SEPTEMBER 6, 2023

Barron County

Steel Press Brake Formed Tub Girder

BARRON COUNTY, WI

COOPER ENGINEERING

valmont STRUCTURES

HIGHWAY STRUCTURES
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Old Structure P-03-0093

3 Span Timber Slab Structure

96.3-FT Total Length

28.5-FT Clear Roadway Width

Load Posted At 20 Tons

Not eligible for replacement using the Wisdot Local Bridge Program

New Structure B-03-0217

Two Span 18-inch Steel PBFTG Structure

4 Girders Per Span, Approximate Weight Of 6,900 Lbs Each

103’-9” Total Length

30-FT Clear Roadway Width

Project Funding

Town of Barron Applied For TRI-S Funding

Received State Funding With a 30% Town Match (Total Cost)

Final Project Cost was $894,629

Why did we choose Steel PBFTGs?

- Following Implementation around Country
- Determined to be a Cost-effective Solution
- Long Life (Galvanized Steel)
- Ease of Construction

How We Contracted

Town of Barron Sent Out RFP's for Design and Construction Engineering

- Selected Cooper Engineering
- Valmont Contracted For Superstructure Design

Construction was Bid

- Larson Construction was Low Bidder

Cooper Engineering Background

Founded in 1950 by Robert G. Cooper, P.E., RLS

Employee Owned (ESOP) since 1997

One Office in Rice Lake, WI Centrally Located in the NW Region

Proven Ability over 40 years Serving WisDOT

Full-service Civil Engineering Firm

- Survey
- Design Engineering
- Environmental/Utility/Stormwater/Lighting
- Construction Engineering (Materials Testing Lab)

29 employees with average experience of 20+ years

- 9 Professional Engineers

Barron County Request for Proposal

Received RFP 8/18/2022 – Due 9/8/2022

Design, Bid, & Construction Inspection for Bridge Replacement (P-03-093)

Funded with LRIP-S (Not a WisDOT project)

Project Schedule:

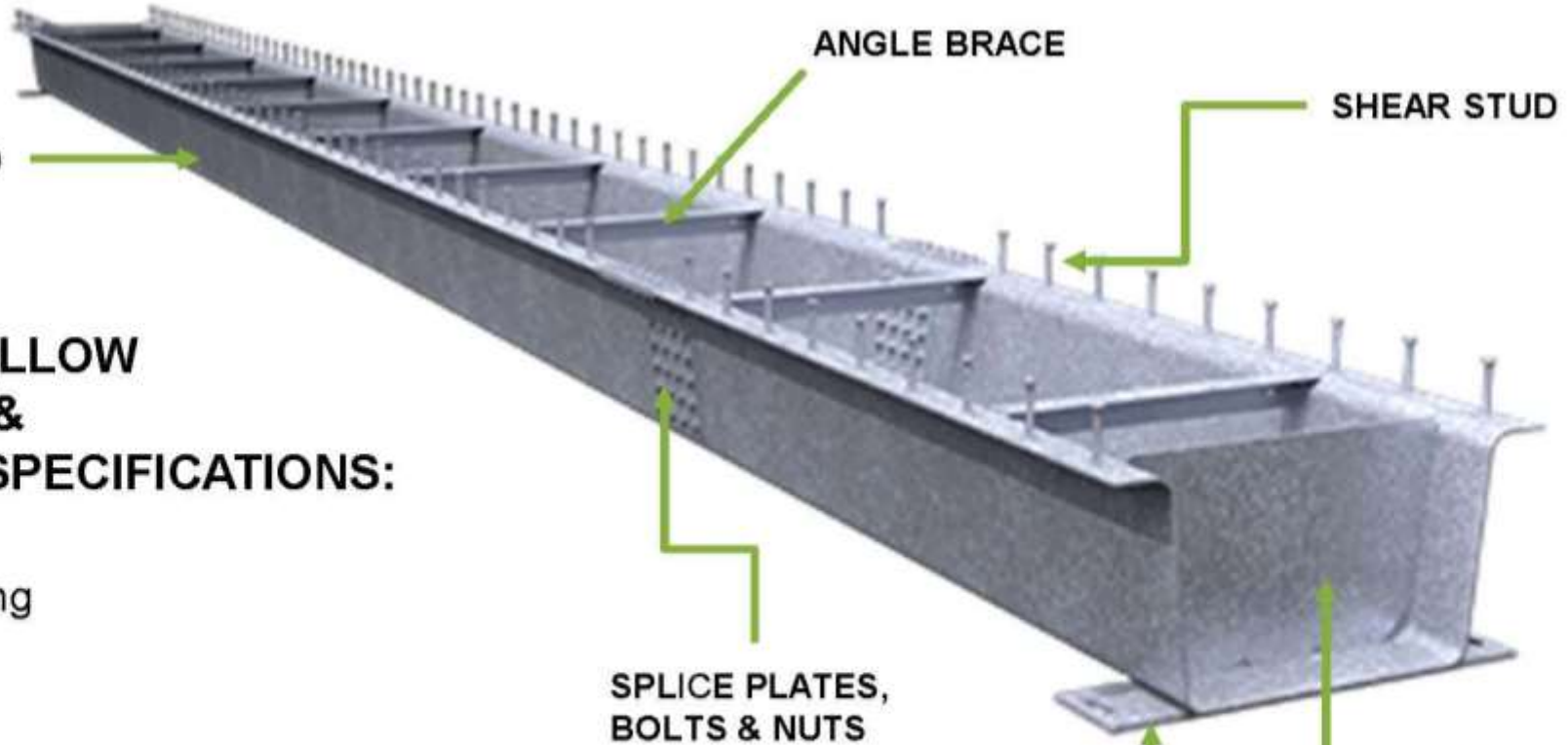
- Project Plans to be completed by January 20th, 2023
- Project Bid on February 16, 2023
- Construction to be completed in 2023

