Steel Press-Brake-Formed Tub Girder Webinar

AASHTO
Innovation Initiative

Zoom Meeting Platform User Information

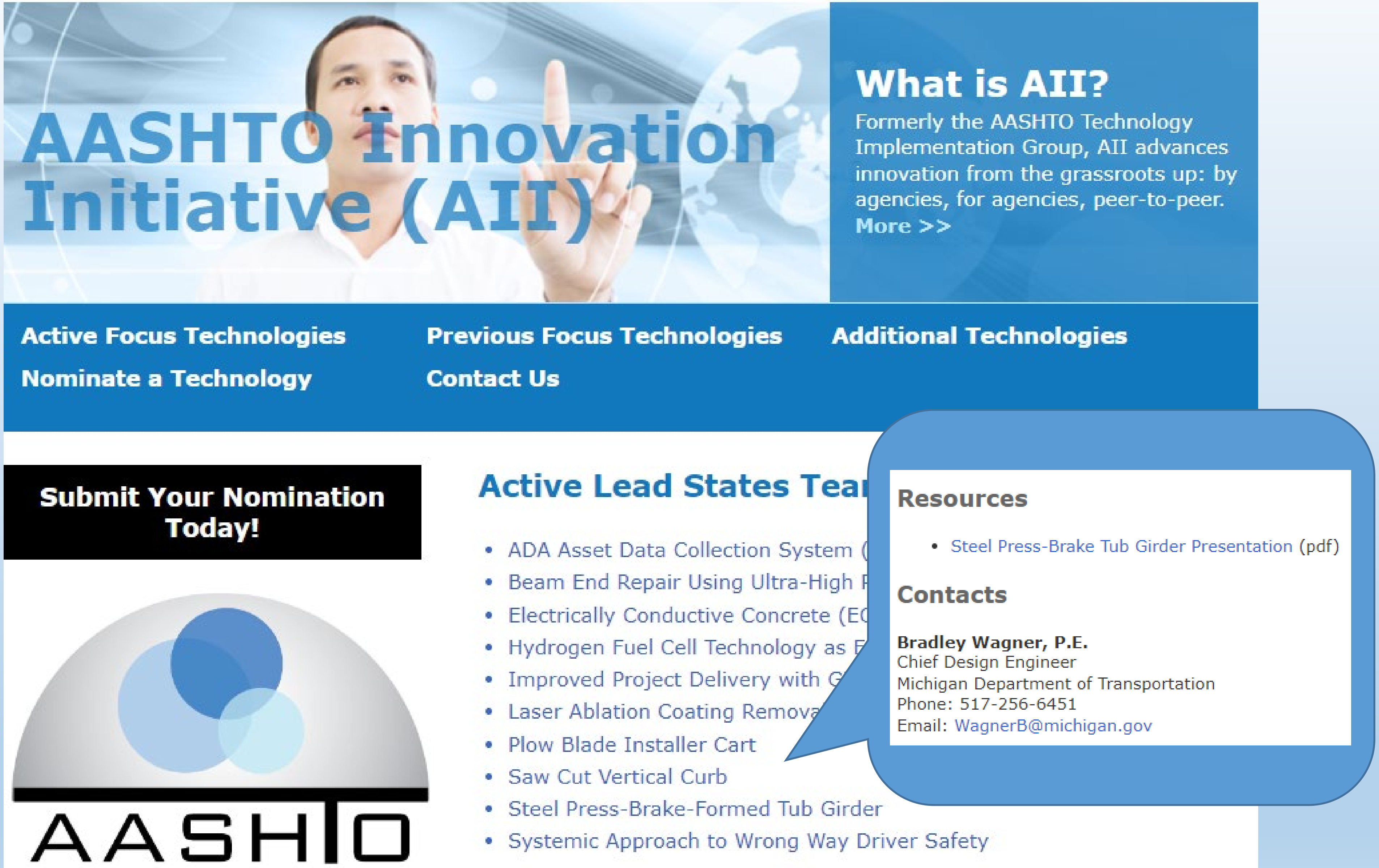
- Participants are currently muted.
- A Question and Answer Session will follow presentations.
- Use Zoom Q & A button to ask questions at any time during the presentations.
- The webinar is being recorded and will be shared on the AII website at aii.transportation.org.

AASHTO
Innovation Initiative

Agenda

1. Overview of AII Program
2. Speaker Introductions
3. Steel Press-Brake-Formed Tub Girder Overview
4. Michigan Department of Transportation Experience
5. Pennsylvania Department of Transportation Experience
6. Missouri Department of Transportation Experience
7. Question and Answer Session with Panel

- Established in 1999 and operating since 2000
- Facilitate the implementation of **high-payoff**, **ready-to-use**, **innovative technologies**
- **100+ innovations**



aii.transportation.org

Expert Panel

Suri Sadasivam
Steel Press-Brake-Formed Tub Girder Facilitator

MDOT
Michigan Department of Transportation

MoDOT

pennsylvania
DEPARTMENT OF TRANSPORTATION

valmont
STRUCTURES

benesch

Guy Nelson

Bradley Wagner

Ihab Darwish

Guozhou Li

Timothy Leaf

Participant Poll

Steel Press-Brake-Formed Tub Girder Overview

Guy Nelson

Short Span Steel Bridges

Press-Brake-Formed Tub Girder (PBFTG) Research Reports

- Non-Proprietary, Developed by the Steel Bridge Industry (AISI/AISC)
- 10 Years of Development and Experimental Testing of Press Brake Formed Tub Girders
- Published a 7 Volume Research Report
- https://www.shortspansteelbridges.org/testing-of-press-brake-tub-girders/

SHORT SPAN STEEL BRIDGE ALLIANCE™

Education
Webinars
Workshops
Conferences

Technical Resources
Standards
Guidelines
Best Practices

Case Studies
Economics: Steel is Cost-Effective
Innovative & ABC Design

Uses Established Technology

Fabrication Follows AASHTO LRFD Bridge Construction Specifications

Section 11.4.3.3 Steel Structures: Bent Plates

- Fracture-critical and nonfracture-critical plates shall be cold bent
- The minimum bend radii for cold bending shall be 5.0 time the thickness of the plate
- For all grades and thicknesses of steel confirming to AASHTO M270

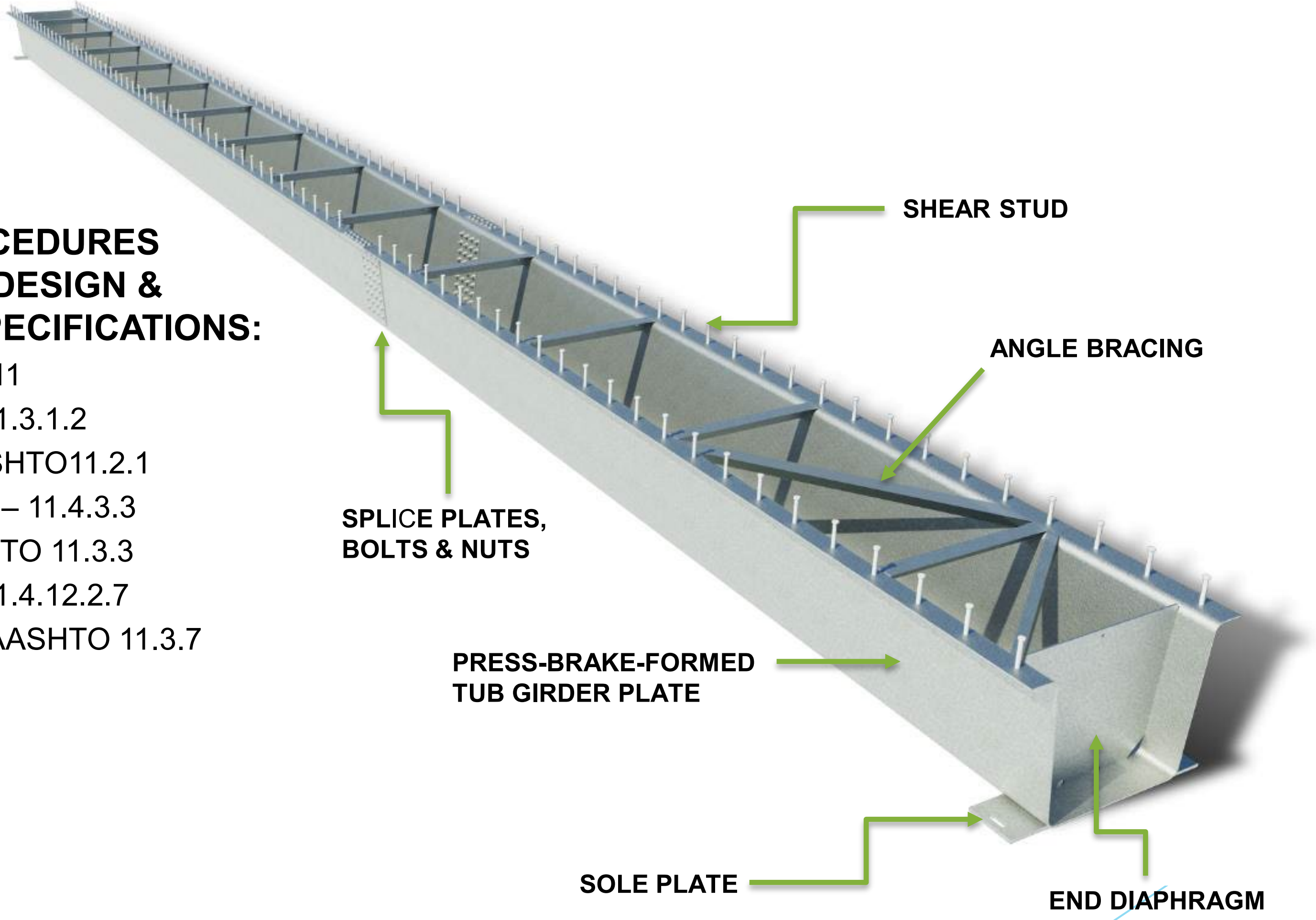
Press-Brake-Formed Tub Girder Description

<u>Iowa State University Definition:</u>

A single steel plate of the desired thickness that is strategically bent into a structural shape. The plate is cold formed into a "U" shape with a press-brake, with each bend occurring along the plate's longitudinal axis.

FABRICATION PROCEDURES FOLLOW AASHTO DESIGN & CONSTRUCTION SPECIFICATIONS:

1. Design – AASHTO 6.11
2. Material – AASHTO 11.3.1.2
3. Shop Drawings – AASHTO11.2.1
4. Press-Brake-Forming – 11.4.3.3
5. Stud Welding – AASHTO 11.3.3
6. Camber – AASHTO 11.4.12.2.7
7. Protective Coating – AASHTO 11.3.7
8. Inspection - NBIS



Press-Brake-Formed Tub Girder Inspection

- No fatigue critical details in tension zones.
- NBIS inspection requirements limited to section loss due to corrosion.
- Visual observation of the interior elements through openings at each end.
- Base metal thickness and coating thickness can both be measured from the outside with an electromagnetic gauge per ASTM E376.

Advantages

- Up to 100 Year Service Life with Galvanized Coating (Other Coatings Available)
- AASHTO LRFD Design - Steel Box Section per AASHTO Section 6.11
    - Additional Analysis Required for LLDF, SSSBA Developing Equations for AASHTO
- Fabrication Process Meets Current AASHTO Specifications for Construction
- Simple Fabrication with Standardized Details
- Easy, Fast, Safe Installations
- Accelerated Bridge Construction (ABC) Options with PBU’s
- Cost Savings by Reuse of Existing Substructure

Suitable Projects

- Any Conventional Beam or Girder Bridge Application
- Up to 100’ Long Spans - Accommodates State Specific Loading Requirements
- Multiple Span Bridges with Continuous Bridge Decks

BARRON COUNTY, WI – 2 52’ SPANS
WDOT LOADING – HL-93

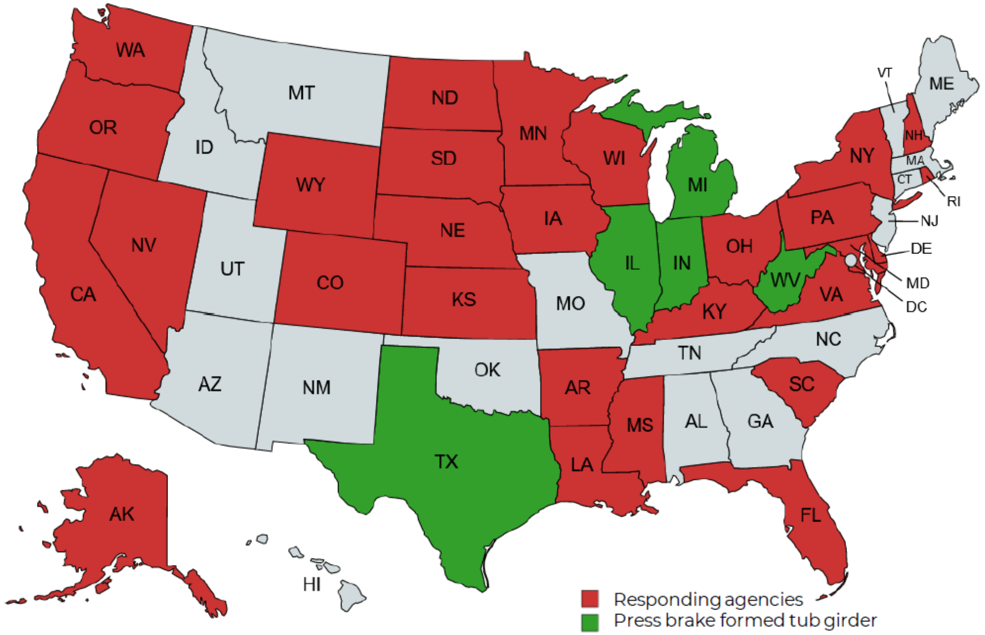
GRAND TRAVERSE COUNTY, MI – 2 55’ SPANS
MDOT LOADING – HL-93(MOD)

