Synopsis:

The New Oregon Road Bridge Replacement was performed as a demonstration project by Erie County. The main focus of the demonstration project was two-fold. The first was to utilize an innovative hybrid FRP/concrete superstructure for the new bridge. The second was to use details and methods that would provide for accelerated construction of the new bridge.

The innovative hybrid superstructure is the first bridge in Erie County using FRP in the superstructure design. It is also only the second bridge in the United States to use a hybrid FRP/concrete design, and the first bridge in North America manufactured by Wagners Composite Fibre Technologies (Australia). This design economizes the use of materials by using an integral concrete deck to take the compressive stresses, while the FRP carries the tensile loads. The hybrid superstructure is lightweight, low-maintenance, and has an expected service life of 100 years. The hybrid superstructure was also prefabricated as 4 panels, which were placed and connected in the field. By prefabricating these elements, the construction of the bridge was accelerated.

The total bridge replacement project was completed within a 31-calendar-day period. During that time, the following was accomplished: existing short-span bridge demolished; new spread footings doweled into rock, formed, and poured; abutments and wingwalls constructed with precast concrete blocks; four (8.9 m long by 2.2 m wide) hybrid FRP/concrete superstructure panels placed, joined, and anchored; polymer and aggregate wearing surface installed; approach slabs formed and poured; approach pavement reconstructed; bridge and approach railing installed; and the bridge reopened to traffic. A 68-ton load test was also performed during this period as an extra measure of safety assurance and to confirm the theoretical design of the innovative superstructure.
The County’s low-bid Contractor fully utilized schedule incentives for the rapid construction project and commented that it “could have been done even faster.” Quality and long-term durability of the superstructure exceed conventional alternatives; therefore, anticipated life-cycle costs are less due to reduced long-term maintenance requirements.

The presentation will focus on a basic overview of the innovative hybrid superstructure design and on the County’s process for developing the project’s fast-track design, fabrication, and construction sequence, which drove the success of this project and minimized disruptions to the traveling public.

About the Presenters:

Jonathan DePlanche’ received his Bachelor’s of Science degree in Civil Engineering from the State University of New York at Buffalo. He has worked for TVGA Consultants for the past 6 years. Jon has been involved in the design of the rehabilitation or replacement of a variety of structural projects, including single and multiple-span bridges. The bridges have included steel girders, prestressed concrete box beams, and fiber-reinforced polymer (FRP) elements. He has contributed on projects from the scoping stage, through field inspection, development of alternatives, detailed design, contract document preparation, and construction inspection.

Carl Dimmig is currently the Erie County Bridge Engineer, a position he has held since 2002. He is responsible for the County’s bridge program, which includes addressing flags, load rating, bridge inspection, permit approvals, and review of all over-dimension truck travel on Erie County roads and bridges. He was a consulting engineer from 1972 to 2001 involved with the design and development of highway projects, culverts, and bridges. He was also involved in bridge inspection and served as Quality Control and Project Manager as well as Load Rating Team Leader from 1978 to 2000. Carl received an AAS in Civil Technology from Erie County Technician Institute (ECC) in 1969 and a BS in Civil Engineering from Tri State University in 1971.

Organizations:
Member of ABCD, ASCE, NSPE, and PCI
Hybrid Reinforced Concrete and Fiber Reinforced Polymer (FRP) Superstructure for an Accelerated Bridge Replacement Project

Presented by:
Carl P. Dimmig, P.E.
Erie County Department of Public Works

Jonathan DePlanche’, P.E.
TVGA Consultants
DEMONSTRATION PROJECT GOALS

• Utilize Details and Methods for Accelerated Construction
• Use Innovative Hybrid Reinforced Concrete/Fiber Reinforced Polymer (FRP) Superstructure
ACCELERATED BRIDGE CONSTRUCTION

“Get In, Get Out, Stay Out”
BENEFITS OF ACCELERATED BRIDGE CONSTRUCTION

• Minimizes Traffic Impacts
• Improves Construction Zone Safety
• Lessens Environmental Impacts
• Increases Quality and Constructability
• Reduces Life-cycle Costs
METHOD TO ACHIEVE ACCELERATED CONSTRUCTION

• Use Prefabricated Elements
  • Decreases Field Time
    – Element Assembly vs. Element Construction
  • Increases Quality
TYPICAL PREFABRICATED BRIDGES

- Large Scale/Complex Projects:
  - Multiple Spans
  - Long Term (Multi-Year) Construction
  - Multi-Million Dollar Projects
  - Not Typically Locally Owned Bridges
OTHER APPLICATIONS