Single stage (road closed) construction with detour plan

The superstructure is intended to be a two-span **Steel Press Brake Formed Tub Girder (PBFTG) (???)**. The superstructure design will be performed by others. Coordination will be required.

Plans, Specification, and Special Provisions per WisDOT

Price ($) Based Proposal



PROCEDURES FOLLOW AASHTO DESIGN & CONSTRUCTION SPECIFICATIONS:

1. Material
2. Press-Brake-Forming
3. Stud Welding
4. Camber
5. Protective Coating
6. Design
7. Shop Drawings
8. Inspection

Components of a Steel PBFTG

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#1 AASHTO STEEL PLATE MATERIAL

AASHTO 11.3.1.2

AASHTO M270. **Made in the USA**. Steel Plates and Structural Shapes shall conform to ASTM A709/A709M.

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#2 AASHTO FORMING

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AASHTO 11.4.3.3 - Bent Plates

Fracture-critical and Non-fracture critical plates and bars shall be cold bent.

#3 AASHTO CAMBERING

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AASHTO 11.4.12.2.7

Cold cambering is a customary means of achieving camber… to avoid impact damage to the steel, it's appropriate to introduce bending pressure in a controlled fashion.

#4 AASHTO WELDING AND SHEAR STUDS

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AASHTO 11.3.3

Certified Welders and welded stud shear connectors shall satisfy all requirements of the AASHTO/AWS D1.5M/D1.5 Bridge Welding Code related to material, manufacturing, physical properties, certification, and welding.

#5 AASHTO PROTECTIVE COATING

AASHTO 11.3.7

Galvanizing shall be in accordance with AASHTO M 111M/M 111 (ASTM A123/A123M)

Overall Project Schedule

9/15/2022 – Cooper Engineering Contract Signed

1/20/2023 – Final Plans Completed

2/1/2023 – Advertised for Bids

2/16/2023 – Project Bid

2/22/2023 – Notice of Award

4/12/2023 – Preconstruction Meeting

4/19/2023 – Construction Begins

5/19/2023 – Steel Tub Girders Delivered

6/22/2023 – Bridge Opens to Traffic

9 Months Total Timeline (Design – Construction)

Project Kickoff

9/15/2022

- Cooper Engineering Contract Signed
- Amy Cronk (WDNR) agreed to perform Wetland Determination
  - Mark Servi already had discussions with WDNR
  - No in-stream prior to May 1, from June 1 to June 30 and after September 15
- Guy Nelson (Valmont) provided U-Beam Design Guidelines
- Requested a WisDOT Bridge Number
- Sent in Diggers Hotline Utility Marking Request
- Signed our subconsultant contract with PSI for Soil Borings
- Had Barron County contract with TRC for Asbestos Survey