IMPERIAL COUNTY, CA – 88’ SPAN
CALTRANS LOADING WITH P-15 PERMIT TRUCK

MERCER COUNTY, PA – 40’ SPAN – 20^{O} SKEW
PennDOT LOADING - PHL-93

State of Practice

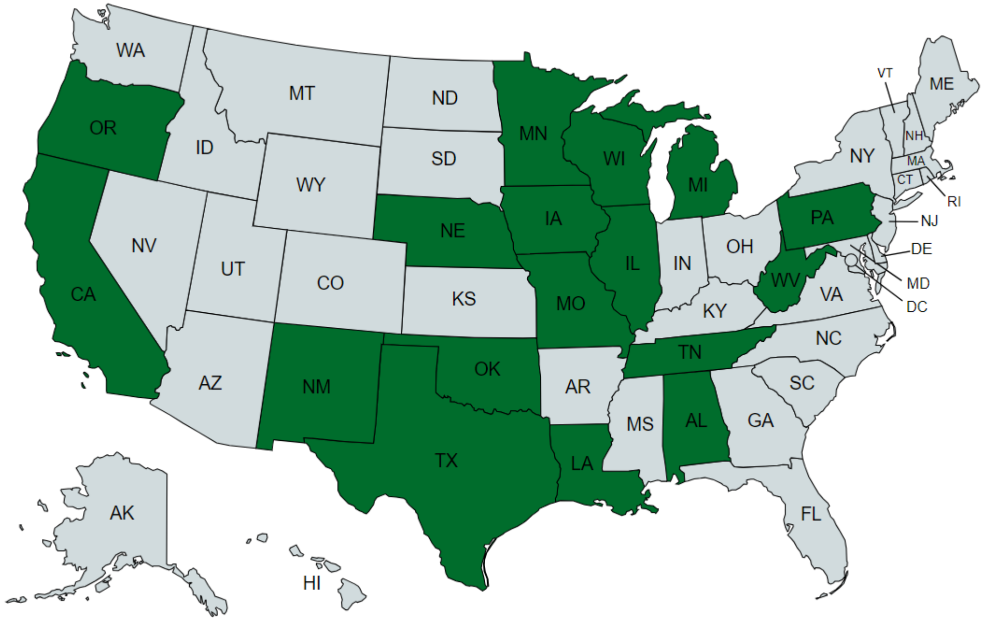
Steel Press Brake Formed Tub Girder Survey Results



- What guidelines and supporting resources do you use for PBFTG?
  - AASHTO LRFD Bridge Design Specifications (39%)
- What specifications do you use for the fabrication and installation of PBFTG?
  - State DOT bridge construction manuals/guidelines (27%)
- What benefits has your agency noted with using PBFTG?
  - Expedites construction (12%)
- What challenges has your agency noted with using PBFTG?
  - Lack of awareness (33%)

Who have implemented this technology?

PBFTG Project	Year	Owner/Agency	State	# of Bridges
Helmlock Private Property, MI	2004	Hemlock Private Property	MI	1
Swan Valley Golf Course, MI	2005	Swan Valley Golf Course	MI	1
Suder Rd., MI	2005	Monroe County Road Commision, MI	MI	1
Tyler Creek Golf Course, MI	2006	Tyler Creek Golf Course	MI	1
Genoa Red Bluff Middle School, TX	2007	Pasadena, Intermediate School Distric	TX	1
Lochridge Road over East and West Canal, MI	2007	Bloomfield Township, MI	MI	2
Shelby County Buck Creek Greenway Pedestrian Bridge	2008	Alabaster, Shelby County	AL	1
Brainerd International Raceway, MN	2008	Brainerd International Raceway	MN	1
Granite Ridge Ranch, TX	2008	Grimes County Road Commision, TX	TX	1
Buffalo Springs Drive, TX	2008	Montgomery County, TX	TX	1
Colfax, Canada	2009	Saskatchewan Ministry of Highways	CAN	1
Addicks Bridge, TX	2010	Center Point Energy	TX	1
Channel Road Bridge, TX	2011	City of Austin, TX	TX	1
US31BR over Pedestrian Trail, MI	2011	Michigan Department of Transporation	MI	1
FM331 Outfall Channel, TX	2011	Center Point Energy	TX	1
Brunner Ditch, Brazoria, TX	2011	Center Point Energy	TX	1
G.C.W.A. Canal, Brazoria, TX	2011	Center Point Energy	TX	1
Spring Gully Bridge, Harris County, TX	2013	Center Point Energy	TX	2
Rustic Road, Columbia, MO	2014	Boone County Road Commision, MO	MO	1
Saw Mill Road, Buchannan, IA	2017	Buchannan county Road Commission	IA	1
Ira Lee Road over Salado Creek, TX	2017	County of Bexar Public Works,TX	TX	1
Marine City Highway Over Unnamed Canal, MI	2017	St Clair County Road Commission, MI	MI	1
Marine City Highway Over Meldrum Drain, MI	2017	St Clair County Road Commission, MI	MI	1
PDX080 Drainage Ditch, Amazon Distribution, OR	2018	City of Pendleton, OR	OR	1
Anchor Bay Drive, St. Clair, MI	2018	Michigan Department of Transporation	MI	1
Orr Road over Weeks Drain, MI	2018	Midland County Road Commission, MI	MI	1
Grey Road over Bullock Creek, MI	2018	Midland County Road Commission, MI	MI	1
Petersburg Road over Swamp Raisin Creek	2019	Monroe County Road Commission, MI	MI	1
Petersburgroad over Macon Drain	2019	Monroe County Road Commission, MI	MI	1
Starville Road over Beaubien Creek	2019	St Clair County Road Commission, MI	MI	1
Otter Creek Township Road 614	2019	Mercer County Bridge Department	PA	1
Eaton County Road Commission	2020	Michigan DOT	MI	1
Ashley Capital Canton	2020	Ashley Capital, LLC	MI	1
Champaign County	2021	County of Champaign	IL	1
Peoria County Evans Mill Road	2021	Peoria County Road Commission	IL	1
Brookshire Golf Club	2021	Brookshire Golf Course	IN	1
USFS Claiborne Parish- Lakey/Caney 902 Bridge	2021	U.S. Forect Service	LA	1
Grand Traverse County River Road 3060	2021	Michigan DOT	MI	1
Grand Traverse County River Road 3061	2021	Michigan DOT	MI	1
Monroe County Cone Road	2021	Michigan DOT	MI	1
Village of Sparta Union Street over Nash Creek	2021	Village of Sparta	MI	1
Clare County Mostetlar Road	2021	Clare County Road Commission	MI	1
USACE Fort Wingate	2021	US Army Corps of Eng.	NM	1
Dogwood Road over Main Canal, Imperial County	2022	Imperial County Public Works	CA	1
MDOT Bridge Bundle	2022	Michigan DOT	MI	19
HUSBAND STREET OVER BOOMER CREEK- STILLWATER OK	2022	City of Stillwater	OK	1
TDOT SR339 JONES COVER ROAD OVER WILHITE CREEK- SEVIER COUNTY-	2022	Tennessee DOT	TN	1
CONROE OVER MARTIN CREEK EAST	2022	City of Conroe	TX	1
CONROE OVER MARTIN CREEK WEST	2022	City of Conroe	TX	1
CLARK ROAD OVER CENTRAL CANAL- IMPERIAL COUNTY- CA	2023	Imperial County Public Works	CA	1
COUNTY BRIDGE W-50 - LINCOLN - NE LANCASTER COUNTY	2023	Lancaster county, NE	NE	1
ALLEN ROAD OVER BLAKELY DRAIN- WAYNE COUNTY MI	2023	Wayne County Road commission	MI	1
TANCO MINE- MANITOBA- CANADA	2023	Tanco Mine	CAN	1
Mercer County - 2611 ,1317, 3113	2023	Mercer County Bridge Department	PA	3
MASON COUNTY FISHER ROAD OVER LINCOLN RIVER- MI	2023	Michigan DOT	MI	1
TOTAL YEARS OF INSTALLATIONS	**19**	**TOTAL # INSTALLATIONS**		**77**



77 TOTAL INSTALLATIONS OVER 20 YEARS

NOTABLE OWNERS: US FOREST SERVICE, US ARMY CORPS OF ENGINEERS, SASKATCHEWAN MINISTRY OF HIGHWAYS

Available Resources

- Specifications: Example Special Provision (MDOT Example Below)
- Research: Short Span Steel Bridge Alliance (SSSBA) Research Reports
- Design: AASHTO Section 6.11 Box Section Flexural Members
- Fabrication: AASHTO LRFD Bridge Fabrication Specifications
- Coming Soon….NSBA PBFTG Design Manual

MDOT SPECIAL PROVISION

MICHIGAN DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
STEEL PRESS-BRAKE-FORMED TUB GIRDER (PBFTG)

SGI:DPZ 1 OF 4 5/27/22

a. Description. Design, load rate, manufacture, and install steel press-brake-formed tub girders (PBFTG) in accordance with the plans, the Michigan Department of Transportation (MDOT) 2020 Standard Specifications for Construction, and as contained herein.

The PBFTG shall include bearing pads, sole plates, shear developers, & hardware as shown on the plans and as required.

b. Design. Certify that the design of the PBFTG is in accordance with AASHTO LRFD Bridge Design Specifications. The design live loading shall be MDOT's HL-93 Mod loading and must be indicated on the plans. The load rating shall pass for all Michigan legal loads and Unrestricted Class A for Overloads. As part of the certification, include the horizontal and vertical reactions at the bearing locations and design calculations. The design must be sealed by a Professional Engineer (PE) licensed in the State of Michigan, and checked and sealed by a PE.

The department reserves the right to reject any beam that fails to meet visual inspection for straightness, twists, bends, etc. The Contractor/Manufacturer will bear all costs to provide a beam that passes all inspections.

i. **Transportation, Handling, Erection, and Construction.** Construct PBFTG in accordance with the MDOT 2020 Standard Specifications for Construction, as shown on plans, and as specified herein.

The Contractor is responsible for proper handling, lifting, storing, transporting and erection of all PBFTG so that they may be placed without damage.

j. **Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item	Pay Unit
Structural Steel, Furn and Fab, Special (Structure Number) ………..............	LSUM
Structural Steel, Erect, Special (Structure Number).......................................	LSUM

Structural Steel, Fun and Fab, Special and Structural Steel, Erect, Special shall include bearing pads, sole plates, shear developers, bolts, washers, welding, welding materials, and hardware as required.

The Contractor is responsible for ordering and obtaining position dowels in accordance with the details in the plans. Position dowels and installation are included in this pay item.

