valmont®
STRUCTURES

PRESENTERS

Jeff Simkins
National Bridge Sales Manager

U-BEAM™ Bridge System

AN AASHTO 2021 FOCUS TECHNOLOGY

GALVANIZED STEEL PRESS-BRAKE-FORMED TUB GIRDERS

Who is Valmont Structures?

AISC INTERMEDIATE BRIDGE CERTIFIED FABRICATOR

Certified Bridge Fabricator - Intermediate (IBR) are typical bridges that do not require extraordinary measures. Typical examples might include:

(1) a rolled beam bridge with field or shop splices, either straight or with a radius over 500 ft;

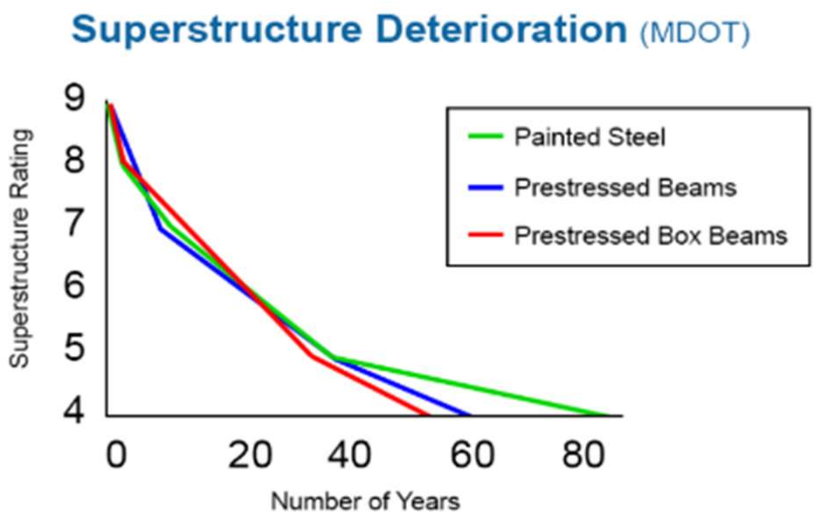
(2) a built-up I-shaped plate girder bridge with constant web depth, with or without splices, either straight or with a radius over 500 ft.

Concrete is what has always been used

"Insanity is doing the same thing over and over and expecting different results."

-- Albert Einstein

- Prestressed concrete box beams have been the standard solution since the 1970s for off-system, local agency, non-interstate bridges.
- MDOT study of current inventory shows pre-stressed concrete box beam service life < 50 years.
- "Bridge engineers need improved design options so they can deliver bridges that are operational for 100 years or more." *FHWA*



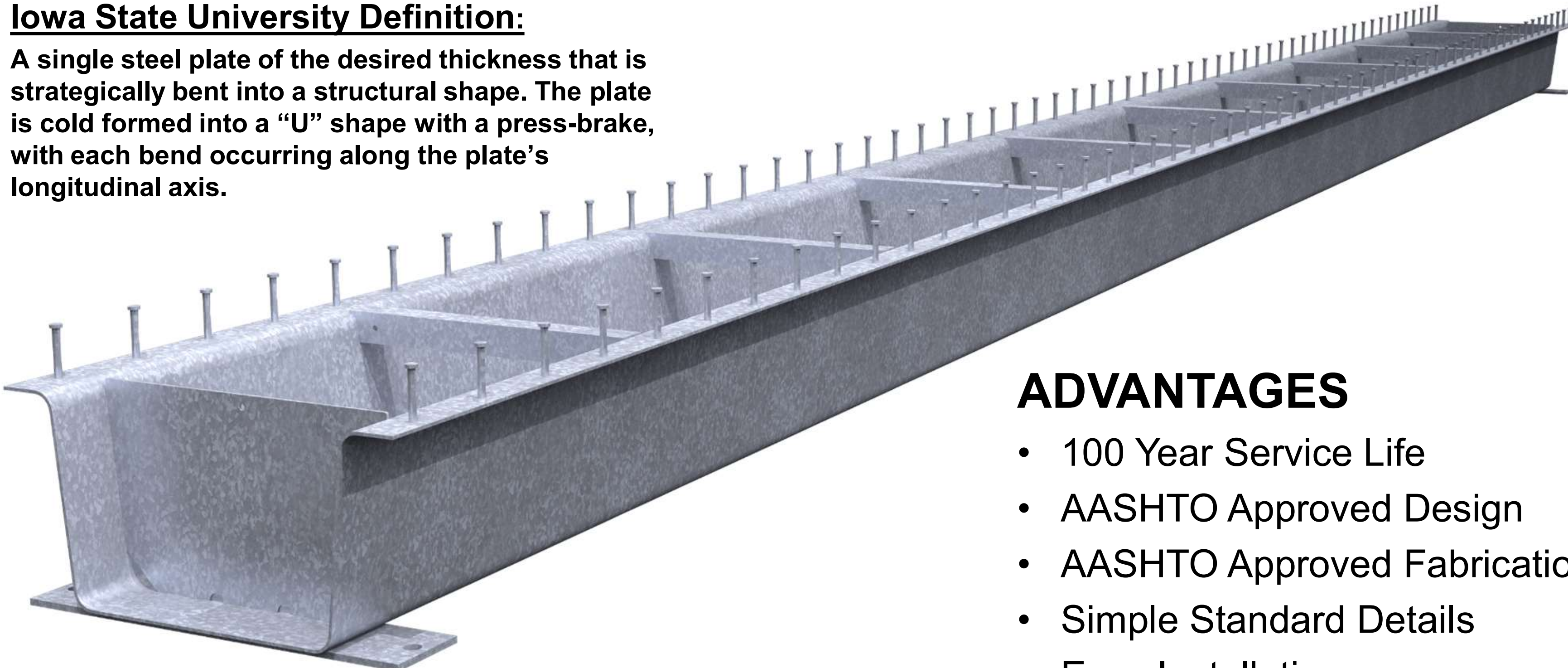
4 - POOR CONDITION: Structural capacity of element is affected or jeopardized by advanced deterioration, section loss, spalling, cracking, or other deficiency.