Project Design Constraints

WDNR 5-FT Min. Navigation Clearance

- Controlled Roadway/Bridge Profile
- Existing structure depth only 18” so must raise road

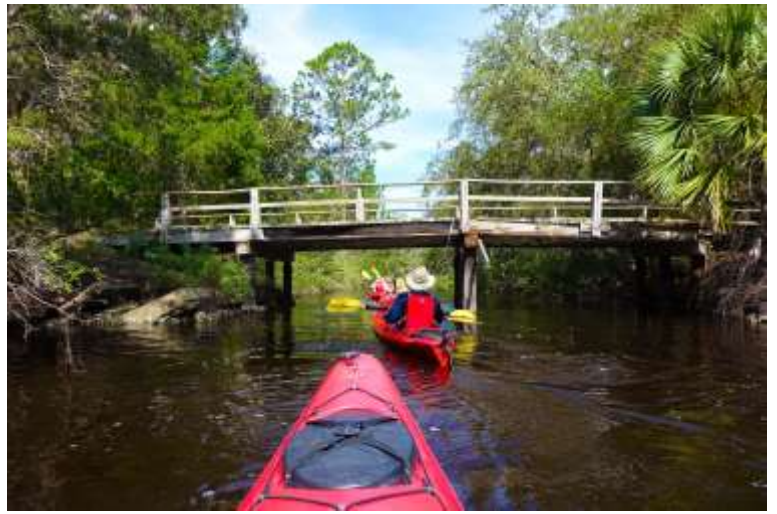
Hydrology & Hydraulics

- Can’t raise HW100 Elevation
- Steel PBFTG doesn’t require any freeboard

Wetland at toe of slope on all four quadrants

Existing 66-FT Wide R/W

- No Time in Schedule to purchase R/W



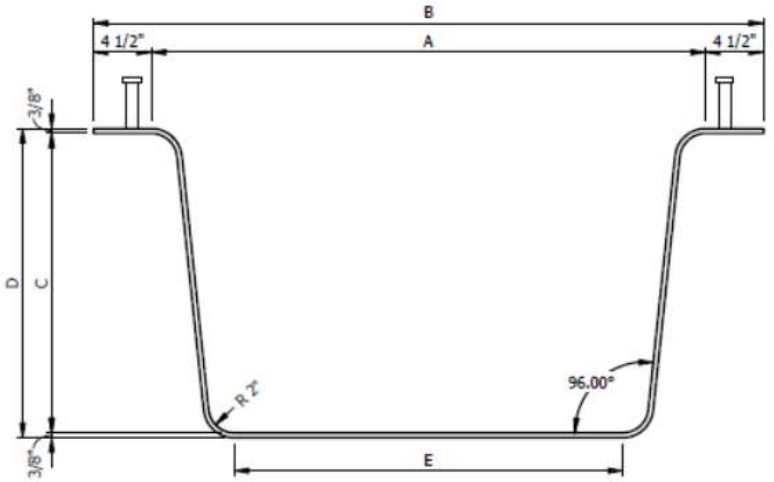
Preliminary Bridge Design

AASHTO Steel U-Beam Design Guidelines

Preliminary Structure: Type, Size, and Location (TSL)

- Steel Press Brake Tub Girder (U18 @ 8’-0”)
- Two Span (RFP said Two Span)
- WisDOT A1 Abutment (Std 12.08) Wings Parallel to Roadway
- WisDOT Pile Bent Pier (Std 13.04) Cofferdam not required
- WisDOT M Railing (Std 30.16) Open Faced b/c Flat Grade