https://www.shortspansteelbridges.org/testing-of-press-brake-tub-girders/

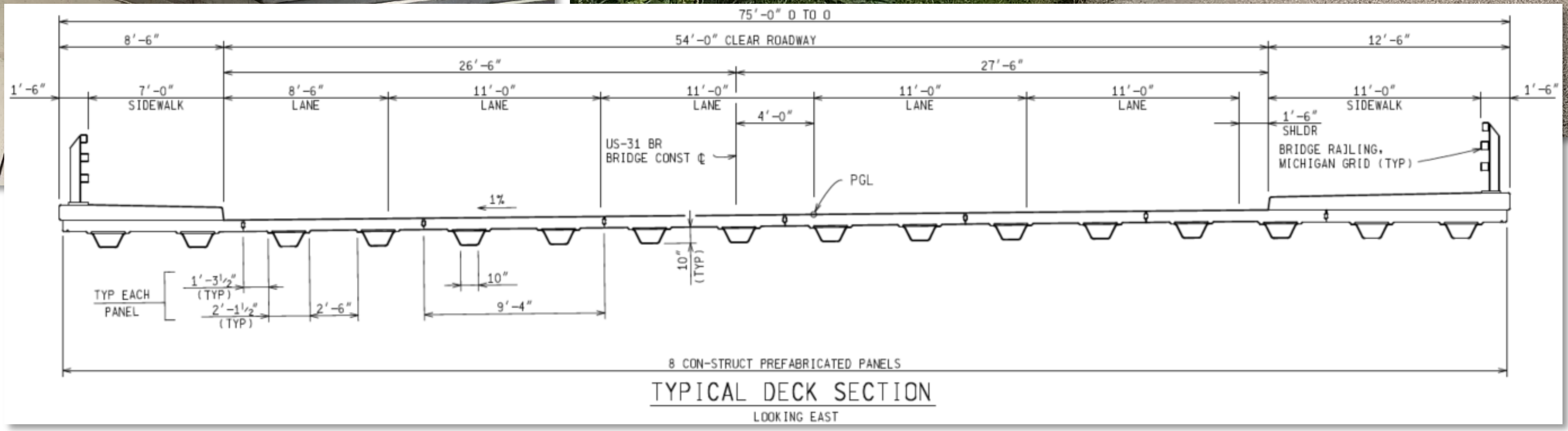
Michigan DOT’s Experience

Bradley Wagner and Ihab Darwish

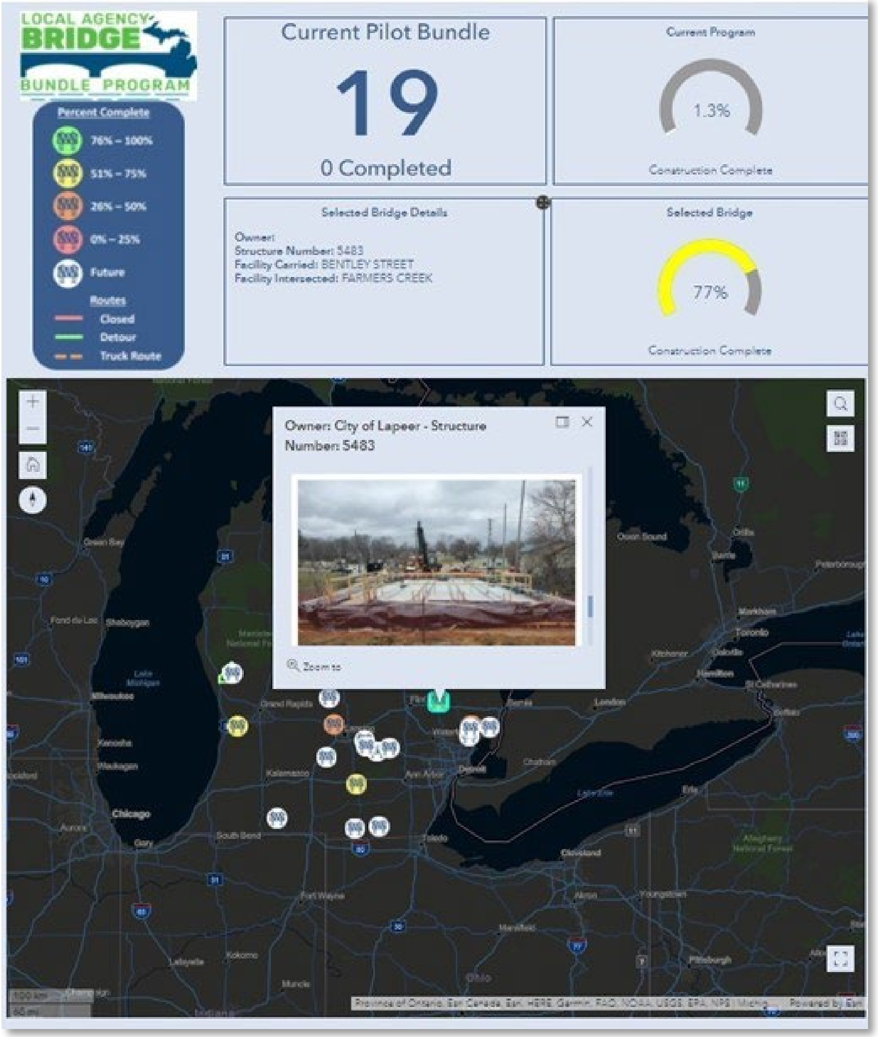
Steel Press-Brake-Formed Tub Girder

- **Michigan's Experience**
- Bradley Wagner, Deputy Chief Bridge Engineer, Michigan DOT
- Ihab Darwish, PhD, PE, SE, Benesch

Whitehall Bridge (2011)

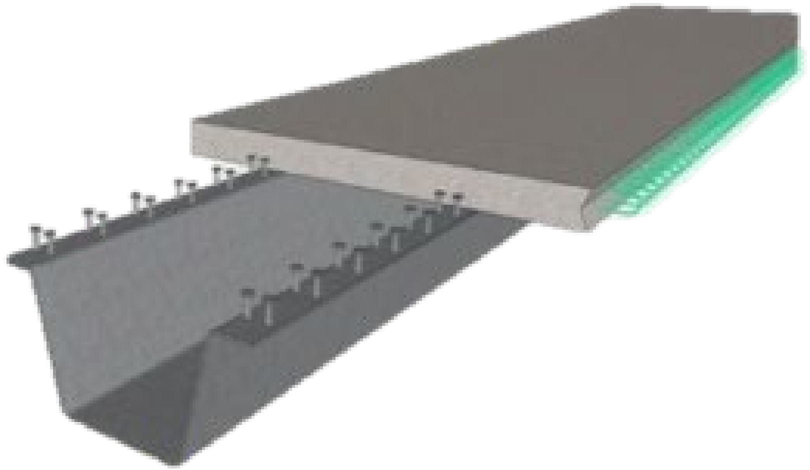


Michigan's Local Agency Bridge Bundling Program



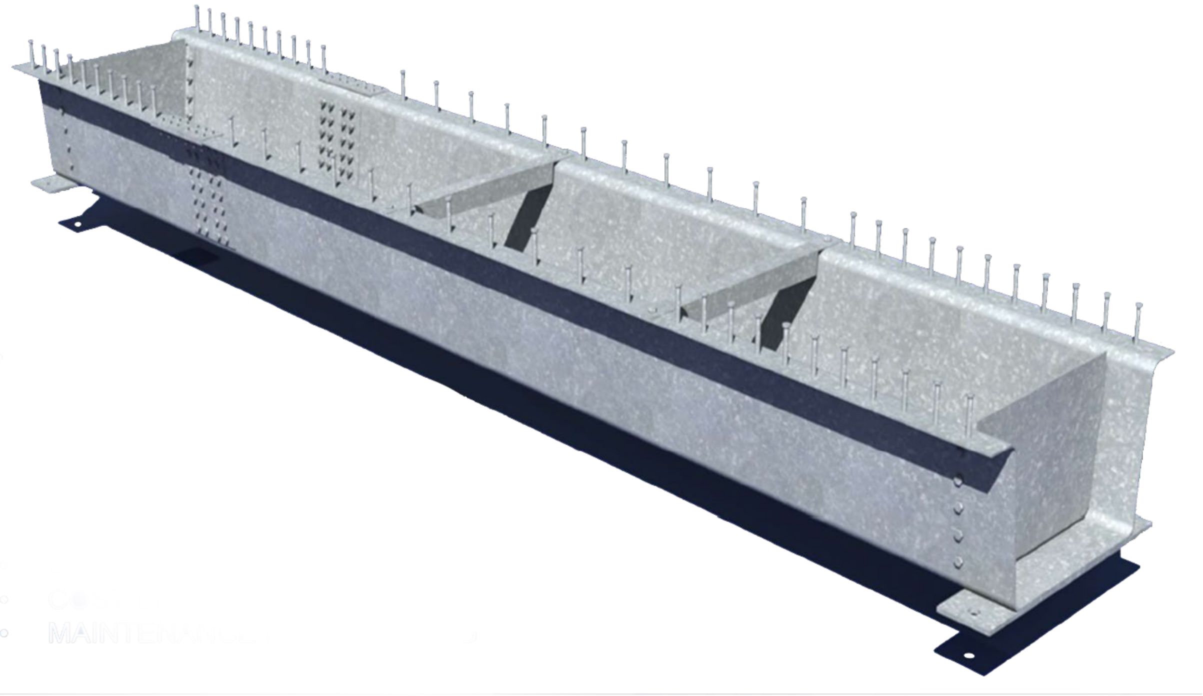
Press Brake Steel Tub Girder

- Press-brake-formed tub girder is a recently developed technology for short span bridge applications.
- Developed by organizations led by SSSBA in response to FHWA challenge to develop cost-effective, short span steel bridge with modular components.
- Could be placed into mainstream and meet needs of today's bridge owners, including Accelerated Bridge Construction (ABC).



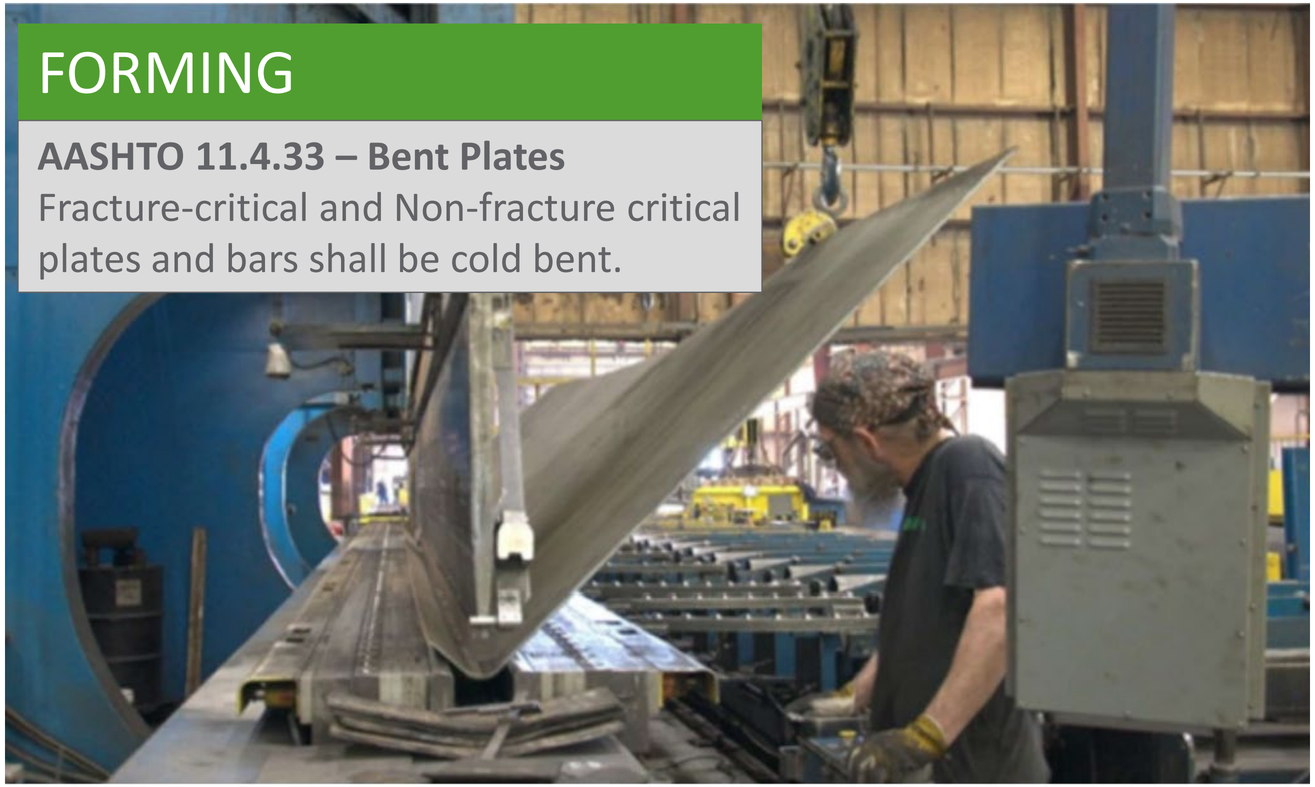
What is a Press Brake Steel Tub Girder

A single steel plate of the desired thickness that is strategically bent into a structural shape. The plate is cold formed into a U shape with a press brake, with each bend occurring along the plate's longitudinal axis.



- Simple
- Cost Effective
- Maintenance Free Coating

Press Brake Steel Tub Girder



FORMING

AASHTO 11.4.33 – Bent Plates
Fracture-critical and Non-fracture critical plates and bars shall be cold bent.

Press Brake Steel Tub Girder

SHEAR STUDS

AASHTO 11.3.3

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.

Press Brake Steel Tub Girder

GALVANIZING

AASHTO 11.3.7

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

Press Brake Steel Tub Girder

What are the concrete driving surface options?