3 - SERIOUS CONDITION: Loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible.

What is a Steel Press-Brake-Formed Tub Girder?

Iowa State University Definition:

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.



ADVANTAGES

- 100 Year Service Life
- AASHTO Approved Design
- AASHTO Approved Fabrication
- Simple Standard Details
- Easy Installation

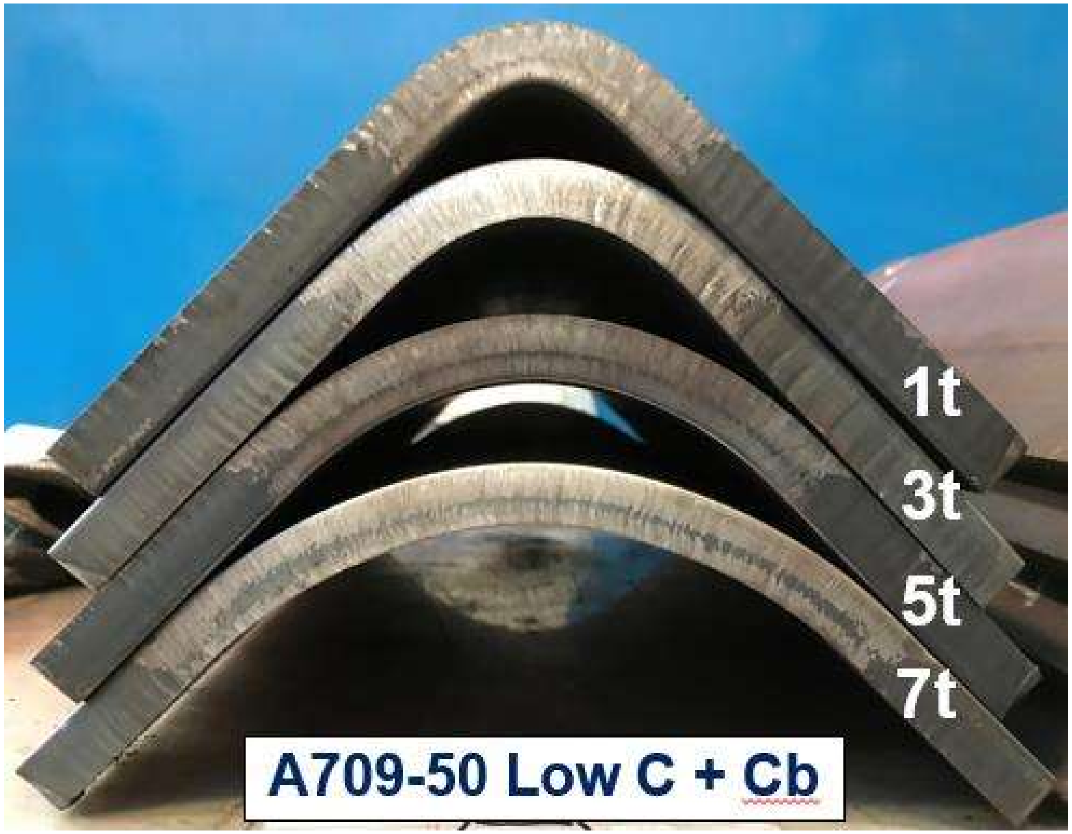
The Innovation: Replacing Welds with Bends

AASHTO LRFD

Bridge Construction Specifications

Section 11.4.3.3 Steel Structures: Bent Plates

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



2021 AASHTO Focus Technology

AASHTO
AASHTO INNOVATION INITIATIVE

NATIONAL RECOGNITION WITH THE AASHTO INNOVATION INITIATIVE AWARD

2020 Press-Brake Tub Girders receive the “2020 Innovation Award” as **a ready-to-implement technology** that offers improved performance/effectiveness and have been demonstrated in "real world" applications.

2021 Press-Brake Tub Girders become a 2021 AASHTO Focus Technology.

2023 Press-Brake Tub Girders to be included in revisions to the 10^{th} Edition of the AASHTO LRFD Bridge Design Specifications. The revisions apply to Specification Equation 6.11.2.2-3, allowing DOTs, Counties and other entities to utilize AASHTO design guidelines instead of rewriting specifications to include U-BEAMs

> “This is great news for state and local Departments of Transportation that are looking for economical, sustainable and accelerated construction solutions for short span bridges, which make up over half of the U.S. bridge inventory.”
>
> - Karl Barth, Ph.D., Associate Professor of Civil and Environmental Engineering at West Virginia University in a recent SSSBA article about the revisions

visit **aii.transportation.org** for more information

Press-Brake-Formed Tub Girders and the SSSBA

- The Press-Brake Tub Girder was developed by the SSSBA
- The term “Press-Brake Tub Girder” was coined by the SSSBA
- The term “Press-Brake Tub Girder” cannot be found in AASHTO
- Press-Brake Tub Girders are AASHTO Box-Section Flexural Members
- Press-Brake Tub Girders are Non-Proprietary and Open Source

SHORT SPAN STEEL BRIDGE ALLIANCE™

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Press-Brake-Formed Tub Girders and the SSSBA

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

- 10 Years of Development and Experimental Testing of Press Brake Tub Girders
- Published a 7 Volume Research Report
- https://www.shortspansteelbridges.org/testing-of-press-brake-tub-girders/