Met with Barron County on 10/24/2023 to approve preliminary design



VALMONT® U-BEAM™ STANDARD CROSS SECTION

U-BEAM™ SELECTION CHART

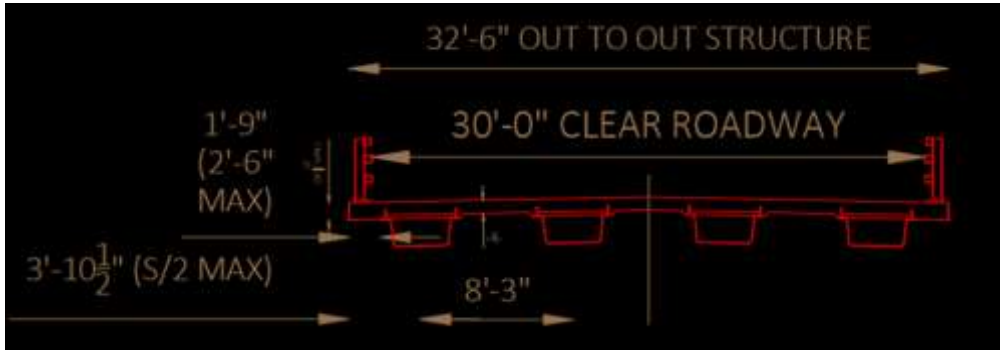
U-BEAM™ SPACING	BRIDGE LENGTH (ft)															
	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4' - 6"	U12	U12	U12	U12	U12	U18	U18	U18	U24	U24	U24	U30	U30	U33	U33	S.D.
5' - 0"	U12	U12	U12	U12	U12	U18	U18	U18	U24	U24	U30	U30	U33	U33	S.D.	S.D.
5' - 6"	U12	U12	U12	U12	U18	U18	U18	U24	U24	U24	U30	U30	U33	U33	S.D.	
6' - 0"	U12	U12	U12	U12	U18	U18	U18	U24	U24	U30	U30	U30	U33	S.D.	S.D.	
6' - 6"	U12	U12	U12	U12	U18	U18	U18	U24	U24	U30	U30	U33	U33	S.D.		
7' - 0"	U12	U12	U12	U12	U18	U18	U24	U24	U24	U30	U30	U33	S.D.	S.D.		
7' - 6"	U12	U12	U12	U12	U18	U18	U24	U24	U30	U30	U33	U33	S.D.			
8' - 0"	U12	U12	U12	U18	U18	U18	U24	U24	U30	U30	U33	S.D.	S.D.			

DESIGNATION	A	B	C	D	E
U12	43"	52"	11 1/4"	12"	32 5/8"
U18	43"	52"	17 1/4"	18"	31 3/8"
U24	43"	52"	23 1/4"	24"	30 1/8"
U30	43"	52"	29 1/4"	30"	28 7/8"
U33	45"	54"	32 1/4"	33"	30 1/4"

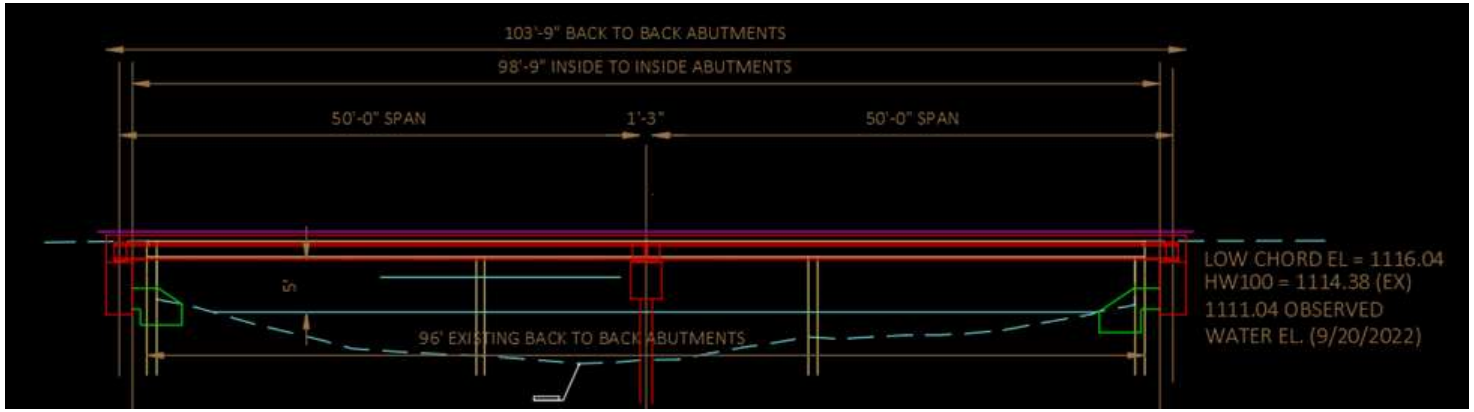
Superstructure Design

Met with Valmont (Guy Nelson) on October 26, 2022

Preliminary Bridge Info Shared



- Two 50-FT spans (103’-9” total structure length)
  - 0% Profile Grade
- Four U18 Steel Tub Girder at 8’-3” o.c.
  - Clear Roadway width = 30’-0”
  - Out-to-out structure Width = 32’-6”
  - 2% Normal Crown
  - Type M Railing
- A1 Fixed Abutments
- Pile Bent Pier