- Cast in-place
- Precast deck field assembled (FA)
- Precast deck pre-assembled (ABC)

Press Brake Steel Tub Girder

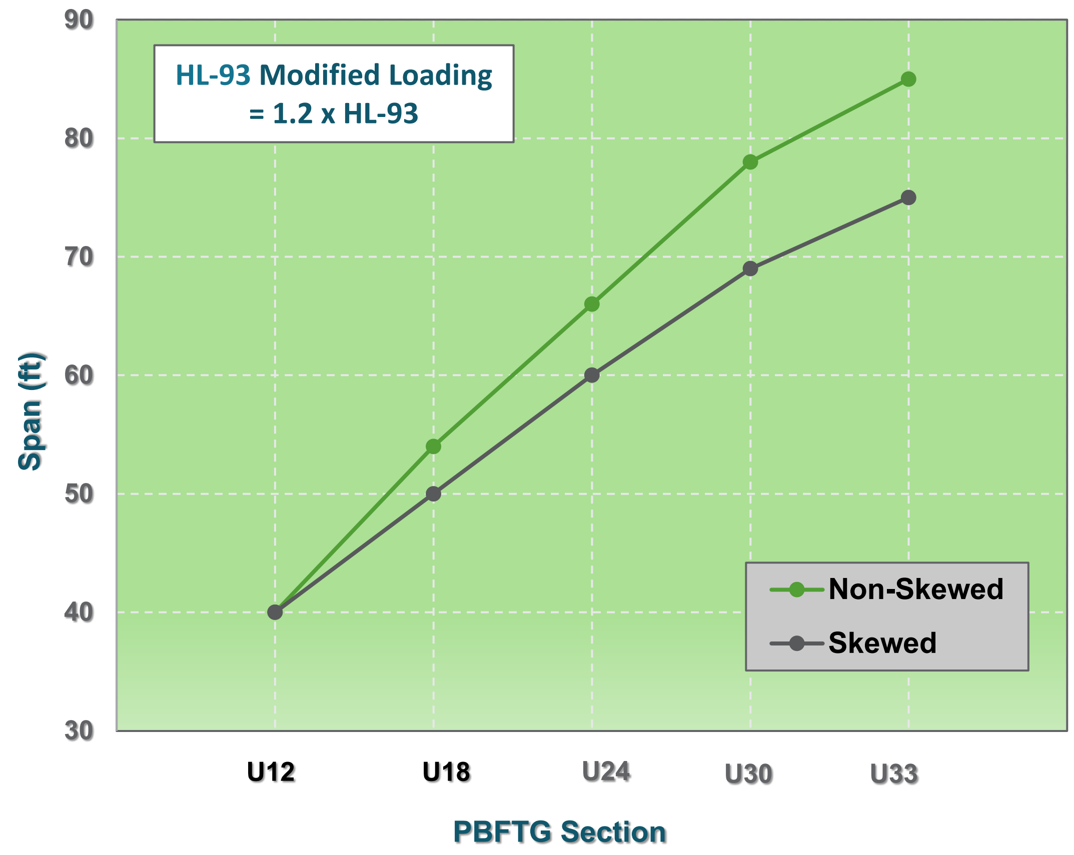
- Works for spans 20’ to 85’
- Can accommodate up to 8” camber using cold bending
- Can be produced in Grade 36, 50 or 70
- Longest section without splicing is 58’

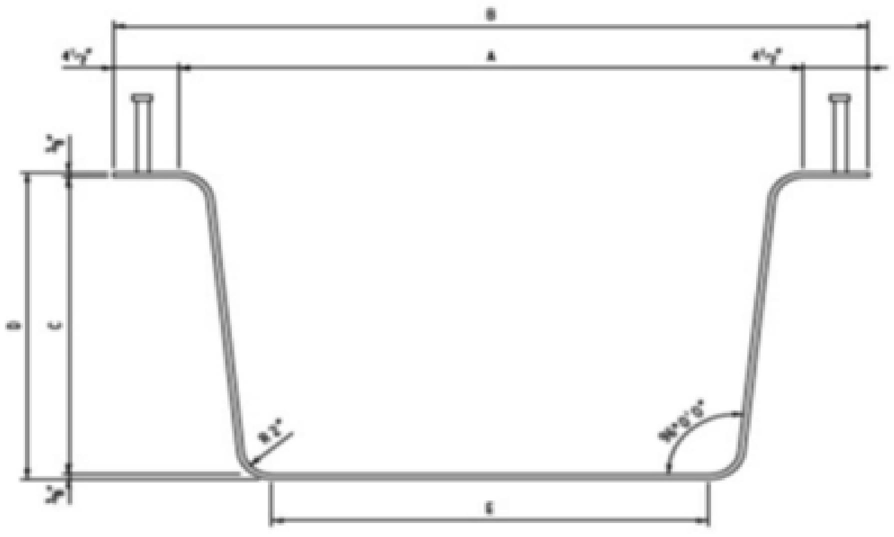
MATERIAL

AASHTO 11.3.1.2

Plates and Structural Shapes Steel plates shall conform to ASTM A709/A709M

Press Brake Steel Tub Girder





AASHTO PBFTG STANDARD TUB GIRDER CROSS SECTION

Section	A	B	C	D	E	bt
U12x89	43	52	11.25	12	32.625	4.5
U18x104	43	52	17.25	18	31.375	4.5
U18x113	43	52	17.25	18	34.94	4.5
U24x117	43	52	23.25	24	30.125	4.5
U24x123	43	52	23.25	24	31.44	4.5
U30x131	43	52	29.25	30	28.875	4.5
U33x141	45	54	32.25	33	30.25	4.5

AASHTO Requirements/Limitations

6.11.2.3—Special Restrictions on Use of Live Load Distribution Factor for Multiple Box Sections

Cross sections of straight bridges consisting of two or more single-cell box sections, for which the live load flexural moment in each box is determined in accordance with the applicable provisions of Article 4.6.2.2.2b, shall satisfy the geometric restrictions specified herein. In addition, the bearing lines shall not be skewed.

The distance center-to-center of flanges of adjacent boxes, *a*, taken at the midspan, shall neither be greater than 120 percent nor less than 80 percent of the distance center-to-center of the flanges of each adjacent box, *w*, as illustrated in Figure 6.11.2.3-1. In addition to the midspan requirement, where nonparallel box sections are used, the

6.11.6.2.2—Sections in Positive Flexure

Sections in horizontally-curved steel girder bridges shall be considered as noncompact sections and shall satisfy the requirements of Article 6.11.7.2.

Sections in straight bridges that satisfy the following requirements shall qualify as compact sections:

- The specified minimum yield strengths of the flanges and web do not exceed 70.0 ksi,
- The web satisfies the requirement of Article 6.11.2.1.2,
- The section is part of a bridge that satisfies the requirements of Article 6.11.2.3,
- The box flange is fully effective as specified in Article 6.11.1.1,

and:

AASHTO Limitations

- Current AASHTO live load distribution factors (LLDFs) for steel box girders have many limitations:

1. Not applicable to skewed multiple box girder bridges.
2. Only applicable to bridges with number of lanes to number of beams between 0.5 and 1.5.
3. Only one expression is specified for shear and moment of interior and fascia beams regardless of the loaded lanes (single or multi-lanes).

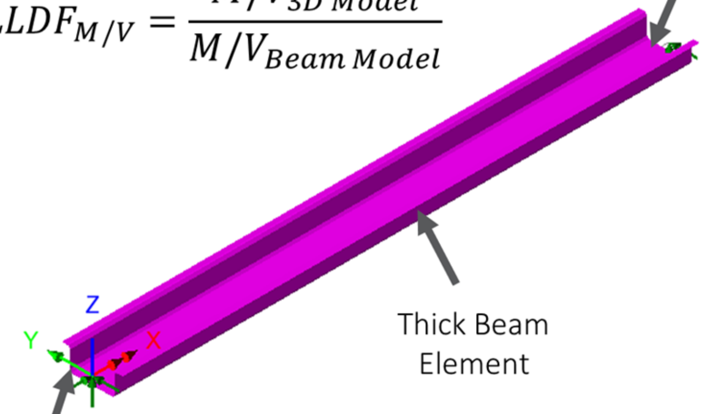
Solution

- Developed a detailed finite element (FE) model using the commercial finite element software LUSAS.
- Validated the FE model against results from a field determined LLDF test for a modular PBFTG bridge.
- Used the FE model in a parametric study to investigate the effects of different geometric parameters on the LLDFs of PBFTG bridges.
- Used the FE results in a regression model to develop new set of equations for the calculation of LLDFs for PBFTG bridges.
- Assessed current AASHTO equations based on FE results.

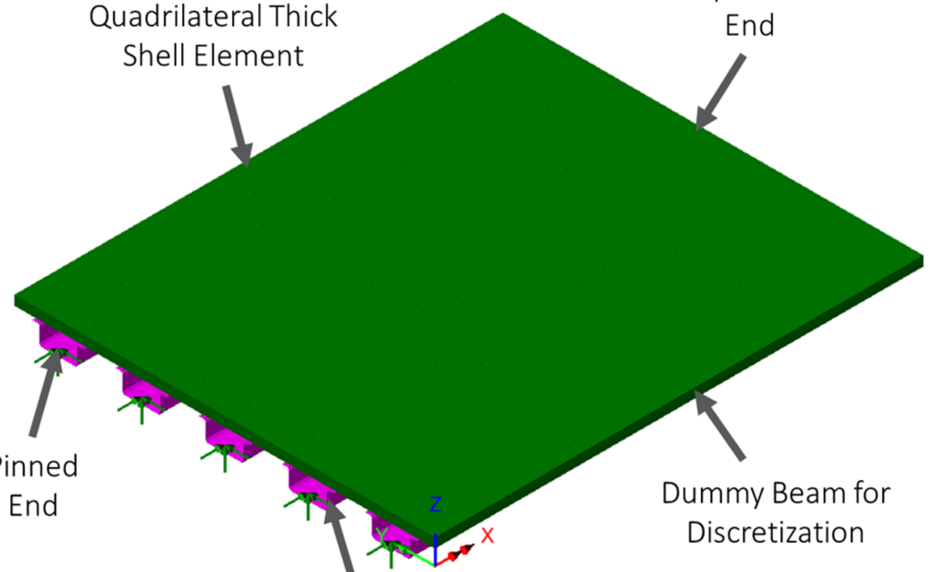
Modelling

LUSAS

$$LLDF_{M/V} = \frac{M/V_{3D\ Model}}{M/V_{Beam\ Model}}$$



Beam Model



3D Model

Model Validation

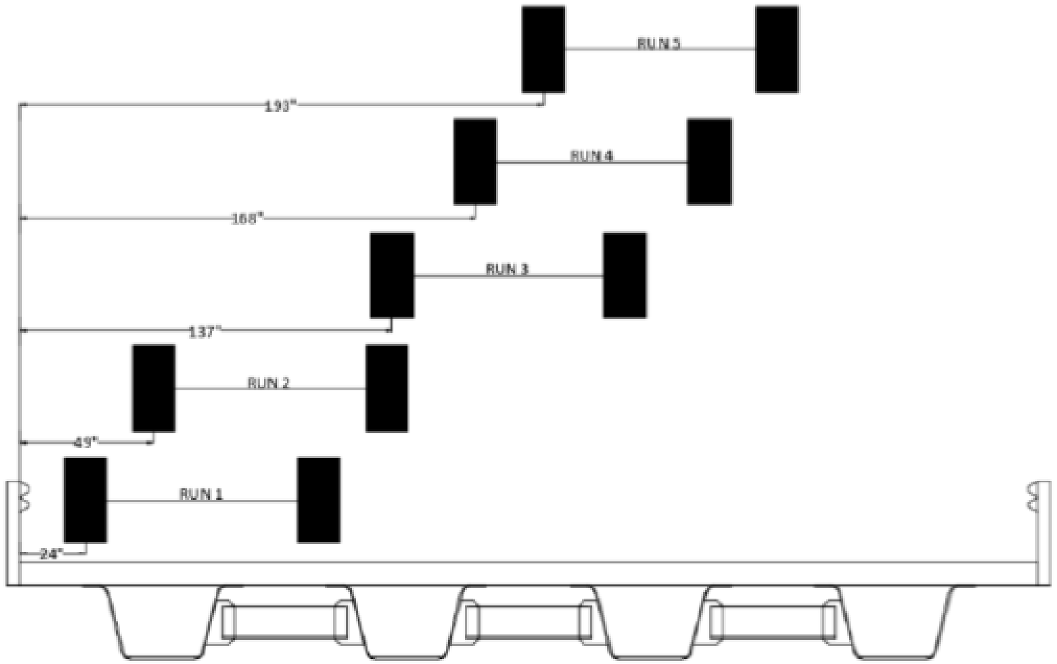
Amish Sawmill Bridge (Gibbs, 2017)

Tandem-Axle Dump Truck (Gibbs, 2017)

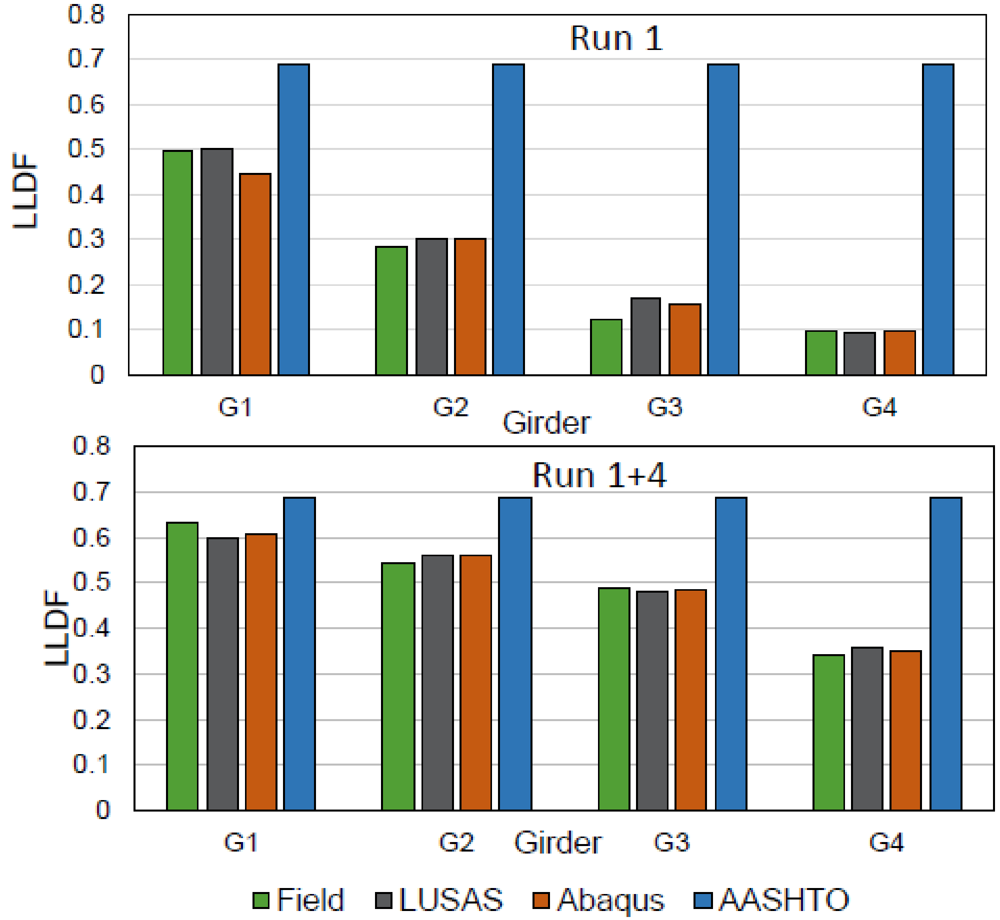
BDI Strain Transducer

$$LLDF_i = \frac{\varepsilon_{G_i}}{\sum_{j=1}^{k} \varepsilon_{G_j}} m$$

Model Validation



Live Load Truck Placements (Gibbs, 2017)



Parametric Study

Studied Bridges

- **Assumptions:**

- Lane width is 12 ft, shoulder width is 8 ft, and barrier width is 8.25 inch.
- Each bridge is designed according to current AASHTO LRFD specs.
- Overhang of fascia beam is calculated based on bridge width and spacing between beams.
- Fascia and first interior beams are considered for LLDF calculation.

