20 YEARS OF DESIGN AND CONSTRUCTION EXPERIENCE

Spliced Precast Girder Bridges

Boggy Creek Interchange – Orlando Florida

20 YEARS OF DESIGN AND CONSTRUCTION EXPERIENCE

Spliced Precast Girder Bridges

Straight Spliced Precast Girder Bridges

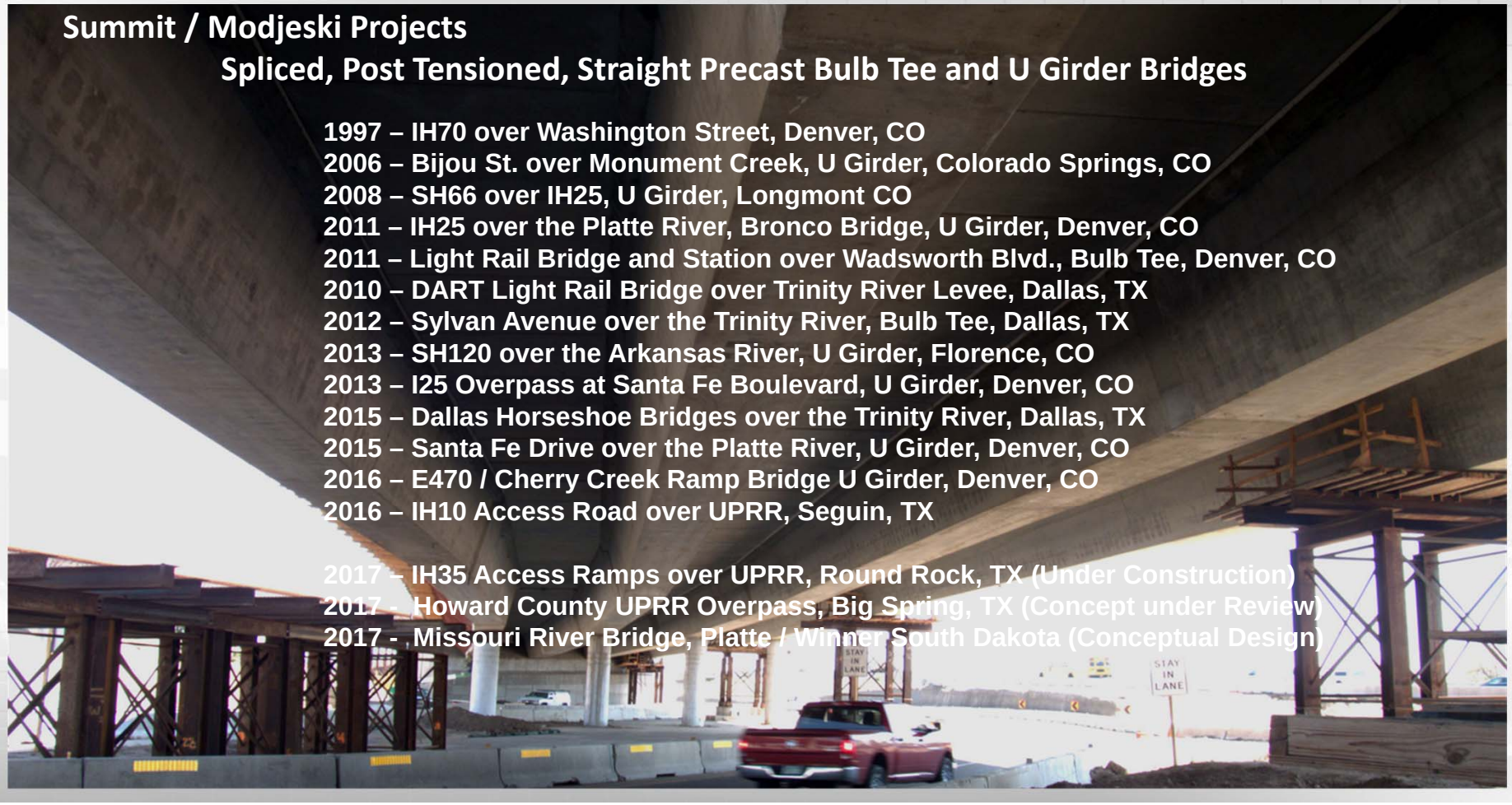
Development of Spliced, Curved U Girder Bridges in Colorado and Florida