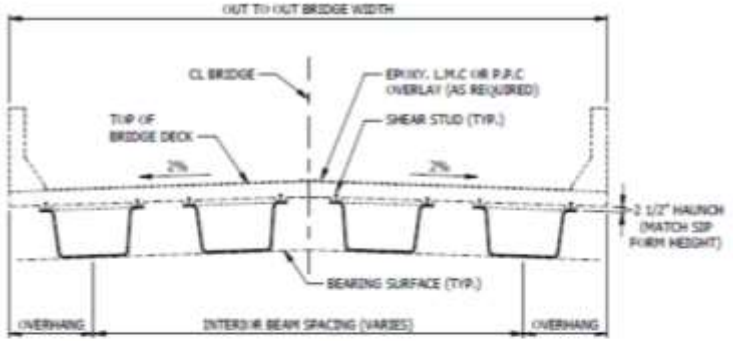


- Use WBM Chapter 17.5 (We provided deck thickness, steel requirements, etc.)

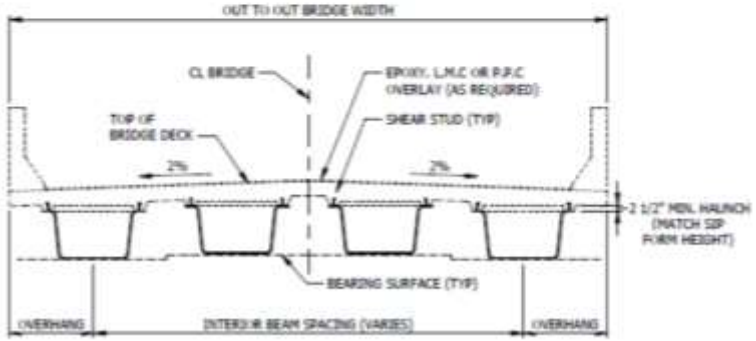
Superstructure Details

Sloped Bearing Surface or Stepped Bearing Surface (S1.07)

- Sloped Bearing Surface
  - More typical for slab bridges or box girders
  - Girders placed at crown angle
  - Consistent haunch height on both sides of girder
  - In future would select this option
- Stepped Bearing Surface
  - Typical for PS Girder or Steel I-Beam bridges
  - Girders are placed level
  - Haunch height varies on each side of girder
  - WisDOT preferred this option to be consistent with other girder bridges
  - Selected for this project



TYPICAL CROSS SECTION



TYPICAL CROSS SECTION (ALTERNATE)

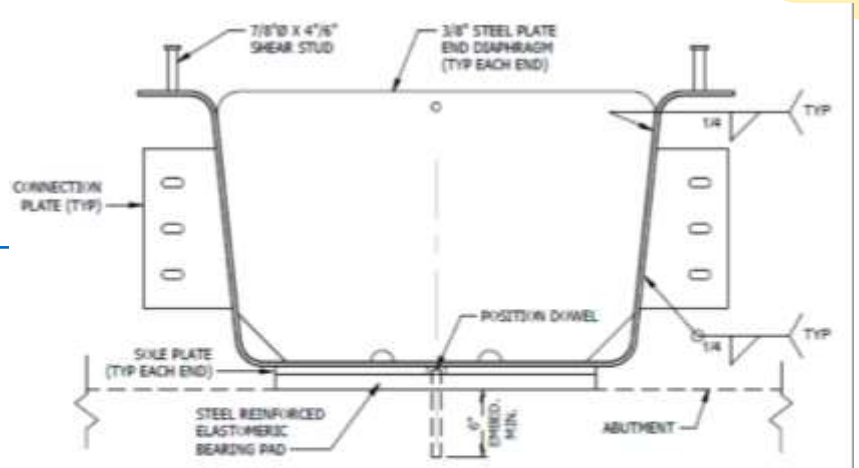
Superstructure Details

Bearing Details (S1.10 & 1.14)

- Position Dowel or Anchor Bolt Details
- All details showed Laminated Elastomeric Bearing Pads (Steel Reinforced)
  - Anchor Bolt: Solid Bearing Pad (No Holes)
  - Fixed Dowel: Single Hole in Middle for Position Dowel
  - Expansion Dowel: Slotted Hole in Middle for Position Dowel

