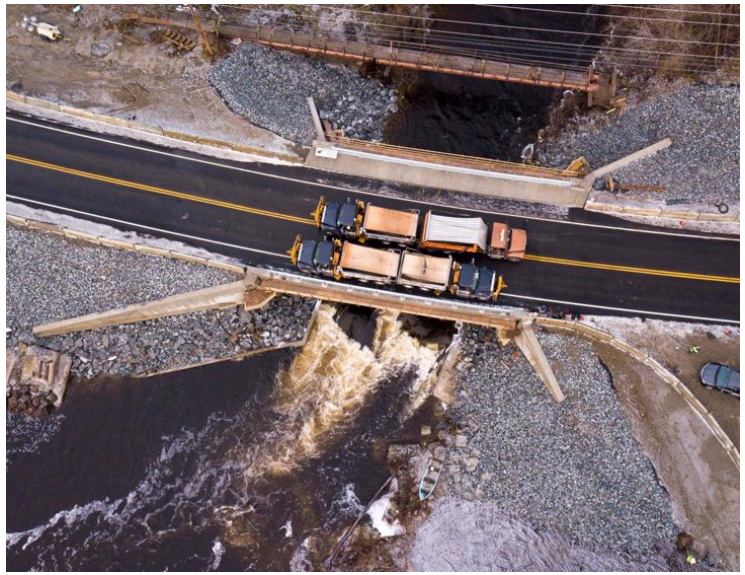
Deflection & Creep Considerations

- Efficient use of carbon fiber in the bottom flange allows for a composite section engineered for deflection criteria set by AASHTO or by project owners.
- For this project, a Span/Deflection of 1200 was achieved, with the AASHTO criteria set at 1000
- The section is designed to AASHTO CFFT 2.7.2, which sets a strain limit to prevent Fatigue and Creep Rupture. The limit is based on:
    - Dead load of the superstructure
    - Applied Live load of AASHTO's fatigue vehicle
- Critical connections were fatigued to six million cycles to meet / exceed requirements of infinite fatigue life as defined by AASHTO.



Grist Mill Load Test

- Instrumented by University of Maine and UMass Lowell
- Load Tested with 4 Fully loaded dump trucks
- Over 260,000 lbs placed in various locations to determine distribution factors and rating factors
- Design Inventory Rating Factor: 1.04
- Load Test Inventory Rating Factor: 1.66
- Achieves good balance of resilience, efficiency, and durability



Sun Island Bridge Replacement (South Pasadena, FL)

47' - 3" Single Span FRP Girders

Sun Island Bridge

- 8 Spans totaling 335’ – Single Lane 14’ wide
- Existing structure composed of adjacent carbon steel prestressed slab beams
- Center two spans showed significant spalling and corrosion after only 25 years of service – this was caused by saltwater spray from watercraft passing beneath the structure
- Strengthened in 2008 with CFRP sheets
- Owner elected to replace center two spans after continued degradation

- Replacement spans are 47’-3”
- 4 Composite Tub Girders per Span
- 7.5” Precast RC Deck
- Designed for 500-year storm surge impact/uplift
- 4 - 44,000 lbs PBUs to accelerate construction
- 100-year design life over salt-water
- Fully non-metallic design

Twin Bridge Replacement (Hampden, ME)

53' Single Span FRP Girders

Hampden Twin Bridge

Year: 2021

Span: 53'

Depth: 20"