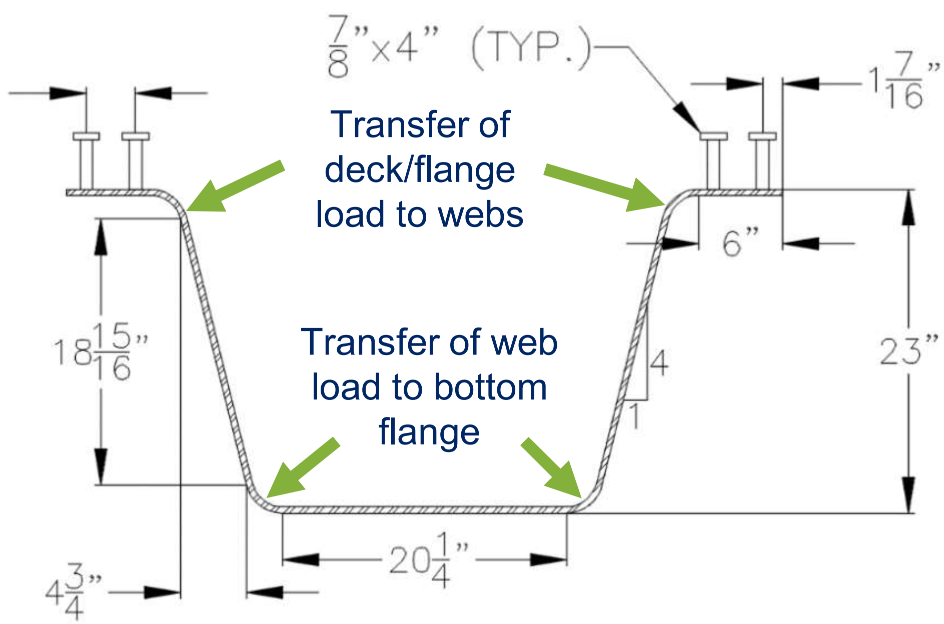
Education
Webinars
Workshops
Conferences

Technical Resources
Standards
Guidelines
Best Practices

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

FATIGUE TESTING OF COMPOSITE PBFTG-DECK MODULE

The Press-Brake-Formed Tub Girder exhibited no damage under fatigue testing simulating:
800 ADT, 15% Truck Traffic, 75-year service life, full AASHTO fatigue truck loading.

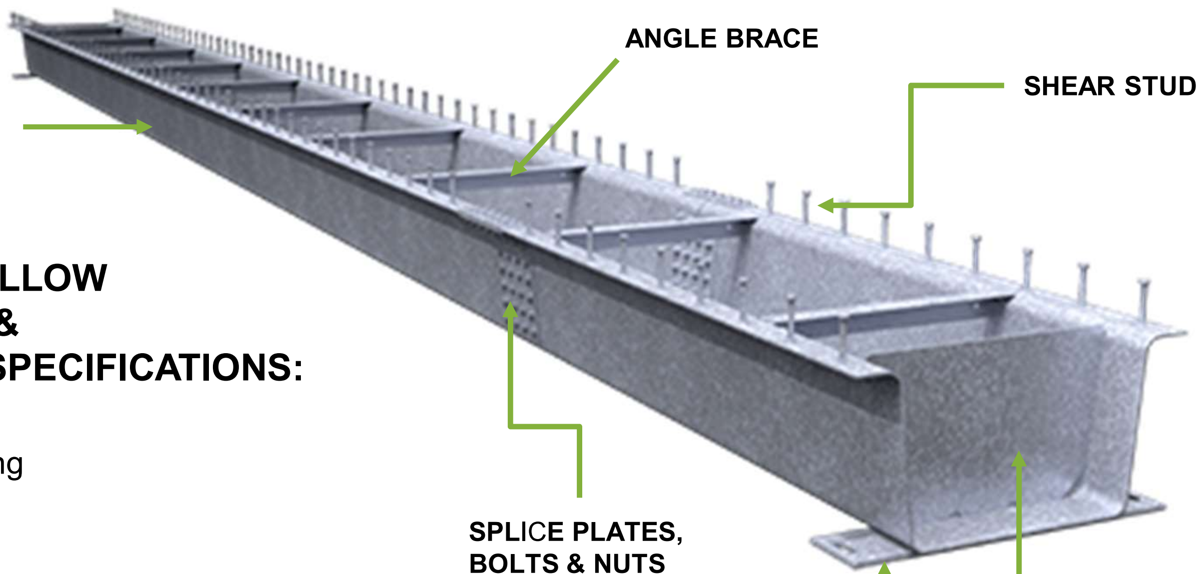


The First Press-Brake Tub Girder Bridge Install

Monroe County Road Commission, Mich.

- 2004 Install
- 40’ Long x 34’ Wide
- NBIS Bi-Annual Inspection
- No signs of deterioration of concrete, driving surface, or corrosion in steel girders

The Valmont U-BEAM™ (a press-brake-formed steel tub girder)



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

#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.

#2 AASHTO FORMING

AASHTO 11.4.3.3 - Bent Plates
Fracture-critical and Non-fracture critical plates and bars shall be cold bent.