	Parameter	Min.	Max.
Studied Parameters	Spacing (S), ft	5.0	8.0
	Number of Lanes (N_L), Ea.	2.0	4.0
	Skew Angle (Θ), °	0.0	30.0
	Span Length (L), ft	25.0	70.0
Generated Parameters	Bridge Width (W), ft	43.38	67.38
	Number of Beams (N_B), Ea.	5.0	13.0
	N_L/N_B	0.25	0.50
	Overhang (O), ft	2.69	5.69
	Clear Roadway (C), ft	40.0	64.0

4 Spacings x 3 N_Ls x 4 Spans x 4 Skews = **192 Bridges**

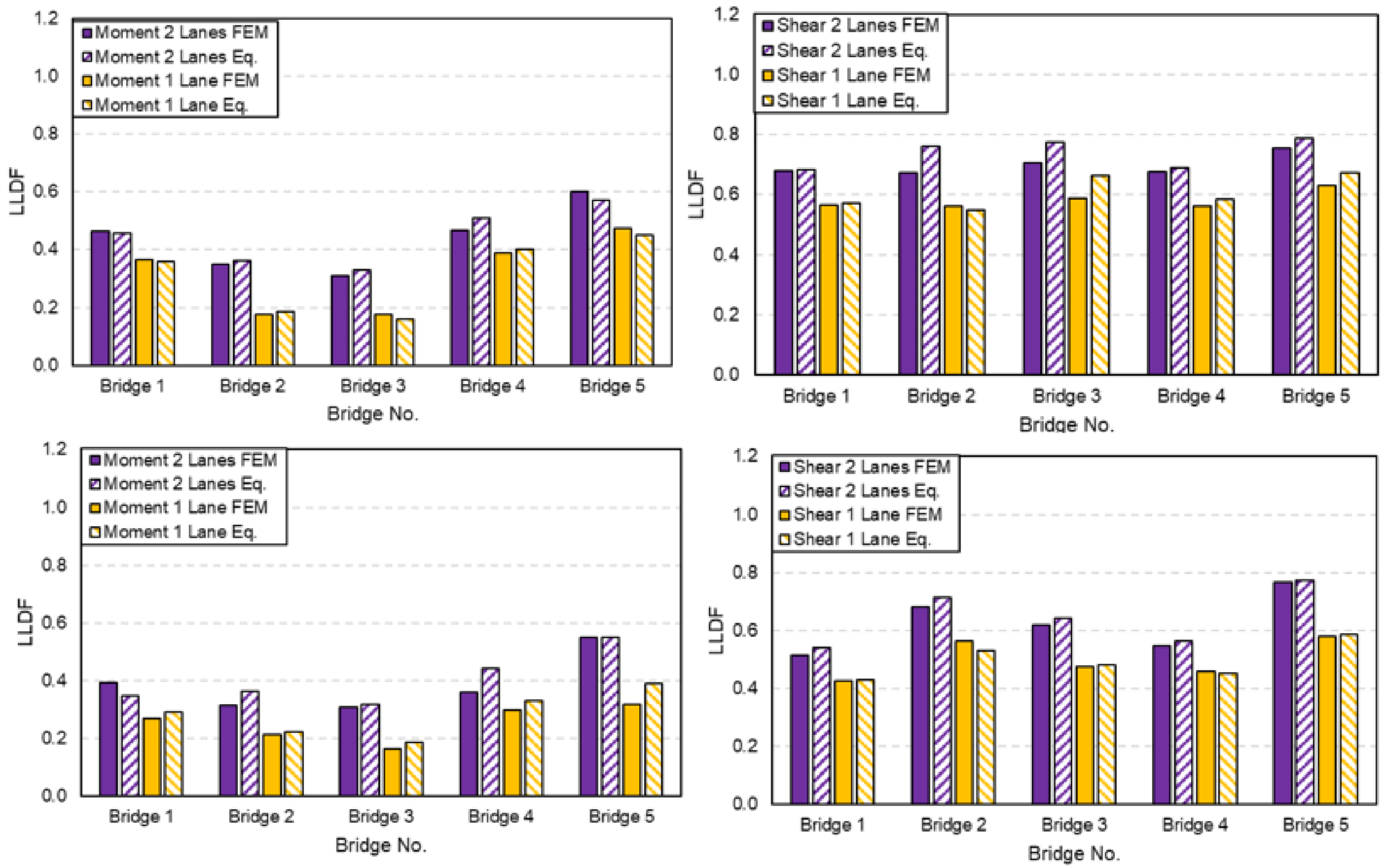
Proposed LLDFs

$$LLDF1 = K_1 S^{P_1} + K_2 L^{P_2} + K_3 \left(\frac{N_L}{N_B}\right)^{P_3} + K_4 \left(\frac{O}{W}\right)^{P_4} \text{(L < 55 ft)}$$

$$LLDF2 = K_1 (S)^{p_1} (L)^{p_2} \text{(L ≥ 55 ft)}$$

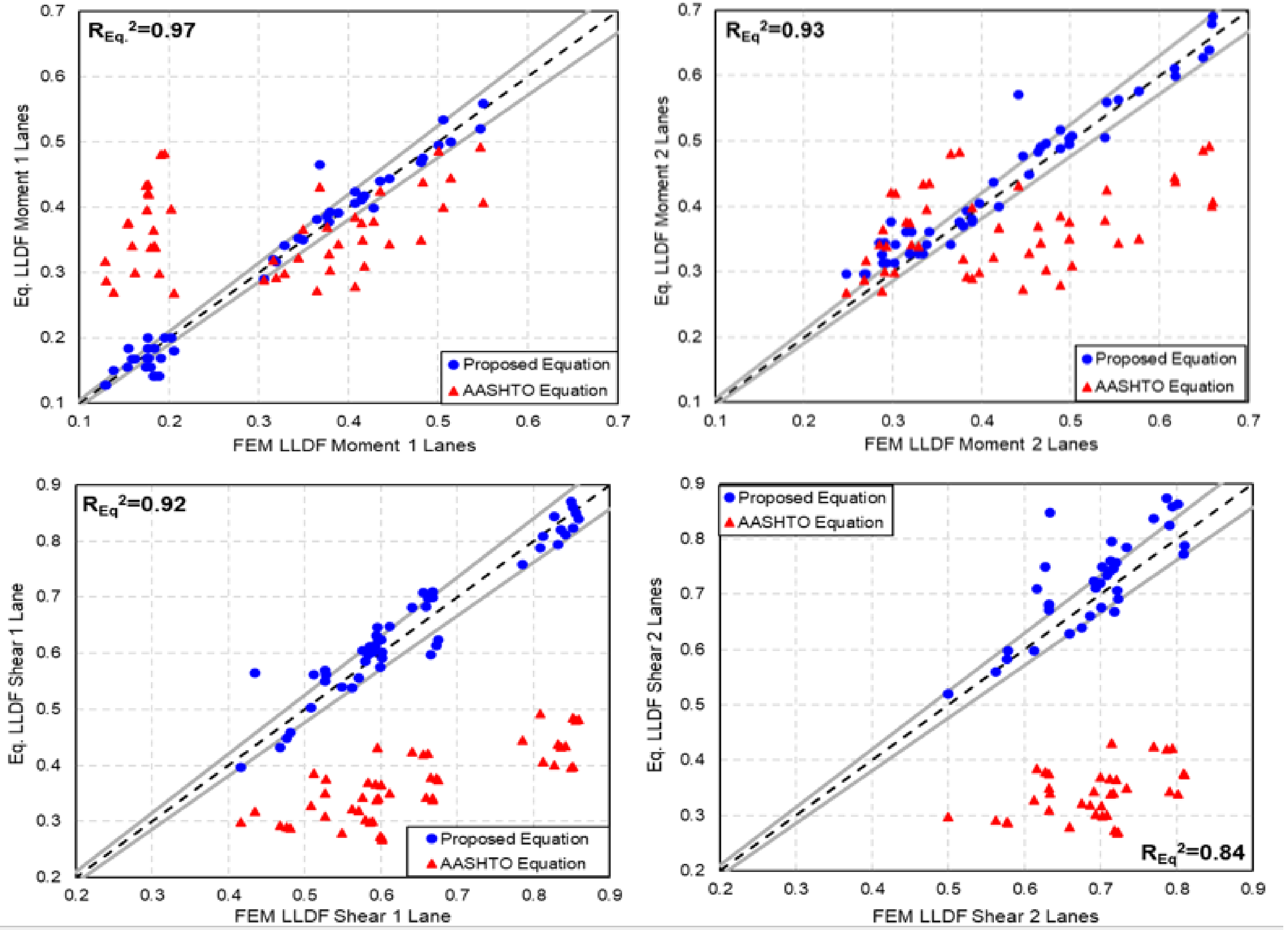
Beam	Design Lanes	M / V	K_1	K_2	K_3	K_4	P_1	P_2	P_3	P_4
Fascia Beam (LLDF)	Single Lane	Moment (L < 55ft)	0.09	0.75	-0.22	1.28	0.1	-0.1	-0.5	0.8
		Moment (L ≥ 55ft)	0.95	--	--	--	0.6	-0.7	--	--
		Shear	-3.61	-1.86	-0.65	6.58	0..05	-0.90	-0.50	0.05
	Multi-lane	Moment (L < 55ft)	0.43	0.35	-0.26	1.62	0.1	-0.1	-0.5	0.8
		Moment (L ≥ 55ft)	1.0	--	--	--	0.3	-0.4	--	--
		Shear	1.04	-0.97	-0.22	2.35	0.05	-0.50	-0.80	0.80
Interior Beam (LLDF)	Single Lane	Moment (L < 55ft)	1.55	-0.95	-0.15	0.21	0.1	0.1	-0.1	0.8
		Moment (L ≥ 55ft)	5.80	--	--	--	0.4	-1	--	--
		Shear	0.10	1.08	-0.08	0.15	0.80	-0.50	-0.50	0.80
	Multi-lane	Moment (L < 55ft)	-2.84	0.035	1.62	0.77	-0.5	0.5	-0.05	0.8
		Moment (L ≥ 55ft)	1.0	--	--	--	0.5	-0.5	--	--
		Shear	0.16	0.64	-0.12	0.18	0.80	-0.50	-0.50	0.80