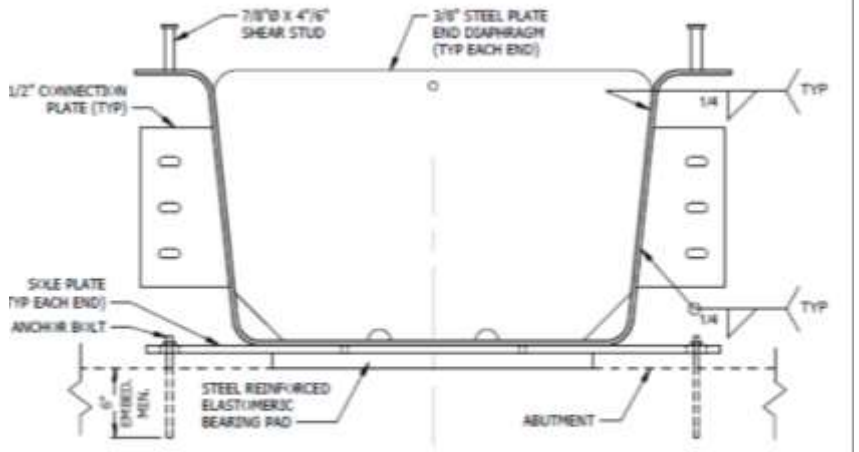
WisDOT Standard Uses Non-Laminated Elastomeric Bearing Pads (Rubber) for Girder Bridges with Fixed Seats

- No Position Dowel or Anchor Bolts were used for this project.
- Non-Laminated Elastomeric Bearing Pad used for this project.



U-BEAM™ END ELEVATION (POSITION DOWEL OPTION)

NOTE: POSITION DOWEL PROVIDED BY OTHERS. U-BEAMS™ SHALL BE SECURED FROM OVERTURNING PRIOR TO ANY CONSTRUCTION, DECK FORMING, OR CONCRETE PLACEMENT OPERATIONS.



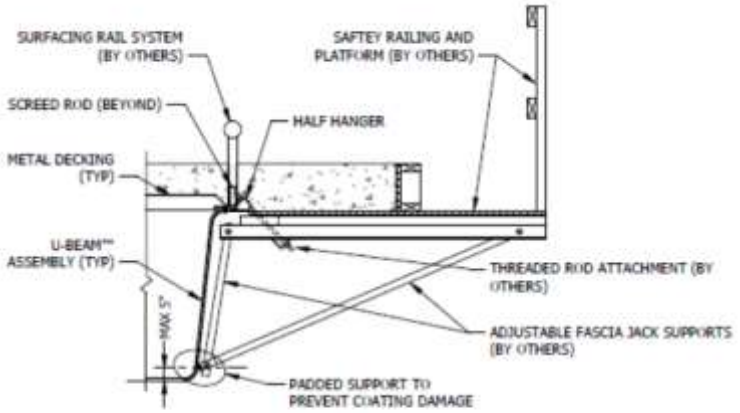
U-BEAM™ END ELEVATION (ANCHOR BOLT OPTION)

NOTE: ANCHOR BOLTS PROVIDED BY OTHERS SHALL BE INSTALLED PRIOR TO ANY CONSTRUCTION DECK FORMING, REBAR PLACEMENT OR CONCRETE PLACEMENT OPERATIONS.

Superstructure Details

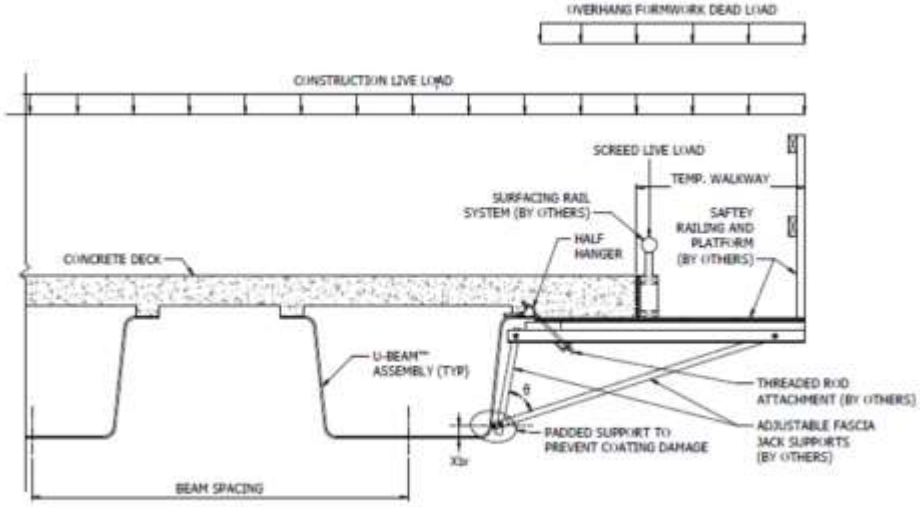
Fascia Support Detail (S1.15)