#3 AASHTO CAMBERING

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

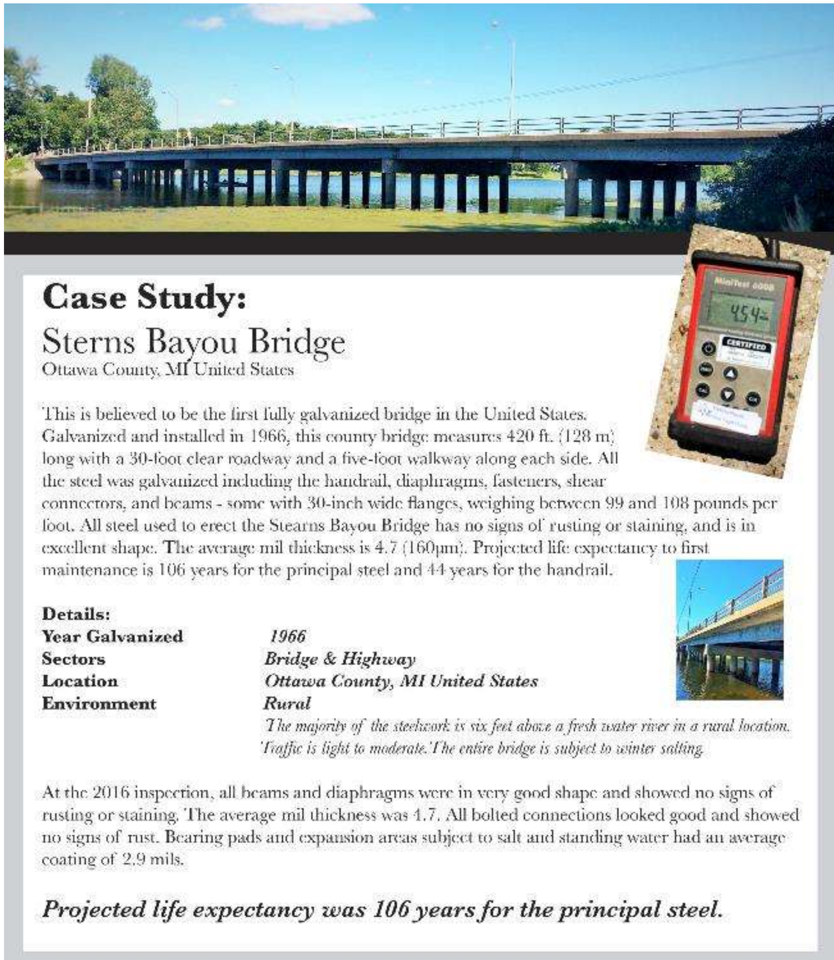
AASHTO 11.3.3
Certified Welders and welded stud shear connectors shall satisfy all requirements of the AASHTO/AWS D1.5M/D1.5 Bridge Welding Code related to material, manufacturing, physical properties, certification, and welding.

#5 AASHTO PROTECTIVE COATING

AASHTO 11.3.7

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

GALVANIZED BRIDGE CASE STUDY



Case Study:

Sterns Bayou Bridge

Ottawa County, MI United States

This is believed to be the first fully galvanized bridge in the United States. Galvanized and installed in 1966, this county bridge measures 420 ft. (128 m) long with a 30-foot clear roadway and a five-foot walkway along each side. All the steel was galvanized including the handrail, diaphragms, fasteners, shear connectors, and beams - some with 30-inch wide flanges, weighing between 99 and 108 pounds per foot. All steel used to erect the Stearns Bayou Bridge has no signs of rusting or staining, and is in excellent shape. The average mil thickness is 4.7 (160µm). Projected life expectancy to first maintenance is 106 years for the principal steel and 44 years for the handrail.

Details:

Year Galvanized	*1966*
Sectors	*Bridge & Highway*
Location	*Ottawa County, MI United States*
Environment	*Rural* *The majority of the steelwork is six feet above a fresh water river in a rural location. Traffic is light to moderate. The entire bridge is subject to winter salting.*

At the 2016 inspection, all beams and diaphragms were in very good shape and showed no signs of rusting or staining. The average mil thickness was 4.7. All bolted connections looked good and showed no signs of rust. Bearing pads and expansion areas subject to salt and standing water had an average coating of 2.9 mils.

Projected life expectancy was 106 years for the principal steel.

Sterns Bayou Bridge: Believed to be the first fully hot-dip galvanized bridge in the US

In service in Michigan for over 50 years with no known maintenance.

Coating has an average thickness of 4.7 mils, with minimum average readings in bearing areas of 2.9 mils.

The coating is projected to have a maintenance-free service life of over 106 years for the principal steel.

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DEVELOPMENT AND EXPERIMENTAL TESTING OF PRESS-BRAKE-FORMED STEEL TUB GIRDERS FOR SHORT SPAN BRIDGE APPLICATIONS

Karl E. Barth, Ph.D.
Gregory K. Michaelson, Ph.D.
Cory L. Gibbs

Submitted to the AISI Steel Market Development Institute Short Span Steel Bridge Alliance

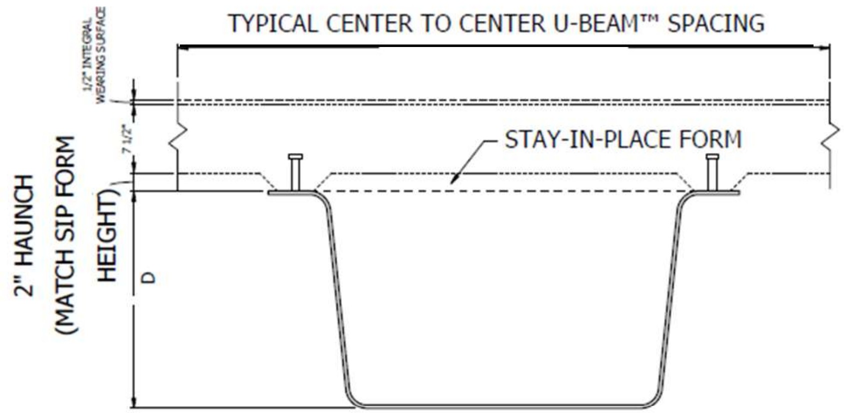
Table 2.2: Equation Legend (AASHTO, 2014)