- Any Bridge Replacement or Rehabilitation:
  - Short Spans
  - Single Spans
  - Low Profile Projects
  - Low Cost Projects
  - Locally Owned Bridges
ERIE COUNTY BRIDGES

• Owns or Maintains Nearly 300 Bridges
  –Approx. 1/3 Are Less Than 12.2 m (40 ft)
  –Many Over 80 Years Old
  –Rapidly Deteriorating
  –High Maintenance Costs

• Many Opportunities for Accelerated Bridge Replacement
PROJECT TIMELINE

• Fall 2003 – Initial Project Discussions
• December 11, 2003 – Resolution Adopted for Hybrid Superstructure Use
HYBRID SUPERSTRUCTURE BENEFITS

• Prefabricated
• High Strength
• Low Weight
• High Resistance to Corrosion
• Low Life-Cycle Costs
• Versatility
HYBRID SUPERSTRUCTURE

• Designed and Manufactured by Wagners Composite Fibre Technologies
  • Located in Toowoomba, Queensland, Australia
• First Wagners Bridge in North America
• First Prefabricated Hybrid Superstructure in the United States
PROJECT LOCATION

- New Oregon Road
- Town of North Collins, Erie County, NY
EXISTING BRIDGE

- 28 ft Single-Span
- AADT of 119
PROPOSED BRIDGE

- Span Length: 8.90 m (29.20 ft)
- Rail-to-Rail Width: 8.54 m (28.02 ft)
- Skew: 0 degrees (no skew)
- Superstructure Depth: 0.598 m (1.96 ft)
- Abutment Height: 1.46 m (4.79 ft) at CL
ACCELERATED CONSTRUCTION SCHEDULE

• Typical Bridge Replacement
  – 3 To 4 Months

• New Oregon Road Bridge Project
  – 40 Calendar Day Goal
  – Incentive/Disincentive: $1000/Day For 10 Calendar Day ($10,000) Maximum
HYBRID DESIGN OVERVIEW

Concrete For Compression Loads

Neutral Axis

Steel For Tensile Loads
HYBRID DESIGN OVERVIEW

Beam Section

Strain Diagram

Effective Section

Resultant Forces

$F_c$

$F_t$
HYBRID DESIGN OVERVIEW

• FRP Used Below the Neutral Axis
• Material Use Is Optimized
  – FRP Is Strong In Tension
  – Concrete Is Good In Compression
HYBRID DESIGN OVERVIEW

155 mm (6 in) - 65 MPa (9.4 ksi) Concrete Deck

100 x 100 x 5 Circ Wound Pultrusion

2.18m (7.15 ft) Wide Panel (TYP.)

E-Glass FRP Tensile Flange
PROJECT TIMELINE

• February 2004 – Detailed Design Begins
• May 28, 2004 – TVGA Approves Hybrid Design
• June 3, 2004 – Project Advertisement
• June 17, 2004 – Bid Opening
• July 25, 2004 – Hybrid Panels Shipped from Australia
• Road Closed
• Demolition Begins
9/13/2004

- Blocks Placed on North Abutment
- Interference on Corners
• First Course Completed on North Abutment
• South Abutment Footing Placed

9/14/2004
• Abutments Completed to Slope Bridge Seat
• Superstructure Panels Arrive On Site
• Two Weeks After Road Closure
• First Interior Panel Installed
• Two Panels Installed
• Exterior Panels Placed on Interior Panels
• Bridge Railing Connection Brackets Installed
• Final Panel Installation
• Overlay Installed
• Cheekwalls Installed
• Inventory Rating: MS-87 (HS-96)
• Operating Rating: MS-134 (HS-148)
10/8/2004

- Bridge Opened to Traffic
- 31 Calendar Day Closure
CONCLUSIONS

• Using Prefabricated Elements Is An Effective Method To Achieve Accelerated Construction
• Hybrid Design Provides An Alternative to Traditional Bridge Superstructures
ACKNOWLEDGEMENTS

• Erie County Department of Public Works
  – Maria Lehman
  – Charles Sickler
  – Wayne Scibor
  – Joseph Monte
• TVGA Consultants
  – Preston Halstead
  – Kenneth Wojtkowski

• Wagners Composite Fibre Technologies
  – Neill Wagner
  – Michael Kemp
  – Robert Steffen
• UCC Constructors, Inc.
• Bridge Composites, LLC
  – Jerome O’Connor
• Bridge Diagnostic, Inc.
QUESTIONS?