- Detail showed paving rail at edge of girder flange.
- WisDOT practice is paving rail at edge of deck
- Valmont updated detail
  - Construction loads governed design
  - Outer girders have welded cover plate on bottom



FASCIA SUPPORT

(RECOMMENDED ASSEMBLY - ALTERNATE SYSTEMS AVAILABLE)



FASCIA SUPPORT CONSTRUCTION LOADS DIAGRAM

(RECOMMENDED ASSEMBLY - ALTERNATE SYSTEMS AVAILABLE)

Superstructure Details

Concrete Deck Support Decking

- Valmont details/pictures show stay in place metal deck between girders.
- County preferred removable plywood forms
  - This allows bottom of concrete deck to be inspected during future bridge inspections.
- Stay in place metal decking was still used on top of the PBFTG. (Non-structural element)

Superstructure Design Schedule

10/26/2022 – Superstructure Design Meeting

11/16/2022 – Valmont provided design loading for piling design

12/6/2022 – Valmont provided preliminary plans for review

12/20/2022 – Valmont provided final plans and specifications.

Valmont had TEGcivil complete the superstructure plans

1505 44TH STREET, SUITE A
WYOMING, MI 49509
PH. (616) 261-8830

Project Specifications & Bidding

Local Bid Project (February 16, 2023)

- Bids Accepted in Person or Online (one of the first projects for us)

Used Current WisDOT Spec Book (2023)

Used WisDOT Bid Items

Valmont Provided Two SPVs

- PBFTG Structural Steel, Furn. and Fab. (LB)
- PBFTG Structural Steel, Erect. (LB)

All structural steel shall be hot-dipped galvanized per WisDOT spec 506.2.10

Fabricator to install concrete fascia form hardware during fabrication.

Expect to take 8-10 weeks to fabricate steel tub girders.

Contract Time: Completion Date contract with maximum 12-week road closure

Contractor required to supply bridge removal plan to WDNR (ECIP plan)

We discussed Mandatory Pre-Bid Meeting since unique structure but did have one

- Provided Valmont U-Beam Installation Guide and Sample Shop Drawings in Bid documents instead

Larson Construction Background

- 70 Years in Business
- Specializes in Smaller Bridges over Water
- Over 700 Structures Built

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Contractor Perspective: Pre-Bid Positives

Advanced Notice of Project	Excellent Construction Window	Familiarity in Design	No Additional Investment
• County initiative to educate contractor pool prior to bid	• Cooperative relationship between Barron County, DNR, and other stakeholders • Allowed for a greater construction window for contractor, yielding lower bid price	• Cooper Engineering is well known in local community, robust design group • Designer used WisDOT standards, designs familiar to contractor community where applicable	• This bridge did not require any investment of additional tools or materials other than what we normally use

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Contractor Perspective: Pre-Bid Concerns

Plan calls for pre-poured diaphragms	• Will girders move during pour?
How to install stable falsework on the superstructure?	• Exterior brackets? • Interior Joists?
Dead load deflection is higher than normal	• What if their engineering isn't accurate?
Potential concrete leaks into the girders	• how to prevent?
Fear of the unknown	• What are they not telling me?

Contractor Perspective: Bidding

All Pre-bid concerns were reduced prior to bid (even the last one)!

Contractor planning

Discussed potential ‘fails’ with bridge foremen

Consultation with Valmont support team

Valmont included a site visit during installation

On-line educational information from Valmont

RFIs with Cooper design team

Jacob was available to answer questions throughout the bidding process

Bid Results

Plan Holders List – 7 Prime Contractors (all local contractors)

Contractor	Bid Price
Larson Construction	$815,878.38
Sheet Piling Services	$851,797.35
Lunda Construction	$870,171.82
Zenith Tech	$966,160.40

Bid Results Comparison

Unit Price PBFTB Fabrication & Erection → $3.65 – $4.34/LB

Deck Area = 3,372 SF → Price/SF = $242/SF

- Note: $/SF (proposed bridge deck area) includes roadway work.