Chapter 2	AASHTO 7th Edition
Equation 2.1	Equation 6.11.2.1.2-1
Equation 2.2	Equation 6.11.2.1.3-1
Equation 2.3	Equation 6.11.2.2-1
Equation 2.4	Equation 6.11.2.2-2
Equation 2.5	Equation 6.11.2.2-3
Equation 2.6	Equation 6.10.3.2.1-1
Equation 2.7	Equation 6.10.3.2.1-2
Equation 2.8	Equation 6.10.3.2.1-3
Equation 2.9	Equation 6.10.3.2.2-1
Equation 2.10	Equation 6.10.3.2.3-1
Equation 2.11	Equation 6.11.3.2-1
Equation 2.12	Equation 6.11.3.2-2
Equation 2.13	Equation 6.11.3.2-3
Equation 2.14	Equation 6.11.3.2-4
Equation 2.15	Equation 6.11.3.2-5
Equation 2.16	Equation 6.10.3.3-1
Equation 2.17	Equation 6.11.9-1
Equation 2.18	Equation 6.10.4.2.2-1
Equation 2.19	Equation 6.10.4.2.2-2
Equation 2.2	Equation 6.10.4.2.2-3
Equation 2.21	Equation 6.10.4.2.2-4
Equation 2.22	Equation 6.6.1.2.2-1
Equation 2.23	Equation 6.6.1.2.5-1
Equation 2.24	Equation 6.6.1.2.5-2
Equation 2.25	Equation 6.6.1.2.5-3
Equation 2.26	Equation 6.11.6.2.2-1
Equation 2.27	Equation 6.10.7.3-1
Equation 2.28	Equation 6.11.7.1.1-1

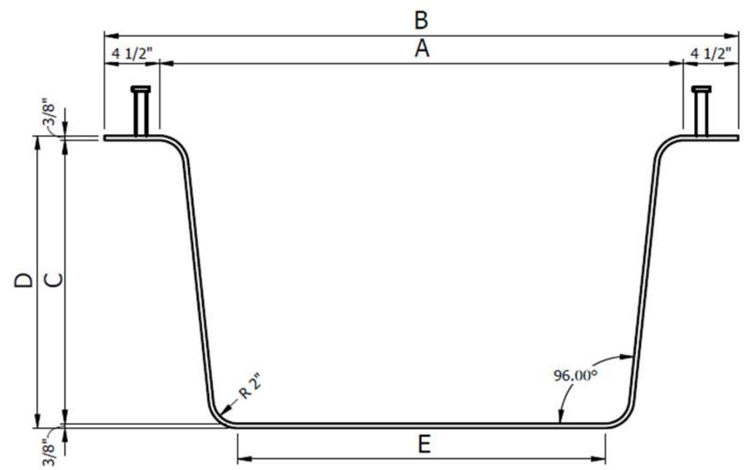
Chapter 2	AASHTO 7th Edition
Equation 2.39	Equation 6.11.8.2.2-4
Equation 2.40	Equation 6.11.8.2.2-5
Equation 2.41	Equation 6.11.8.2.2-6
Equation 2.42	Equation 6.11.8.2.2-7
Equation 2.43	Equation 6.11.8.2.2-8
Equation 2.44	Equation 6.11.8.2.2-9
Equation 2.45	Equation 6.11.8.2.2-10
Equation 2.46	Equation 6.11.8.2.2-11
Equation 2.47	Equation 6.11.8.2.2-12
Equation 2.48	Equation 6.11.8.2.3-1
Equation 2.49	Equation 6.11.8.2.3-2
Equation 2.50	Equation 6.11.8.2.3-3
Equation 2.51	Equation 6.11.8.3-1
Equation 2.52	Equation 6.10.9.1-1
Equation 2.53	Equation 6.10.9.2-1
Equation 2.54	Equation 6.10.9.2-2
Equation 2.55	Equation 6.10.9.3.2-1
Equation 2.56	Equation 6.10.9.3.2-2
Equation 2.57	Equation 6.10.9.3.2-3
Equation 2.58	Equation 6.10.9.3.2-4
Equation 2.59	Equation 6.10.9.3.2-5
Equation 2.60	Equation 6.10.9.3.2-6
Equation 2.61	Equation 6.10.9.3.2-7
Equation 2.62	Equation 6.10.9.3.2-8
Equation 2.63	Equation 6.10.9.3.3-1
Equation 2.64	Equation 6.10.9.3.3-2

#6 AASHTO DESIGN

AASHTO LRFD Bridge Design Specifications 8th Edition (2017) Section 6.11.
Steel Structures. Box-Section Flexural Members. SSSBA Verification.



VALMONT® U-BEAM™ STANDARD COMPOSITE CROSS SECTION



VALMONT® U-BEAM™ STANDARD CROSS SECTION

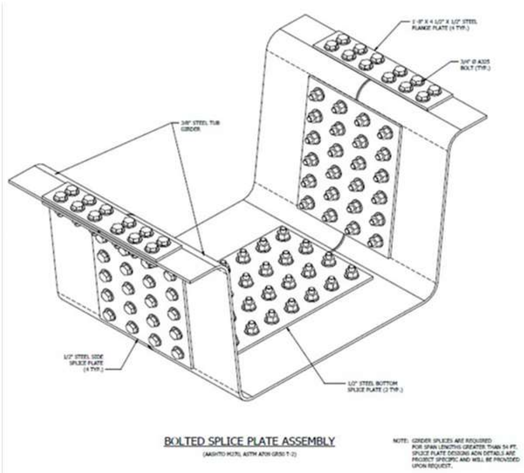
U-BEAM™ SPACING	BRIDGE LENGTH (ft)															
	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
4' - 6"	U12	U12	U12	U12	U12	U18	U18	U18	U24	U24	U24	U30	U30	U33	U33	S.D.
5' - 0"	U12	U12	U12	U12	U12	U18	U18	U18	U24	U24	U30	U30	U33	U33	S.D.	S.D.
5' - 6"	U12	U12	U12	U12	U18	U18	U18	U24	U24	U24	U30	U30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