Assessment of Proposed LLDFs



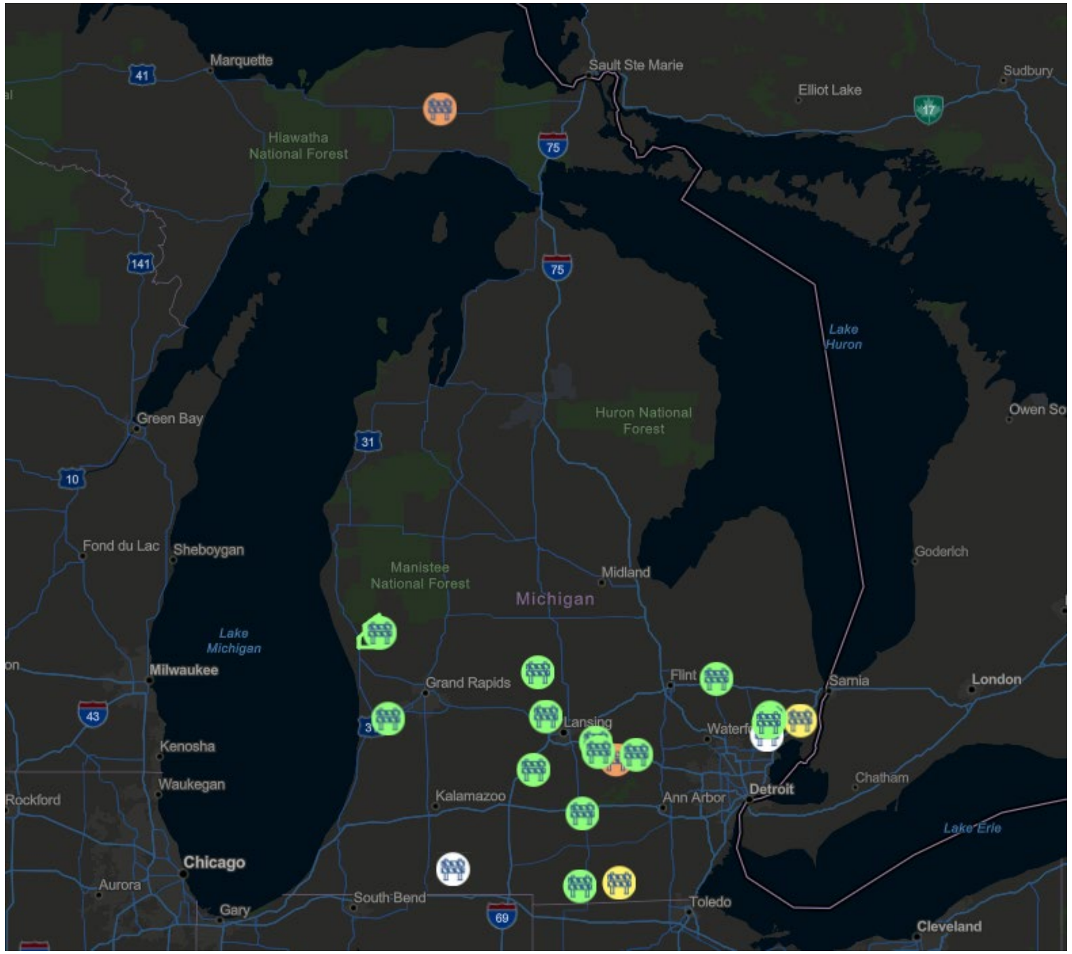
Bridge ID	S (ft)	N_L	L (ft)	Ɵ (º)
Bridge 1	5.66	4.00	50.00	17
Bridge 2	7.74	2.00	59.00	27
Bridge 3	6.76	3.00	67.00	13
Bridge 4	5.89	2.00	42.00	18
Bridge 5	7.88	3.00	41.00	11

Assessment of Proposed LLDFs



MDOT Pilot Project

- Superstructure replacement of 19 bridges across the state
- Construction cost: $24.3 million
- Benesch was the lead designer of a joint venture between two contractors
- Superstructures were replaced with press brake galvanized steel tub girders
- Bridge spans between 30’ and 60’
- 12’, 18” & 24” PBFTG used



Pre-Bid Investigation

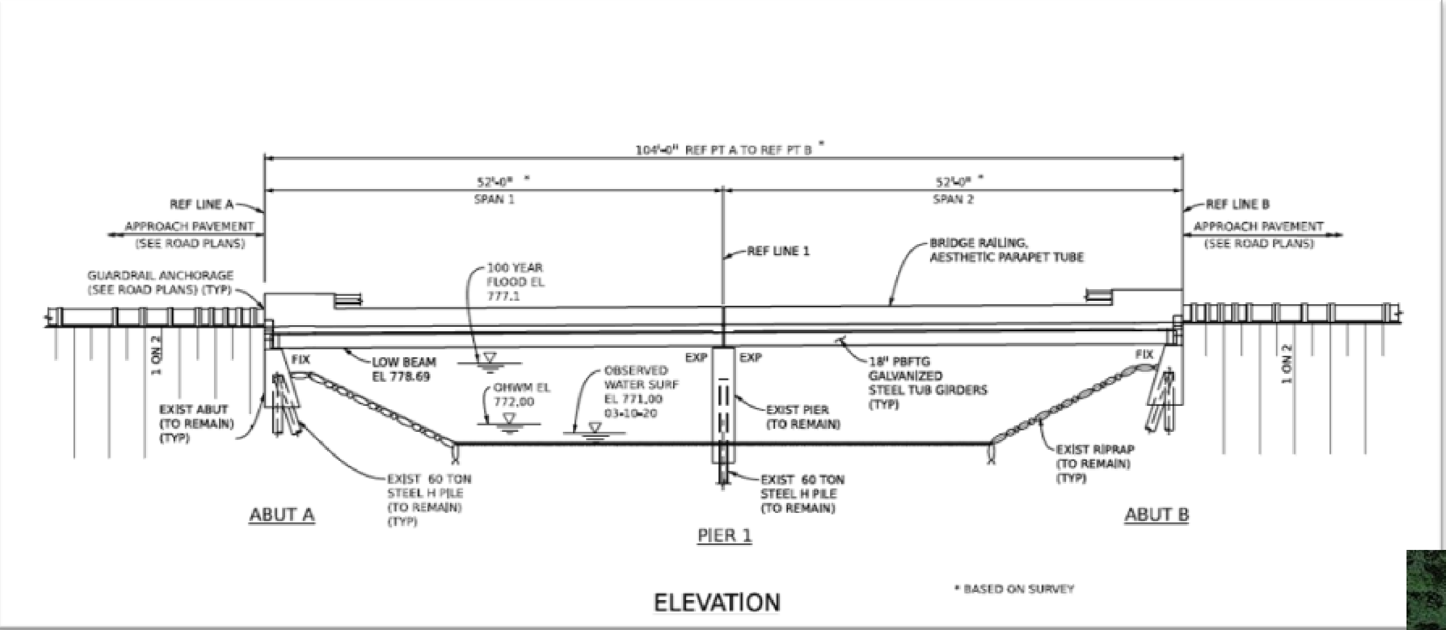
- Investigated rolled steel beams, prestressed concrete beams and press brake tub girders
- Goals to minimize grade raise, superstructure weight, and cost
- Economy of scale using one superstructure type among all bridges
- In general, furn, fab and erect cost of PBTG is lower than rolled steel beams and concrete box beams

Cost Comparisons (2021)

Beam Type	% Cost Variance (Furn & Fab)
PBTG	0%
Steel I Beam or Plate Girder	+19%
Concrete Box Beams	-15%

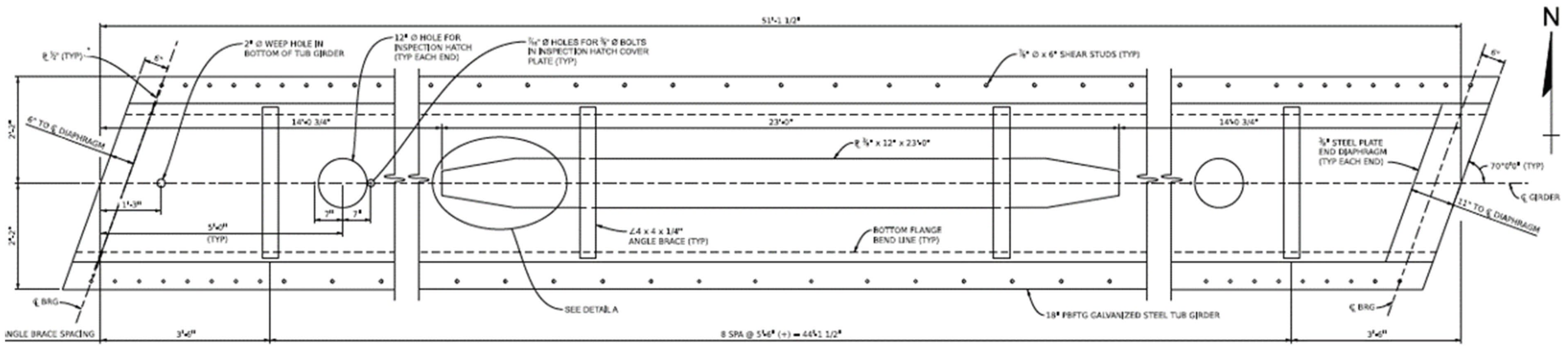
- Proposed superstructure weight shall not exceed as-built superstructure weight plus 10% (5% for some bridges), or
- Shall not exceed existing superstructure weight including overlays
- Concrete box beams are the cheaper option strictly for beam materials
- Due to the weight of the box beams, there would have been substructure modifications needed for some of the bridges to increase the carrying capacity
- Erection cost of PGTG for spans up to 58’ would offset the increased material cost

Herbison Road over the Looking Glass River



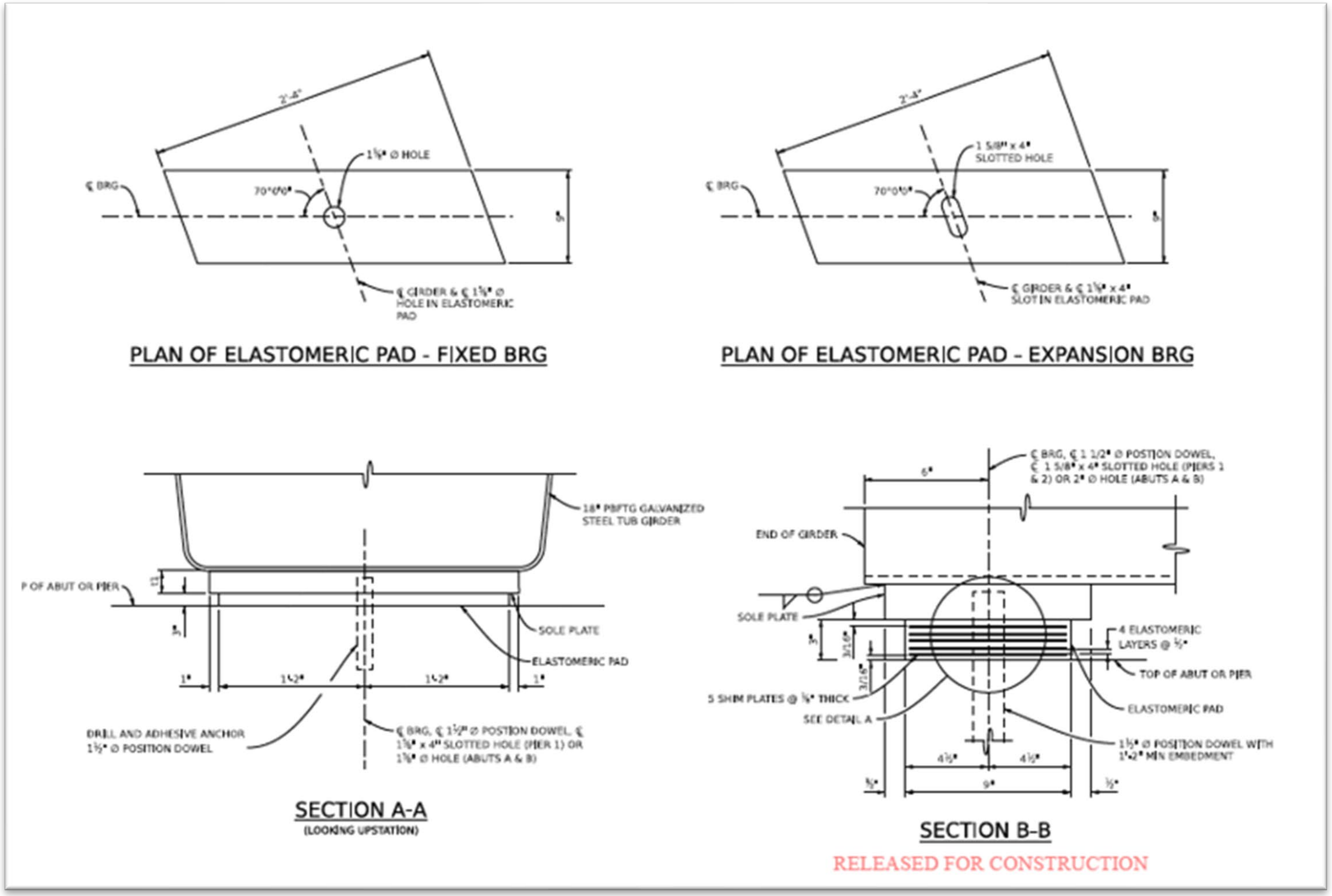
- 20' skew bridge
- Clinton County
- Existing super is 27" SBS box beams
- New super is 18" PBFTG with 9" composite deck

Herbison Road over the Looking Glass River



GIRDER PLAN - SPAN 2

Herbison Road over the Looking Glass River



Herbison Road over the Looking Glass River

Herbison Road over the Looking Glass River

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Herbison Road over the Looking Glass River