WisDOT Current Price Trends (Prices from 2/14/23 letting unless noted otherwise)

- Concrete PS Girder: $247/SF (B-11-0175)
- Two Span Concrete Haunch Slab: $286/SF (B-54-0140) (3/14/23) (High??, expect closer to $220/SF?)
- Concrete PS Box Girder: $411/SF (B-18-0242)
- Two Span Concrete Slab Bridge: $297/SF (B-10-0401) or $246/SF (B-39-13) (3/14/23)

- Larson Construction thoughts on how $/FT compares with other bridge types.

Contractor Perspective: Pre-Construction

Upon winning the bid, Larson immediately formalized our construction plan and ordered materials and drew up specific plans to address each pre-bid concern:

Will girders move during diaphragm pours?

Girders can be weighted simply by laying a bundle of decking materials transverse to the beams

How to install stable exterior overhang brackets on the superstructure (sloped beam faces could create instability)?

- Tight spacing, wood backers on overhang brackets

How can we keep our joist hangers from rotating during placement?

- Walers bolted to the beam tops, behind joist hangers

Potential concrete leaks into the girders

- caulk as needed?

What if Engineered Dead load calculations are incorrect and Fear of the Unknown?

- Allayed by past project track record, conversations with Valmont team

Construction Timeline

Work Item	Date
Start Construction	April 19, 2023
Start in-stream Pier Work	May 2, 2023
Steel PBFTG Delivered	May 15, 2023
Concrete Deck Pour	May 30, 2023
Road Opened	June 22, 2023

Project completed in 10 weeks

- < 12 Weeks Contract Provided
- 1 Week ahead of original Larson Schedule

Construction Pictures – Steel PBFTG

Construction Pictures – Steel PBFTG

Construction Pictures - Diaphragms

Construction Pictures – Steel PBFTG

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Construction Pictures – Deck Forms

Construction Pictures – Steel PBFTG

Construction Pictures – Deck Forms

Construction Pictures – Deck Pour

Abutment Gap Repair

Pier Crack Repair

Construction Pictures – Finished

Lessons Learned - Design

- Require Tub Girders to be bolted down
- Require abutment/pier diaphragms to be poured with the deck.
  - Eliminate Issues with abutment gap & pier cracking
  - Would using laminated bearing pads also help with this??
- Place tub girders on slope abutment so haunch is consistent on both sides of the girder.
- Use overhang = 25 – 33% of girder spacing (per Michael Barker)
  - We used S/2 (i.e. 50%)
    - eSPAN 140 wouldn't suggest this girder type initially for this bridge because of this
  - Construction loads (paving machine) controlled for this project
- Have primary bridge designer do superstructure sheets

Contractor Perspective: Post Construction

Construction Lessons Learned:

- Sloped beam seats
- Drill holes in flanges for anchors
- Don’t pour diaphragms in advance
- The camber DOES come out of the beams!
- Early involvement with contracting community, DNR were critical to success
- Strong Valmont support helped the process

WisDOT Perspective

- WisDOT currently does have guidance for Steel PBFTG.
- Per WisDOT Design Section Chief (Aaron Bonk) they will be allowed on a “case by case” basis.
- Michigan DOT has sample SPV that could be used.
  - SPV requires design, load rate, manufacture, and install.
  - Similar to WisDOT Timber Bridge SPV
- WisDOT has had internal discussions so stay tuned.

Where to use in the future?

Most Logical:

- Where structure height is a controlling factor.
- Low clearances and/or high cost to raise road profile.
- Doesn't require freeboard → Don't need to raise road profile as much
- Accelerated Bridge Construction (ABC)

Today: Wherever PS Box girders/beams were going to be used.

- 50-60 FT Spans where clearance is a concern.

In the Future?: Alt. to PS Girders

- Comparable Cost
- Shallower Structure Depth

SSSBA: Alt. to Concrete Slab Bridges

- Girder bridges are generally cheaper $/FT
- HW100 is below the expected low chord (Special detail if not)
- Gives more options for future rehab (Deck Replacement or concrete overlay)

Question & Answer

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