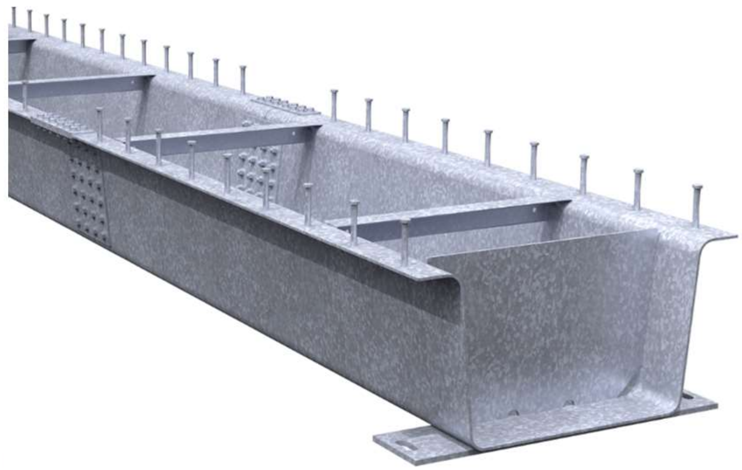
DESIGNATION	A	B	C	D	E
U12	43"	52"	11 1/4"	12"	32 5/8"
U18	43"	52"	17 1/4"	18"	31 3/8"
U24	43"	52"	23 1/4"	24"	30 1/8"
U30	43"	52"	29 1/4"	30"	28 7/8"
U33	45"	54"	32 1/4"	33"	30 1/4"

VALMONT U-BEAM™ DESIGN GUIDELINES

AASHTO LRFD Bridge Design Specifications 8th Edition (2017) Section 6.11.

Steel Structures. Box-Section Flexural Members





Surface Condition	Definition	Ks (Slip Coefficient)
Class A	Unpainted clean mill scale Blast-cleaned surfaces with Class A coatings	0.30
Class B	Unpainted blast-cleaned surfaces to SSPC-SP 6 or better Blast-cleaned surfaces with Class B coatings Unsealed (pure Zn or 85/15 Zn/Al) thermal-sprayed coatings with a thickness ? 16 mils	0.50
Class C	Hot-dip galvanized surfaces (roughening by wire brushing no longer required)	0.30
Class D	Blast-cleaned surfaces (including HDG) painted with organic zinc-rich coatings	0.45

AASHTO BOLTED SPLICE DESIGN

AASHTO LRFD Bridge Construction Specifications 4th Edition (2017) Section11.5.5.3 Surface Conditions. Faying surfaces specified to be galvanized shall be hot-dip galvanized in accordance with AASHTO M111 (ASTM A123).

AASHTO LRFD Bridge Design Specifications 8th Edition (2017) Section 6.13.2.8 Slip Resistance. Class C Surface: hot-dip galvanized surfaces (K_s=0.30)

#8 NBIS INSPECTION

No fatigue critical details. Visual inspection only, required to ensure no deterioration of the base metal:

1. Inspection ports allow for visual inspection of the interior
2. Two 1½” diameter weep holes at each end allow drainage

VALMONT U-BEAM™ INSPECTION

- NBIS inspection requirements for U-BEAMs are limited to section loss due to corrosion.
- Visual observation of the interior U-BEAM™ elements through openings at each end.
- Visual inspection should look for chalky white staining or zinc oxide build-up on the surface.
- **Base metal thickness and coating thickness can both be measured from the outside with an electromagnetic gauge per ASTM E376**.

CONCRETE DRIVING SURFACE OPTIONS

CAST-IN-PLACE CONCRETE BRIDGE DECK

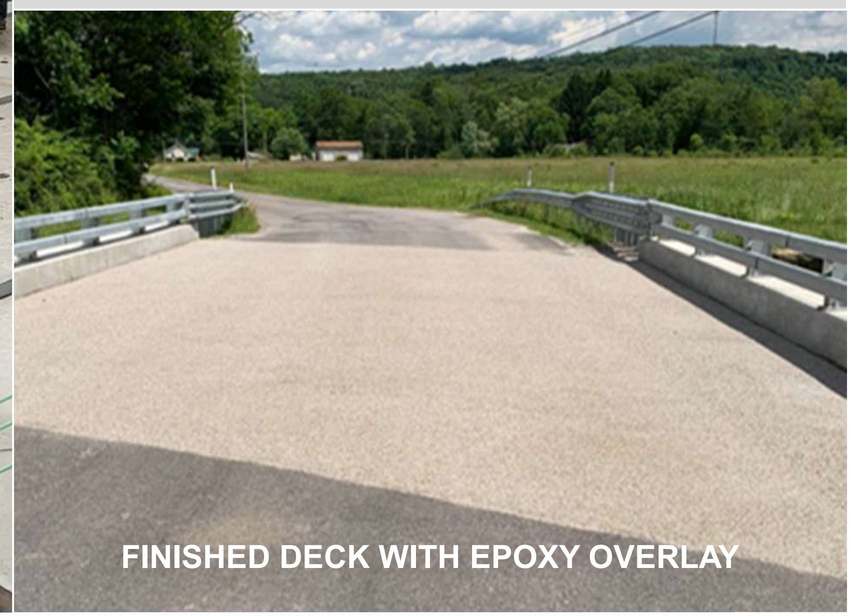
- Local DOT Approved Concrete Mix Design
- Contractor Installed

VALMONT COMPLETE BRIDGE SYSYTEM

- Local DOT Approved Concrete Mix Design
- Precast with Local Qualified Supplier and Approved Procedures

FULL DEPTH PRECAST CONCRETE DECK PANELS

- Produced in a controlled environment at Local Qualified Precast Manufacturer
- Local DOT Approved Mix Design
- Cast in Accordance with Local Approved Procedures



FINISHED DECK WITH EPOXY OVERLAY

2019 CHAMPAIGN COUNTY, IL LIFE CYCLE COST


JOB SITE TOUR: PBTG TECHNOLOGY
How it compares to traditional construction methods.
JOIN CHAMPAIGN COUNTY ENGINEER JEFF BLUE FOR A JOB SITE TOUR OF A PBTG BRIDGE
Wednesday, March 2 | 1-3pm CT
826 County Road 800N, Tolono, IL
(Located 15 minutes southwest of THE Conference venue)
Review an existing installation up close and personal for a better understanding of the PBTG technology and how it compares to traditional construction methods.