FDOT and PennDOT standards for Spliced U Girder Bridges

Case Study: JT Butler Expressway in Jacksonville Florida

Sylvan Avenue over the Trinity River – Dallas Texas

CURRENT STATE OF THE ART | Spliced Precast Girder Bridges



Summit / Modjeski Projects

Spliced, Post Tensioned, Straight Precast Bulb Tee and U Girder Bridges

1997 – IH70 over Washington Street, Denver, CO
2006 – Bijou St. over Monument Creek, U Girder, Colorado Springs, CO
2008 – SH66 over IH25, U Girder, Longmont CO
2011 – IH25 over the Platte River, Bronco Bridge, U Girder, Denver, CO
2011 – Light Rail Bridge and Station over Wadsworth Blvd., Bulb Tee, Denver, CO
2010 – DART Light Rail Bridge over Trinity River Levee, Dallas, TX
2012 – Sylvan Avenue over the Trinity River, Bulb Tee, Dallas, TX
2013 – SH120 over the Arkansas River, U Girder, Florence, CO
2013 – I25 Overpass at Santa Fe Boulevard, U Girder, Denver, CO
2015 – Dallas Horseshoe Bridges over the Trinity River, Dallas, TX
2015 – Santa Fe Drive over the Platte River, U Girder, Denver, CO
2016 – E470 / Cherry Creek Ramp Bridge U Girder, Denver, CO
2016 – IH10 Access Road over UPRR, Seguin, TX

2017 – IH35 Access Ramps over UPRR, Round Rock, TX (Under Construction)
2017 - Howard County UPRR Overpass, Big Spring, TX (Concept under Review)
2017 - Missouri River Bridge, Platte / Winner South Dakota (Conceptual Design)

CURRENT STATE OF THE ART | Spliced Precast Girder Bridges

Summit / Modjeski Projects
Spliced, Post Tensioned, Curved Precast U/Box Girder Bridges

Early Curved Precast Girder Bridges
- 2000 – Parker Road / IH225, Curved CIP U girders

Colorado
- 2005 – 270 / IH25 Ramp K
- 2008 – E470 / IH70 Ramp H
- 2008 – 270 / IH76 Ramp Y
- 2008 – Austin Bluffs over Union
- 2008 – IH25/Trinidad Phase I
- 2009 – SH58 / IH70 Ramp A
- 2010 – IH25/Trinidad Phase II
- 2012 – C470 @ Santa Fe Drive
- 2013 – I25 Ramp 1 @ Santa Fe Drive
- 2015 – I25 Ramp 5N, (Designed)

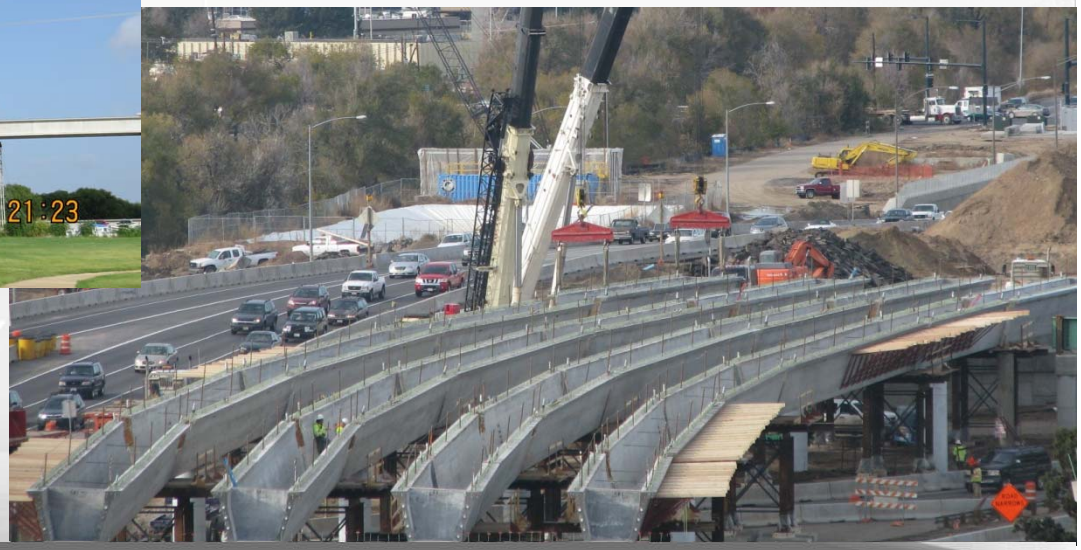
Florida
- 2015 – Boggy Creek Interchange, Orlando FL
- 2017 – J T Butler Expressway Flyover 1, (Under Construction)
- 2017 - Sound Transit Light Rail Bridges, Seattle, WA

