Saving Time with Steel Tub Girders in St. Clair County

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Project Manager

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Structural Engineer
St. Clair County, Michigan

226 Bridges County Wide

- 38 Load Limit Posted
- 2 Closed To Traffic

Structure Condition Summary

- Good/Fair (5 or Greater) 185
- Poor (4) 21
- Serious/Critical (3 or Less) 20
History of TEG Engineering, LLC

- Prequalified for Design Services with both TxDOT and MDOT
- Headquartered in Grand Rapids, Michigan, other office in Houston
- Over 22 Employees
- Civil Structural Engineering Firm Specializing in Precast Concrete for Heavy Civil Construction.
- Member of AISC, ACI, PCI, NSBA and SSSBA
Prefabricated Structures Specialists

- TEG selected by CBP, one of over 300 applicants
Prefabricated Structures Specialists

- 30’ Tall Precast Concrete Wall
2 Posted Bridges on Marine City Hwy

- Marine City Highway over Unnamed Canal (4-08)
- Marine City Highway over Meldrum Drain (4-09)
2 Superstructure Replacements on a heavily trafficked local highway

Marine City Highway is a 2 lane road with more than 16,000 ADT.
Goals of Superstructure Replacement

- Utilize the existing abutments
- Match the existing superstructure depth
- Maintain constructability by county maintenance crew
- Structure design per MDOT HL-93(MOD) loading
- Additional 60 year service life

Existing Marine City Hwy over Meldrum Drain (4-09)
Why Tub Girders Were Chosen

Steel Bridge
$75,000
+ HMA Overlay
+ Guardrail
+ Labor
+ Equipment

Pre-Cast Box Culvert
$63,000
+ Headwalls
+ Wing Walls
+ Crane Rental
+ Earthwork/Heavy Demo
+ HMA
+ Labor
+ Equipment
Tub Girder with Pre-Cast Deck

$57,000
+ HMA Approaches
+ Epoxy Overlay
+ Guardrail
+ Labor
+ Equipment

***Based on Engineer’s Estimate, the Tub Girder system was approximately 10% cheaper in this particular application.
History of the Con-Struct System

- Con-Struct was Developed in 2003
- Con-Struct is a Press-Brake-Formed Steel Tub Girder Bridge System with a Network of Manufacturers throughout the United States.
- First Project was in Saginaw, MI 2004
- Approved for use in 5 States and Saskatchewan, Canada.
- Over 25 bridges installed with Spans ranging from 20’ to 80’
- Bridge Locations in Missouri, Michigan, Texas, Minnesota and Colfax, SK

Bridge over Brainerd Raceway Installed in 2007.
Con-Struct Bridge System Components

FHWA GRS-IBS Project

Integral Backwall
Con-Struct Prefabricated Bridge Solution

- Con-Struct Standardized and Simplified Fabrication and Details
- Industry can Produce Press Brake Formed Steel Tub Girders in 58’ Continuous Lengths
- Precast Concrete Industry Involved in Manufacturing Process
- New high-strength, non-shrink grouts provide durable solutions for deck joints
- FHWA involvement in innovative projects and funding (ABC, UHPC and GRS)
Con-Struct Prefabricated Bridge Solution

- Independently researched and tested by MDOT through Michigan State University (MDOT installed their own bridge in 2011)
- Installed and ready for traffic in a single day
- Simple and durable deck joint connection
- 75 year service life
- Delivered and installed at less cost than that of conventionally constructed concrete beam bridges

Tested Capacity Exceeds AASHTO

\[ M_y = 65 \text{ kip-ft} \]
\[ M_u = 106 \text{ kip-ft} \]
\[ M_n = 80 \text{ kip-ft (AASHTO)} \]
Press-Brake-Formed Steel Tub Girders

- 2016 Research Funded by SSSBA
  - IBC-16-95 *Evaluation of Modular Press-Brake-Formed Steel Tub Girders*
  - Joint effort from West Virginia University, Marshall University and University of Wyoming
- Assess Feasibility and Details
- Test Fatigue and Distribution Factors
- Determine Applicable Design Methods
  - AASHTO LRFD
Press-Brake-Formed Steel Tub Girder

- Press-Brake-Formed Steel Tub Girders - No Flange to Web Welds, Reduced Fabrication Costs
- Per AISC Bend Radius > 4t - No Brittle Fracture, AASHTO Category B Fatigue