Herbison Road over the Looking Glass River

Herbison Road over the Looking Glass River

Herbison Road over the Looking Glass River

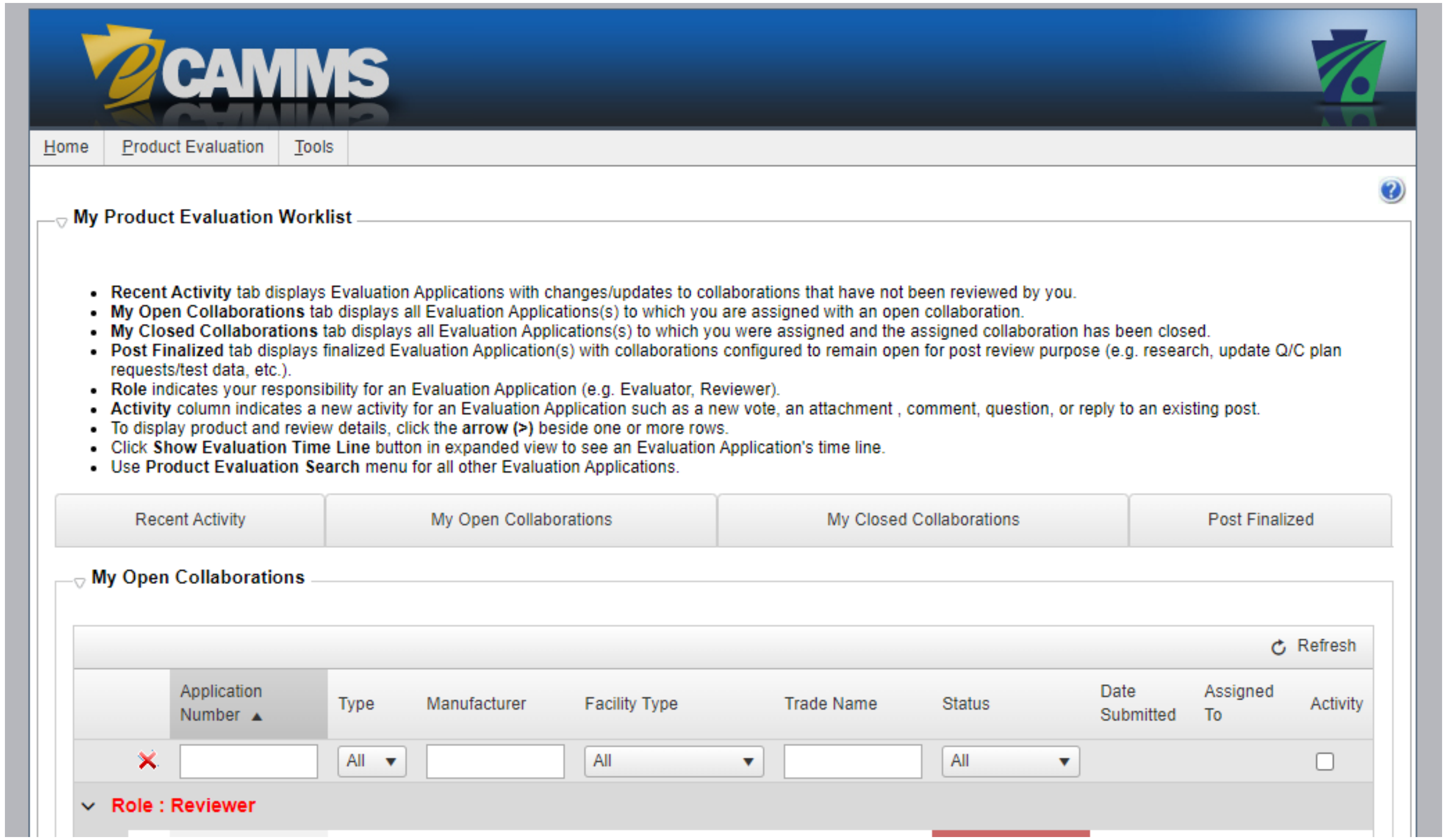
Pennsylvania DOT's Experience

Guozhou Li

PennDOT new product review and approval

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- PennDOT new products review policy/procedure



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SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- PennDOT new products review technical comments

PennDOT Bridge Design and Technology Division

SUBMISSION REVIEW COMMENTS

County: Statewide **S.R.-Sec:** ______ **Seg/Offset:** ______ **S-#** ______

Project: Steel Tub Girder Bridge (Press-Brake-Formed)

☐ Pre-TS&L ☐ TS&L ☐ Foundation ☐ Pre-Final ☐ Final Plan ☒ Other New Product

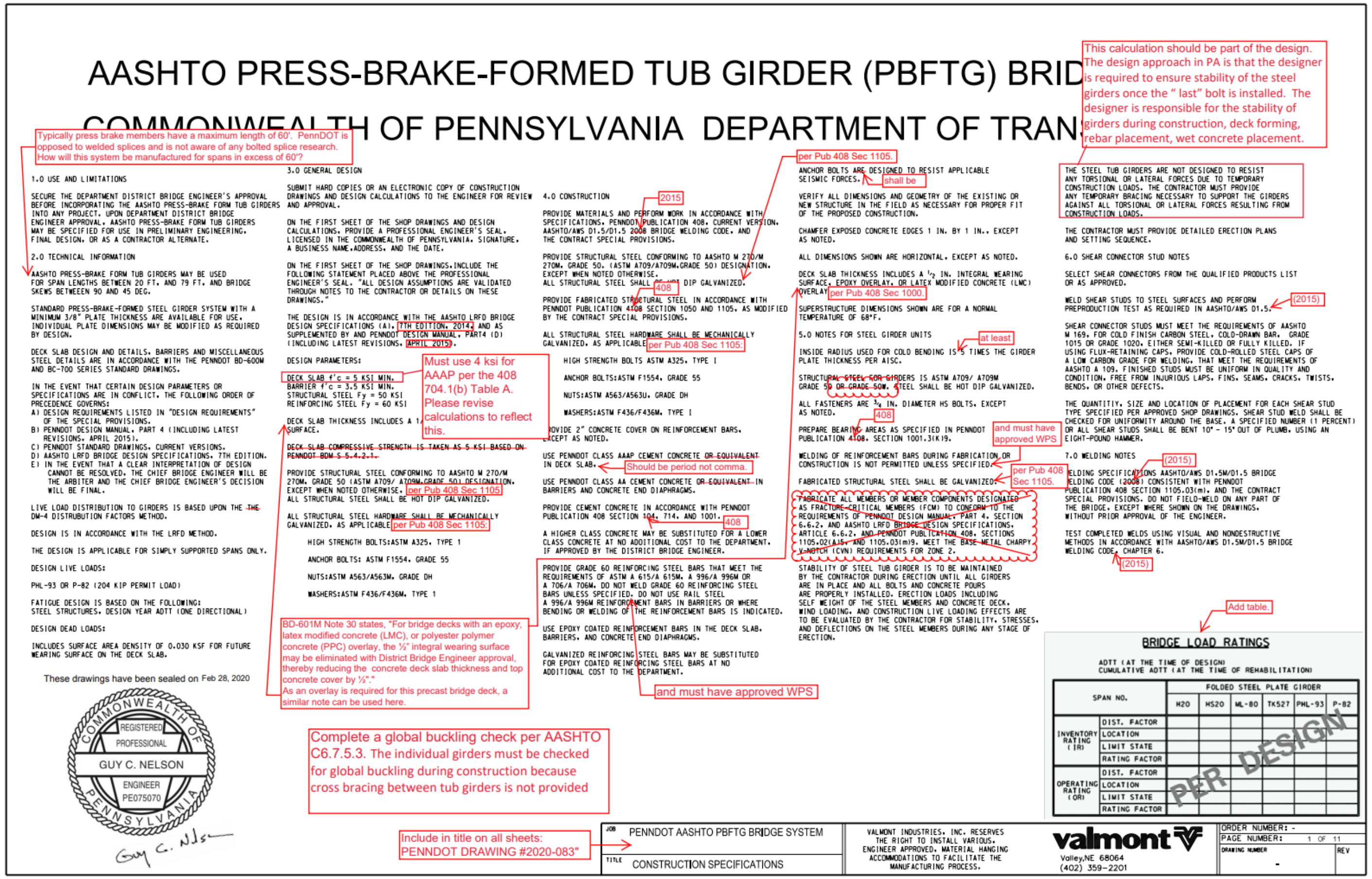
Submission Prepared by: Valmont **Date Received:** 05/07/2020

Review # 1 **Reviewer:** GL/DMiraglia/KRS **Date:** 07/24/2020 **Page** 1 **of** 5

Comment No.	Submission Document	Sheet or Page No.	COMMENTS
1	Design	General	Provide a written description of a construction methodology that will allow for the future redecking of the bridge.
2	Design	General	If this is a patented system, submit patent information for review.
3	Design	General	Revise concrete strength to 4 ksi to reflect AAAP specifications.
4	Design	General	The design approach in PA is that the designer is required to ensure stability of the steel girders once the " last" bolt is installed. The designer is responsible for the stability of girders during construction, deck forming, rebar placement, wet concrete placement.
5	Design	General	Complete a global buckling check per AASHTO C6.7.5.3. The individual girders must be checked for global buckling during construction because cross bracing between tub girders is not provided. Check the non-composite stability and behavior of the tub girders during deck pour.

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- PennDOT new products review technical comments



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SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Technical review procedure

1.0 USE AND LIMITATIONS

VALMONT TAKES FULL RESPONSIBILITY FOR THE ENGINEERING THEORY AND CALCULATION CORRECTNESS AND ENSURING THAT ALL DESIGN ASSUMPTIONS ARE VALIDATED IN THE CONTRACT DOCUMENTS EITHER BY NEEDED DETAILS OR CONSTRUCTION SPECIFICATIONS. VALMONT IS TO PREPARE DESIGN CALCULATIONS AND CONTRACT DRAWINGS IN ACCORDANCE WITH GUIDELINES SPECIFIED HEREIN AND PENNSYLVANIA DEPARTMENT OF TRANSPORTATION DESIGN MANUAL, PART 4.

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Technical review procedure

  - Design Example

EXAMPLE DESIGN CALCULATIONS FOR A 60-FOOT SIMPLY SUPPORTED PRESS-BRAKE-FORMED TUB GIRDER BRIDGE INCORPORATING 96-INCH STANDARD MILL PLATE ADJUSTED TO A 94-INCH WIDE PLATE SECTION TO ACCOMMODATE ASTM A6 CAMBER ALLOWANCE

Karl E. Barth, Ph.D.
Gregory K. Michaelson, Ph.D.
Robert M. Tennant

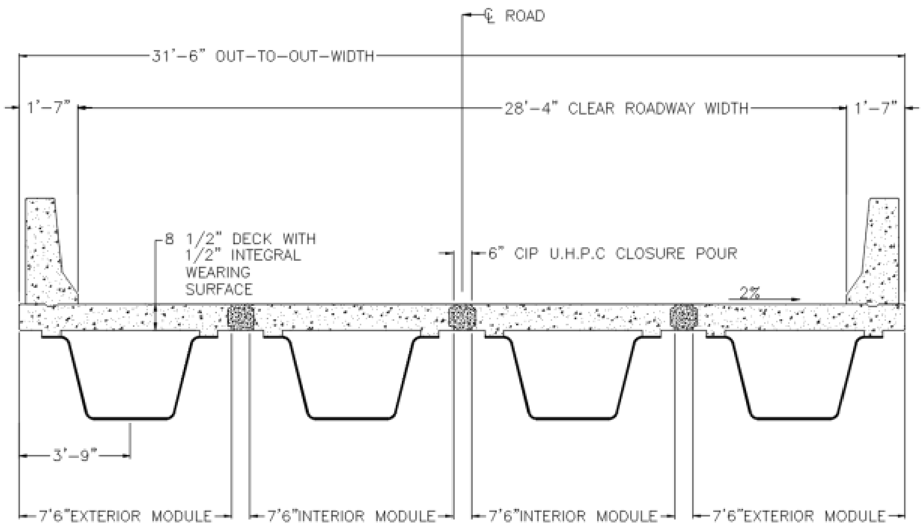
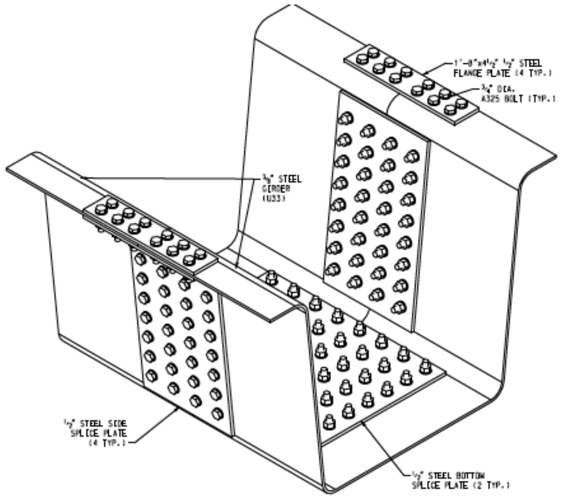


Figure 2.1: Typical Bridge Cross Section

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Technical review procedure

  - Inspection hole. added
  - Maximum camber: 8 in
  - Precast deck panel only
  - UHPC closure pour: BD-605M
  - Splice details are provided