Precast Bridge Applications using Straight, Standard Shapes

Long Span Spliced Girder Bridges using Standard Bulb Tee Sections

Sylvan Avenue over the Trinity River – Dallas Texas

Complex Interchange Projects Using Standard U Girder Sections



IH25 / Santa Fe Interchange, Denver CO

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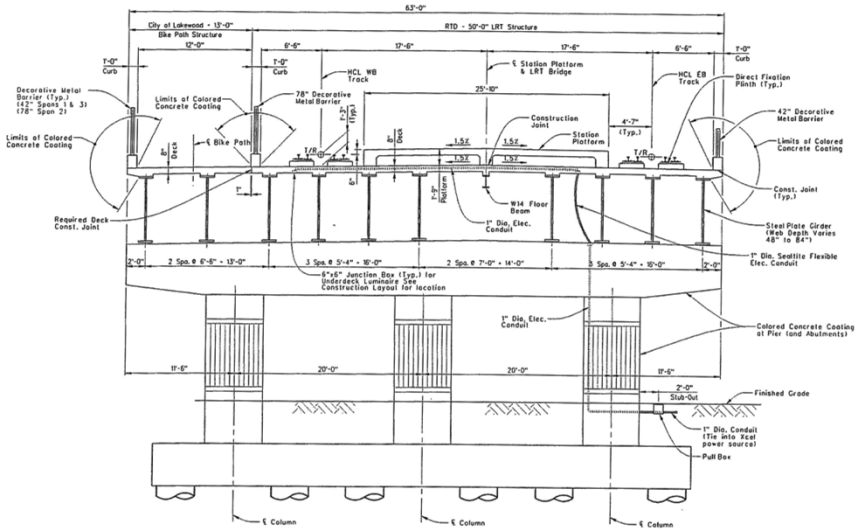
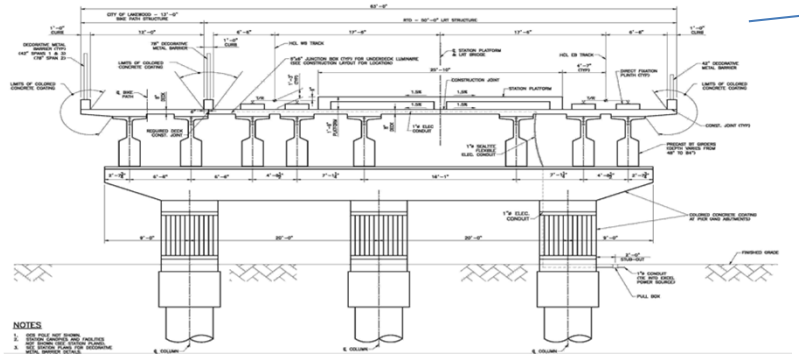
Spliced Bulb Tee Bridges

Wadsworth Light Rail Bridge and Station, Denver Colorado





Design

Original Steel Design

- 10 Haunched Steel Plate Girders, 48” to 84” Web Depth
- Varying Cambers for each girder line
- Drop Cap Bent with bearings and CIP Diaphragm
- 12 Drilled Shafts and Footing foundation

Precast Concrete Alternate Design

- 8 Continuous, Spliced Precast Concrete Girders, 48” to 84” Deep
- Uniform Cambers
- Drop Cap w/ Integral Diaphragm, no bearings
- Single Drilled shaft at each pier