Skew: 15

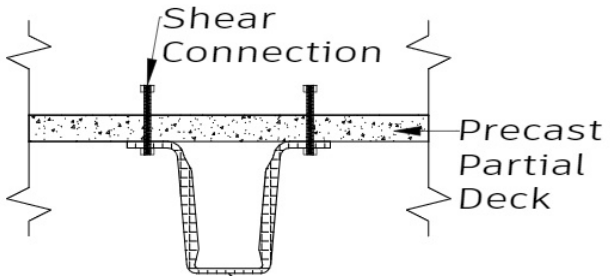
Girders: 6 FRP GBeams

Owner: Maine DOT

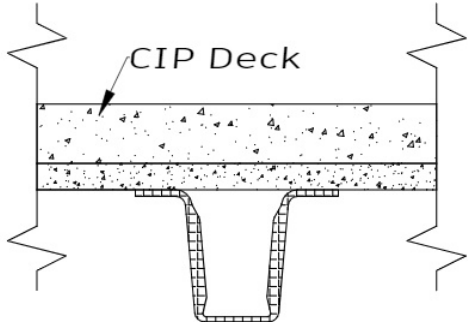
Engineer: AIT Bridges, WSP

Contractor: CPM

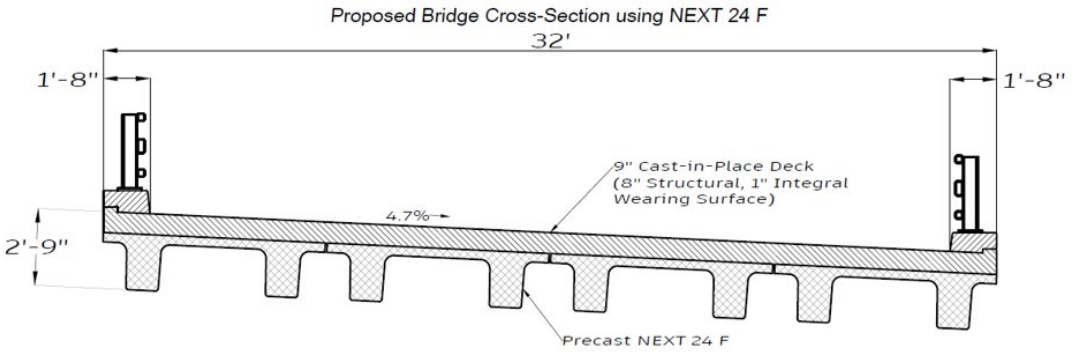
Module Section

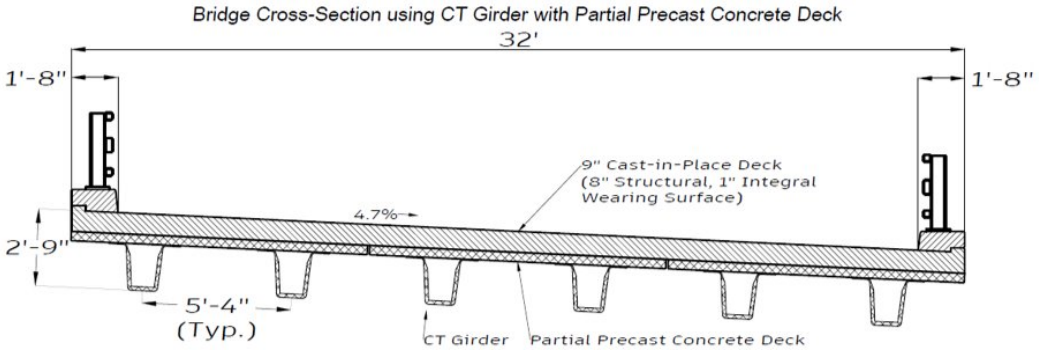


Final Section



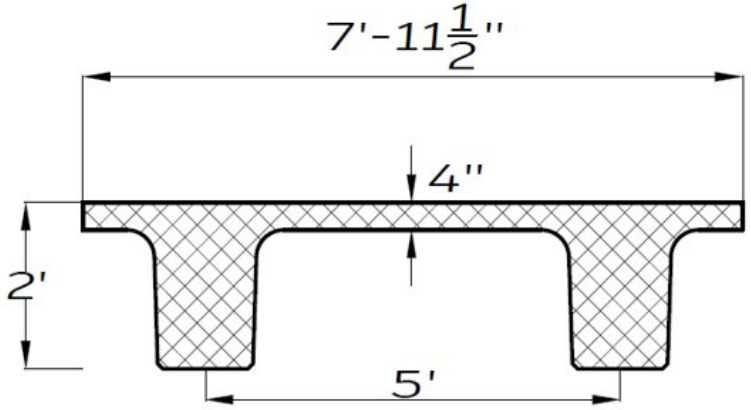
GBeam VS. Precast NEXT 24 F



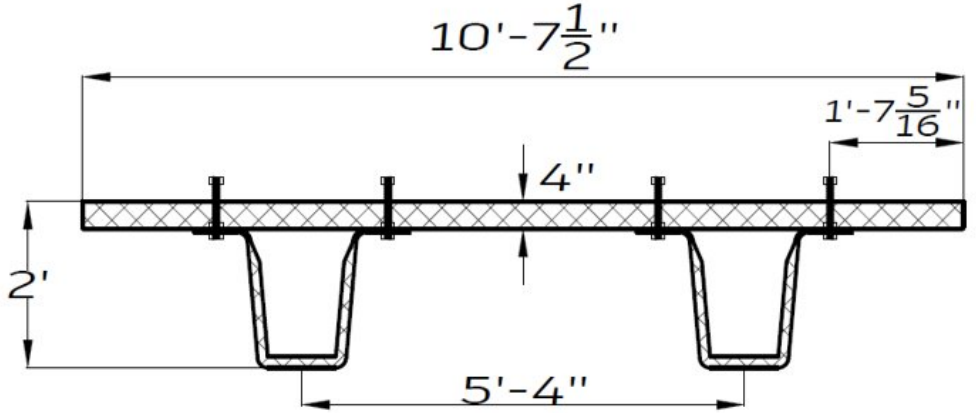


53’ Module Shipped to The Construction Site

Precast NEXT 24 F 53,318 lbs.