60’ Long Press Brake

ASTM A572 or A588 Steel

4t Bend Radius

Cold Bending Steel Plate Tub Girder
Press-Brake-Formed Steel Tub Girder - Galvanize

- Hot-Dip Galvanized to Provide 60+ Year Protective Coating
- Stern Bayou in Ottawa County was Galvanized in 1966 with no current signs of coating deterioration
Precast Concrete Deck Panels

• Simple Panel Installation Utilizing High Strength Grout
  • MDOT Type H-1
  • QuickCrete Precision Grout
  • Dayton Superior Conspec 100

Place Grout into Precast Panel Shear Stud Pockets and Tranverse Joints
AASHTO/MDOT Design Procedures

- Standard Designs from 20’ to 80’ Spans
- Follows AASHTO LRFD and MDOT Design for HL-93(MOD) Loading
- Tested AASHTO Live Load Distribution Factors
- Easy to Follow and Check Mathcad Calculations
- Compatible with MDOT Load Rating Standard Spreadsheet
Con-Struct Prefabricated Bridge Advantages

- LEED Material Comparison
  - Prestressed Concrete Beam (PCB) vs. Con-Struct Steel Tub
  - 88% of Steel is Recycled
  - \( \frac{1}{2} \) the Volume = \( \frac{1}{2} \) the Weight

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<th>PCB</th>
<th>Con-Struct</th>
<th>Unit</th>
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<td>VOLUME_STEEL TOTAL</td>
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Fabrication For New Superstructures

- Fabrication of the Con-Struct superstructure began 2 months prior to bridge demolition
- Bridge units were manufactured at ADL Systems in Portland, MI
- In-plant Quality Assurance Testing Done by Consultant

Galvanized Steel Tub Girders

Fabrication of Bridge Unit
Demolition of Existing Bridges

• On Monday Oct 9\textsuperscript{th}, (Nov 6\textsuperscript{th}) Marine City Highway was closed to traffic
• Monday and Tuesday county crew removed existing bridge superstructure

Existing Steel Beams

Existing Substructure to Remain
Repair of Existing Abutments

- Existing abutments were repaired with Transpo T-17 Polymer Concrete patch material
- MDOT heavy riprap was used as scour protection of existing spread footing abutment

Existing Abutments

Riprap for Scour Protection
Install New Superstructure

- On Thursday Oct 12th (Nov 9th) Con-Struct bridge units were delivered
- Bearing pads and expansion joint material were placed on abutment
- Con-Struct superstructure units arrived before 8:00a.m.

Bearing and Joint Filler

Con-Struct Bridge Units
Install New Superstructure

- County excavator was used to install 25’ span units for bridge 4-08 (crane was used for 35’ 4-09)
- All 6 Con-Struct superstructure units were all placed before noon
- Units were cast with integral backwalls
Install New Superstructure

• Transpo T-17 Polymer Concrete was used for the deck joint between units
• T-17 was tested for rebar development length and the joint designed specifically for T-17 material

Forming Deck Joint

Pouring T-17 Polymer Joint Concrete
Finishing Touches

- Over the following 5 days asphalt approaches were paved,
- Guardrail posts were installed........
Finishing Touches

- Slopes were re-graded,
- Existing wing walls were repaired……..
Finishing Touches

- A thin epoxy overlay was placed on the new concrete deck surface for 4-08 bridge.
- The thin epoxy overlay was not done for 4-09 bridge due to weather limitations.

Place Epoxy Compound

Cover with Aggregate and Re-Epoxy
Finishing Touches

• Guardrail was installed
• Slopes were restored
Marine City Hwy over Unnamed Canal (4-08)

- Total Completed Cost = $180,751.46
  - Includes material, labor, overhead, equipment
- Total Completion Time = 10 Working Days
Marine City Hwy over Meldrum Drain (4-09)

- Total Completed Cost = $222,843.83
  - Includes material, labor, overhead, equipment
- Total Completion Time = 10 Working Days
Installation Video
Saving Time with Steel Tub Girders in St. Clair County

In Conclusion:
• 80% Less Expensive Than Reconstruction
• 90% Less Traffic Delays

Past successes are bridges that lead to our next victory.
~ Jeffrey Benjamin
Thank you for your time!

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