Most Long-Term Bang For Your Buck?

Precast Beams	Steel Beams With Concrete Deck	Concrete Slab Bridge	Galvanized PBTG With Concrete Deck
• $200/SF • Expected Life - 50 Years	• $300/SF • Expected Life - 75 Years	• $500/SF • Expected Life - 75 Years	• $263/SF • Expected Life - 100 Years

Reference: Jeff Blue, P.E., Champagne County Bridge Division

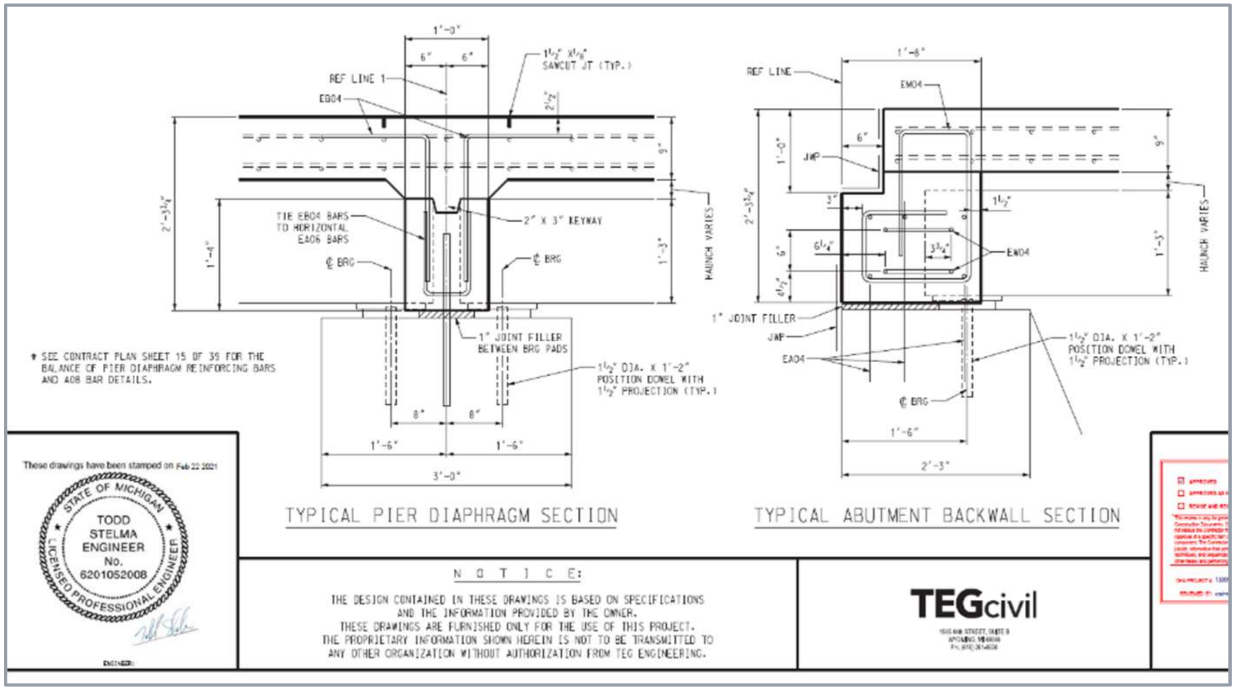
U-BEAM™ Advantage – Lifetime Value

HIGHEST LIFETIME VALUE – Press-Brake Tub Girder				
Bridge Technology	Precast Beams	Galvanized PBTG with Concrete Deck	Steel Beams with Concrete Deck	Concrete Slab Bridge
Cost Per Square Foot	$200	$263	$300F	$500
Expected Service Life	50 years	100 years	75 years	75 years
Cost Per Square Foot Over Lifetime	**$4**	☆ **$2.6** ☆	**$4**	**$6.7**

Reference: Jeff Blue, P.E., Champagne County Bridge Division

Latest Installation, Grand Traverse County, MI

- Contractor chose to VECP cast-in-place deck option



Grand Traverse County, MI, Installation

Consultant designed as precast concrete bridge deck, contractor chose to VECP cast-in-place deck option