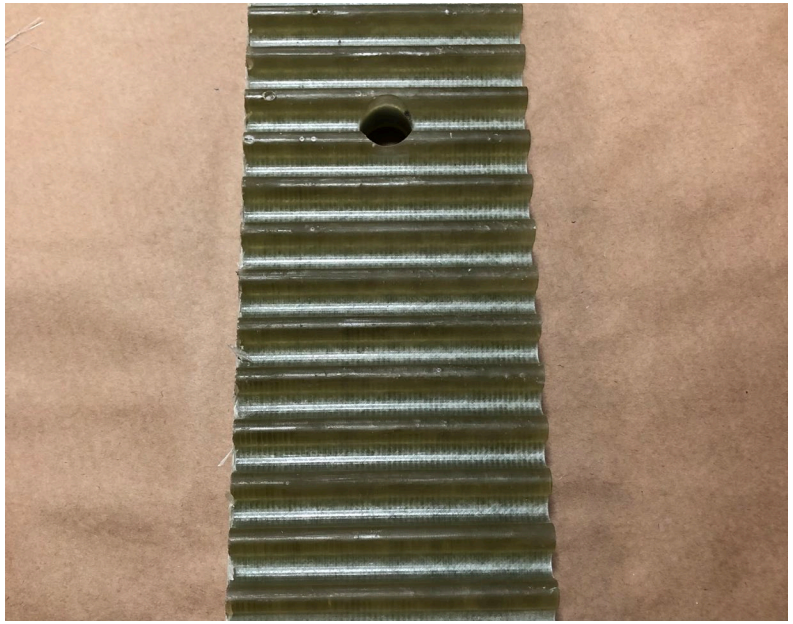


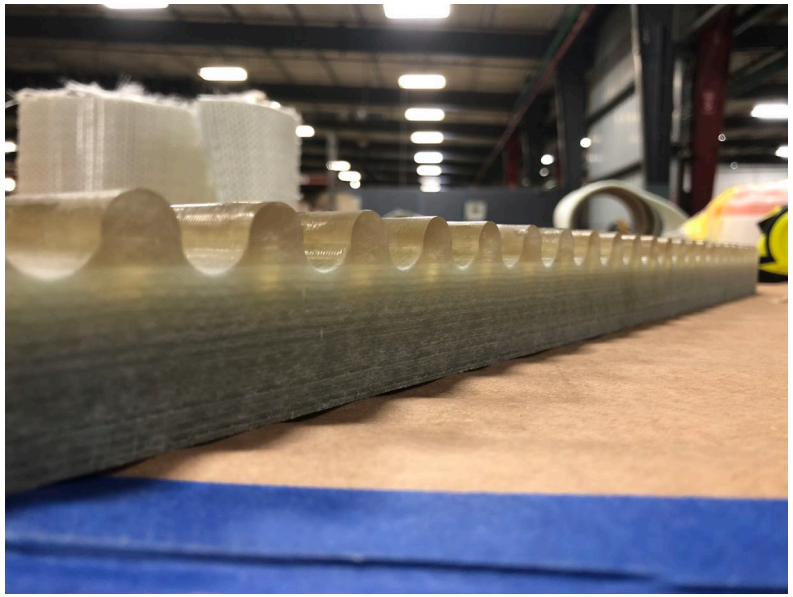
GBeam Option 32,860 lbs.



Twin Bridge Design & Improvements

- Existing structure is a 25' span
- New structure will span 53' allowing more water flow and a better habitat connectivity
- Ridges were added along the top flange for redundancy in connecting the deck with the girder
- OPAN fiber exterior greatly increases heat & flame resistance
- Improvements in Layup resulted in less material required for longer spans





Conclusion

- FRP Structures can provide excellent resilience
- Composite materials are durable and long-lasting
- FRP Structures are sustainable structures, minimizing environmental impacts while providing a longer service life with minimum future maintenance
- Application of FRP in Infrastructure has increased significantly in the last two decades primarily because of the material's innate resilience
- With increased use, there will be increased guidance
- Designing an FRP beam bridge in compliance with the AASHTO LRFD bridge design guide is not much different than designing with steel or concrete.

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