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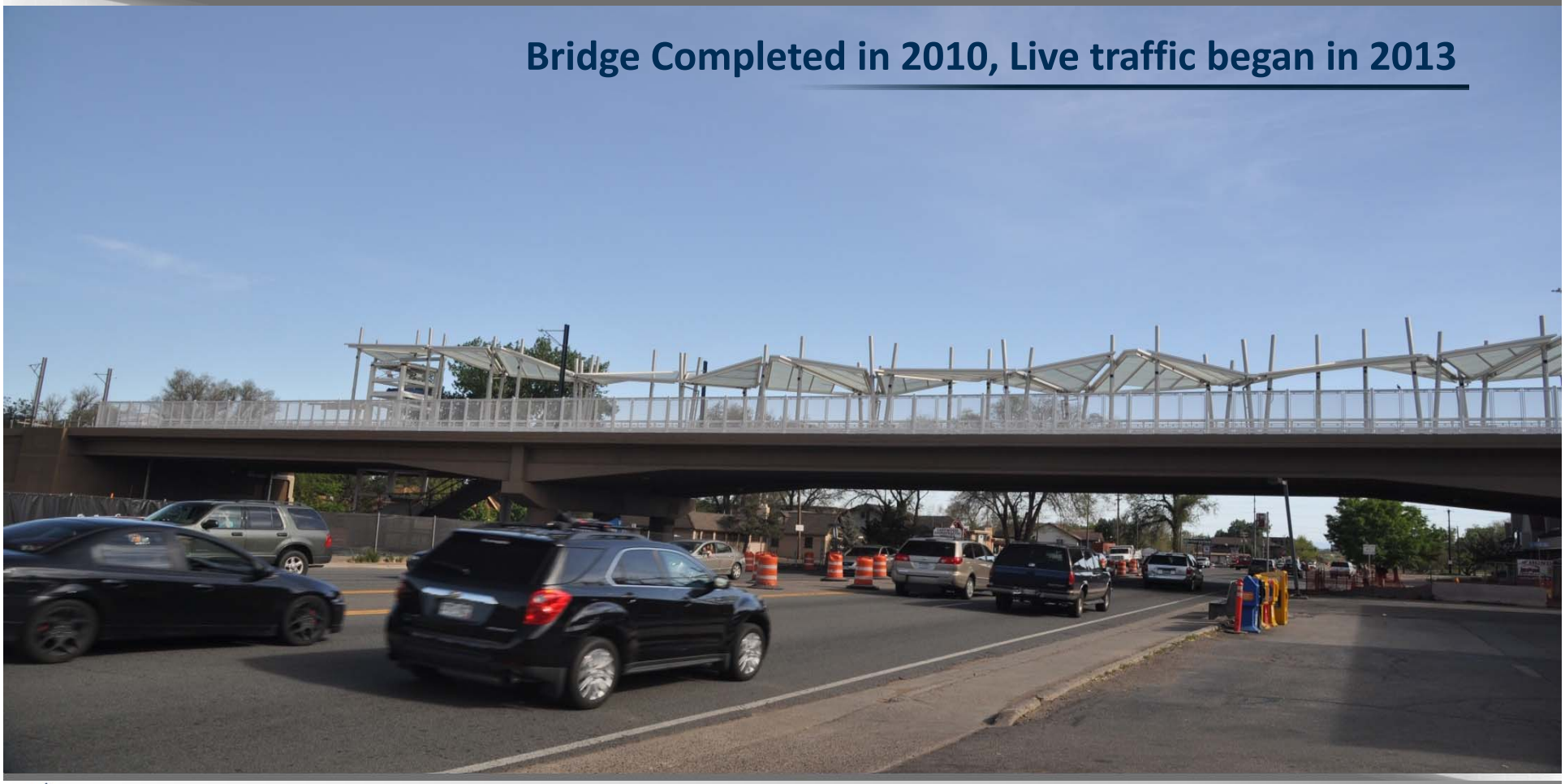
Precast Girders set on Temporary Shoring

- Girder Post Tensioning Stress in one stage
- Diaphragms and Splices formed and cast