The Boardman River is considered one of the top ten trout streams in Michigan

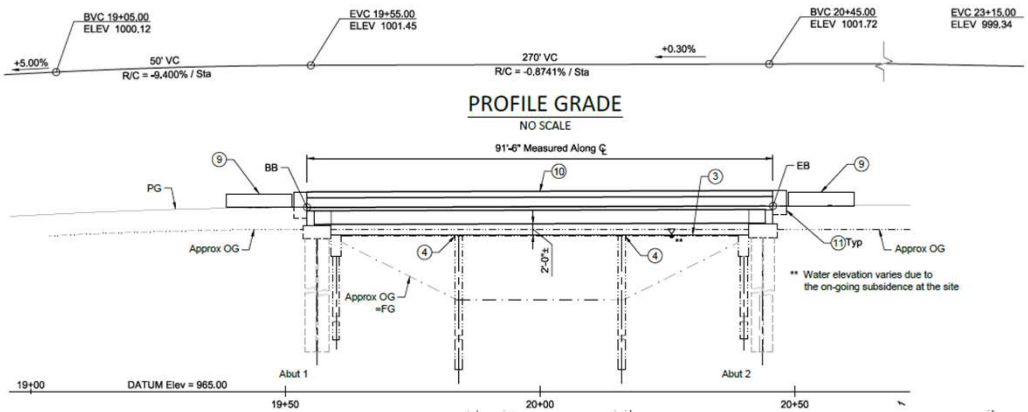
Grand Traverse County, MI, Installation

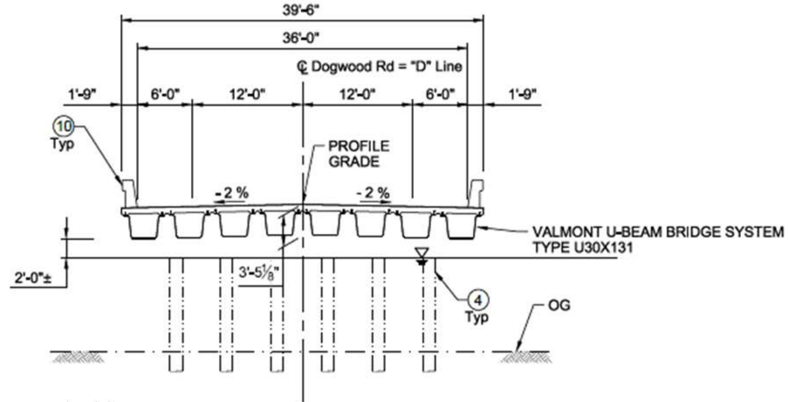
2 Span cast-in-place deck, open to traffic 2 weeks after U-BEAMs delivered

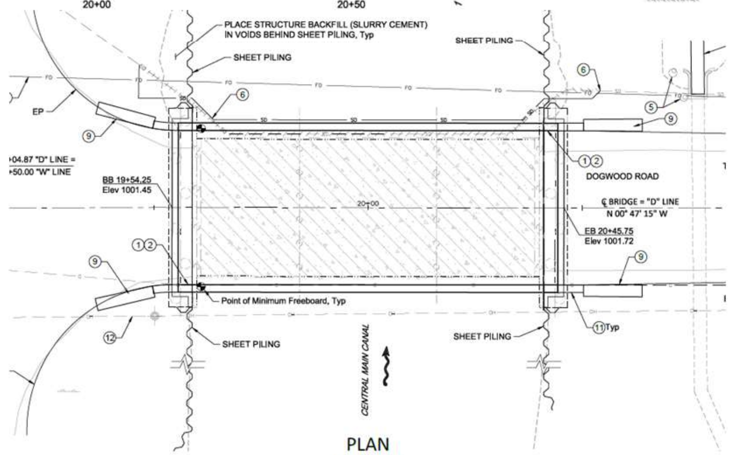
Grand Traverse County, MI, Installation

2022 IMPERIAL COUNTY CALIFORNIA

Dogwood Road Over Main Canal, Imperial County





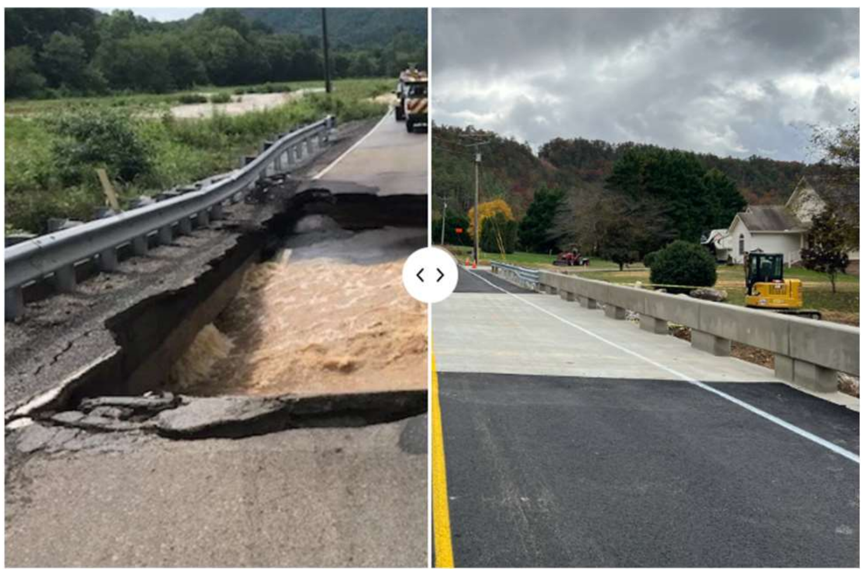


Dogwood Road Over Main Canal, Imperial County

2022 TDOT
SEVIER COUNTY

Expedited U-BEAM™ Bridge Installations

- TDOT Sevier County, TN, Emergency Bridge Replacement
- TDOT purchased U-BEAMs direct from Valmont
- Beams supplied in 6 weeks
- Bridge opened in less than 3 months



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Tub Girder ADVANTAGE: Time Savings

Reduce Construction Schedule By As Much As One Year!

Valmont provided all 157 U-BEAMs in an eight-month construction season:

- Secured ALL 500 tons of material for project by 3/12/21
- 3rd party inspection at Valmont Jasper, TN, facility
- Hot-Dip Galvanizing at Valmont Birmingham, AL, facility

Tub Girder ADVANTAGE: Economy of Scale

Efficient Freight, Easy Handling

Utilize regional carries on standard trailers:

- Deliver as many as six U-BEAMs in a single load
- unload with light equipment (rubber mounted)
- Easy job site storage (smaller footprint)
- Easy accessibility to job site (important in rural locations)

Tub Girder ADVANTAGE: Reduced Construction Cost

Simple Rigging, Smaller Equipment

Installation Made Easy:

- Nylon slings with basket rigging
- Extended reach of equipment (eliminate use of barges)
- Use of smaller equipment (some sites only need an excavator)
- Easy accessibility to job site (important in rural locations)

Tub Girder ADVANTAGE: Reduced Construction Cost

Less Field Work, Less Exposure to Hazardous Conditions

Forming Made Simple:

- No external intermediate diaphragms
- Concrete forming directly atop top flanges (no welding)
- Constant haunch (no survey prior to installation)
- Pre-installed formwork hardware (half-hangers and screed studs)
- Easily and safely install fascia brackets on the ground

THANK YOU

PRESENTED BY
Jeff Simkins
National Bridge Sales Manager
Valmont Industries, Inc.
Jeff.Simkins@valmont.com
618-570-6841