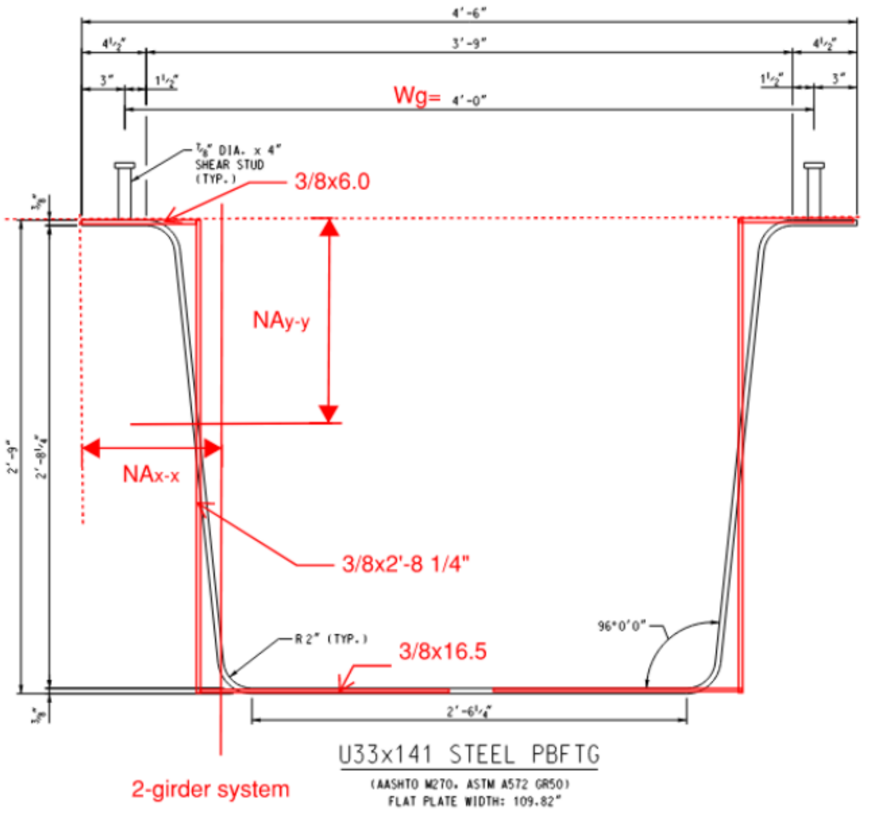


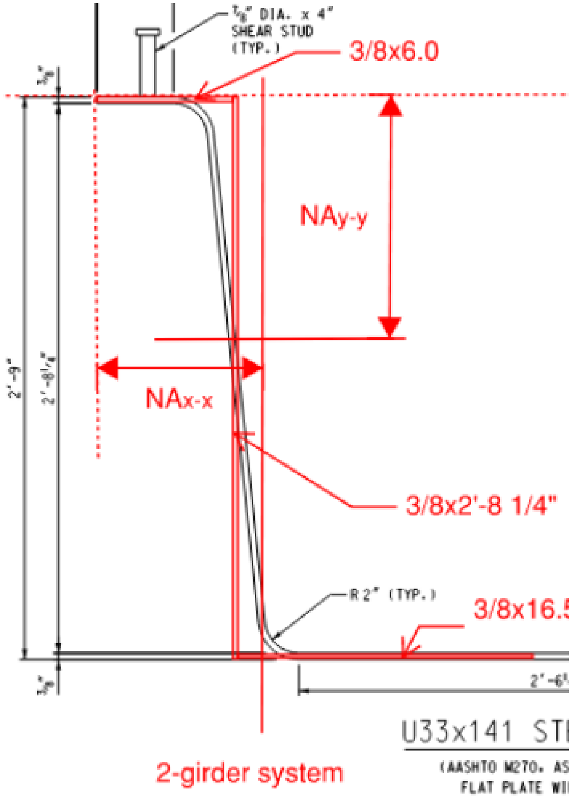
ISO
BOLTED SPLICE PLATE ASSEMBLY (U33)

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Technical review procedure

Steel Tub girder global buckling check





Treat as two separate I girders conservatively (top flange=6.0in and bottom flange=16.5in, web=32.25in) with spacing 48in

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Technical review procedure

AASHTO S 6.10.3.4.2

$$M_{gs} = C_{bs} \frac{\pi^2 w_g E}{L^2} \sqrt{I_{eff} I_x} \qquad (6.10.3.4.2\text{-}1)$$

in which:

C_{bs} = system moment gradient modifier
= 1.1 for simply-supported units
= 2.0 for continuous-span units

- For doubly symmetric girders:

$$I_{eff} = I_y \qquad (6.10.3.4.2\text{-}2)$$

- For singly symmetric girders:

$$I_{eff} = I_{yc} + \left(\frac{t}{c}\right) I_{yt} \qquad (6.10.3.4.2\text{-}3)$$

where:

c = distance from the centroid of the noncomposite steel section under consideration to the centroid of the compression flange (in.). The distance shall be taken as positive.

I_x = noncomposite moment of inertia about the horizontal centroidal axis of a single girder within the span under consideration ($in.^4$)

I_{yc}, I_{yt} = moments of inertia of the compression and tension flange, respectively, about the vertical centroidal axis of a single girder within the span under consideration ($in.^4$)

I_y = noncomposite moment of inertia about the vertical centroidal axis of a single girder within the span under consideration ($in.^4$)

L = length of the span under consideration (in.)

t = distance from the centroid of the noncomposite steel section under consideration to the centroid of the tension flange (in.). The distance shall be taken as positive.

w_g = girder spacing for a two-girder system or the distance between the two exterior girders of the unit for a three-girder system (in.)

Should the sum of the largest total factored girder moments across the width of the unit within the span under consideration exceed 70 percent of M_{gs}, the following alternatives may be considered:

- The addition of flange level lateral bracing adjacent to the supports of the span may be considered as discussed in Article 6.7.5.2;
- The unit may be revised to increase the system stiffness; or
- The amplified girder second-order displacements of the span during the deck placement may be evaluated to verify that they are within tolerances permitted by the Owner.

$$Load := 7ft(8in) \cdot 150pcf + (6.0in \cdot 0.375in + 32.25in \cdot 0.375in + 16.5in \cdot 0.375in) \cdot 2 \cdot 490pcf = 0.07 \cdot \frac{kip}{in}$$

Construction load factor: $LF := 1.25$

Factored load: $Load_{factored} := LF \cdot Load = 0.087 \cdot \frac{kip}{in}$

$$M := \frac{L^2 \cdot Load_{factored}}{8} = 9826 \cdot kip \cdot in$$

$$70\% \cdot M_{gs} = 11904 \cdot kip \cdot in$$

Check: $Buckling := if[M < (70\% \cdot M_{gs}), "OK", "NG"] = "OK"$

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Approval/disapproval decision

BULLETIN 15 **(Publication 35)**
Qualified Products List for Construction

Posted:
7/2/2023 10:00:09PM

Bulletin 15 Description

Bulletin 15 is a listing of prequalified materials that are eligible for use on Department construction projects. The purpose of Bulletin 15 is to provide contractors, consultants, Department personnel, manufacturers, suppliers, and others with easy access to a listing of products whose manufacturers have demonstrated the capability to perform in accordance with Department specifications and to be accepted by certification on PennDOT construction projects. Contractors are ultimately responsible to the Department for the performance of all materials and products supplied to, installed or placed on, and/or incorporated into Department construction projects, notwithstanding the listing of any such materials and products in Bulletin 15

VAL-4 15 Plant	**Valmont Industries, Inc., 15000 Valmont Plaza, Omaha, NE 68154** http://www.valmont.com/ **1950 Industrial Boulevard Jasper, TN 37347**		
	Certified Structural Steel Fabricator	IBR	2020-083Q
VALM1 15 Plant	**Valmont Industries, Inc., 7002 N 288th Street, Valley, NE 68064** http://www.valmont.com/ **Valley, NE 68064**		
	Certified Structural Steel Fabricator	SBR	-----

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Approval/disapproval decision

Approved Bridge and Structure Products

Product No.	Strike-Off-Letter Number	Product Name	Company	Approval Date On Drawing	Revision Date(s)	Drawing Number	No. of Index Shts. (PDF Files)	Is Item Patented? (Y/N)
		Index	-	-		-	10	
		All Active Products (No. 2 thru No. 90)	-	-		-	792	
87	**	Press-Brake-Formed Tub Girder (PBFTG) Bridge System	Valmont Industries, Inc.	10/29/2021		2020-083	1	N

pennsylvania
DEPARTMENT OF TRANSPORTATION

SPBTG(Steel Press-Brake-Formed Tub Girder) 2020-083 PennDOT review

- Responsibility of the using the approved new product/design details.

Product:
Item 9000-xxxx – Press-Brake-Formed Tub Girder (PBFTG) Bridge System
Valmont Industries, Inc.
PennDOT Drawing # 2020-083

Approval Date:
October 29, 2021

Application/Use:
PBFTG Bridge System manufactured by Valmont Industries, Inc., Valley, Nebraska has been approved to be used as an "Alternate" to bridge or culvert systems.

PBFTG Bridge System is permitted for NHS systems. District Executives may permit the use of this PBFTG Bridge System as an "Alternate" on a project-by-project basis.

PBFTG Bridge System is limited to the following applications as prototype installations:

- Span length: 20 feet to 79 feet
- Skew angle: 45 degrees to 90 degrees
- Structure configuration: Simple Span

PBFTG Bridge System is to be designed/analyzed to meet both AASHTO and Design Manual, Part 4 design criteria. A Load Rating Table and Rating Procedure must be incorporated on the Contract Drawings. Contact Valmont Industries, Inc., Valley, Nebraska for design and/or analysis questions.

Specifications:
Design/Material/Construction Specifications for this steel tub girder system are specified on PennDOT Drawing #2020-083 dated 10/29/2021 of PBFTG Bridge System.

Drawing:
Attached is a copy of PennDOT Drawing # 2020-083.

Comments:
On those projects permitting the use of this system as an alternate, a special provision should be included in the proposal to indicate that the "PBFTG Bridge System" as an alternate is allowed.

Missouri DOT’s Experience

Timothy Leaf

Missouri’s Experience with the Steel Press-Brake Formed Tub Girders

MoDOT

AASHTO Innovation Initiative

Boone County - Rustic Road

Boone County - Rustic Road

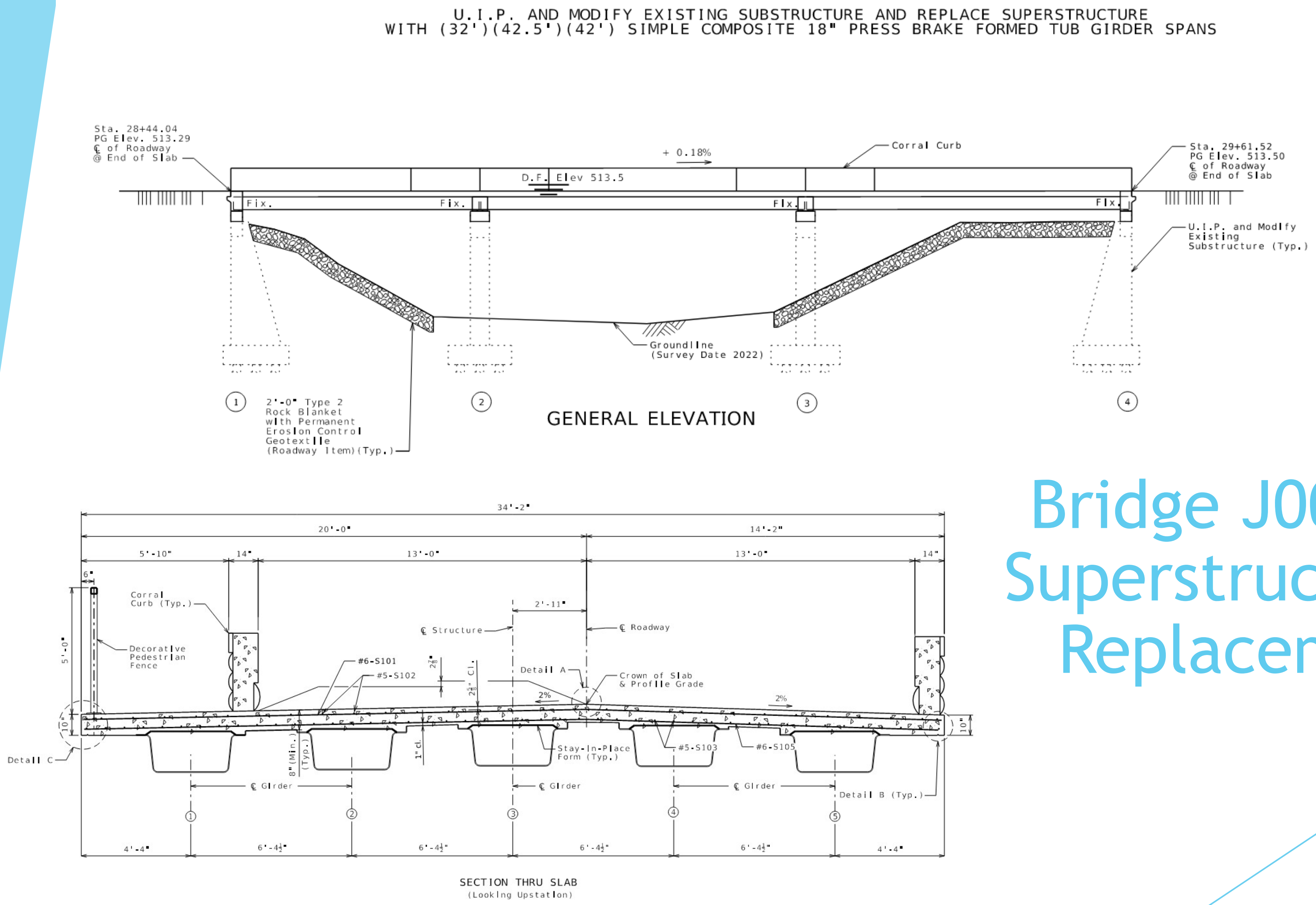
Boone County - Rustic Road

Boone County - Rustic Road

Boone County - Rustic Road

Bridge J0009
Gasconade County
Route 19

Bridge J0009
Gasconade County
Route 19



Bridge J00092 Superstructure Replacement

Question and Answer Session

AASHTO
Innovation Initiative

Thank you!

aii.transportation.org