Platforms & Station integral with Bridge Deck


Bridge Completed in 2010, Live traffic began in 2013

Texas Looks to the Future with Spliced Precast Construction

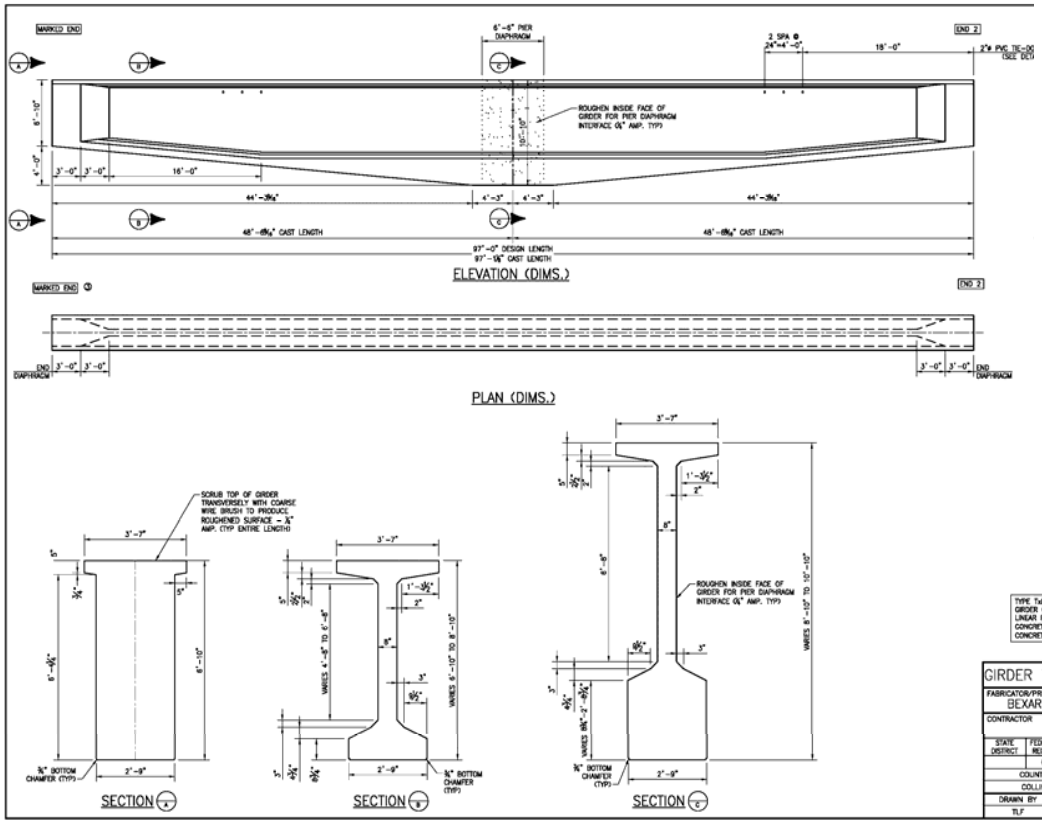
7 Projects completed or under construction in the last 7 years

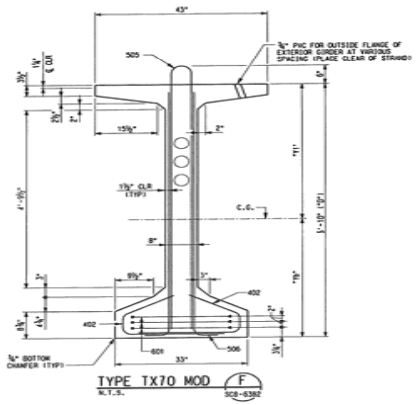
All projects from Design / Build and City Improvement Projects

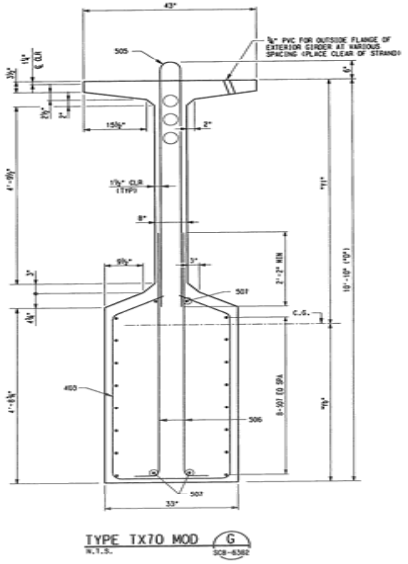
Trinity River Corridor between Dallas and Fort Worth

2 New Precaster initiated projects under way in Central Texas designed by M&M/Summit

Precaster's Modified Pier Girder Cross Section:







Original Pier Girder Cross Section

Girder Cross section modified to reduce shipping weight

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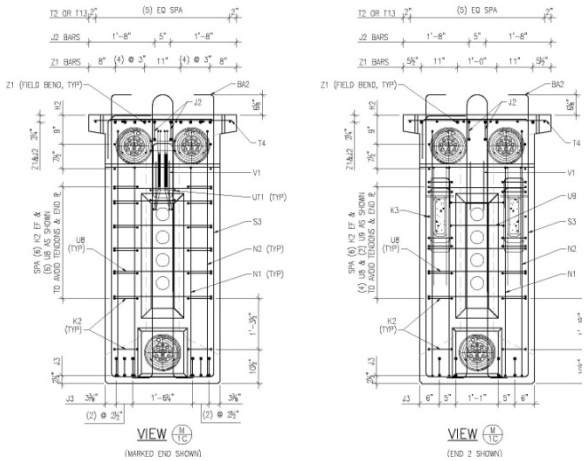
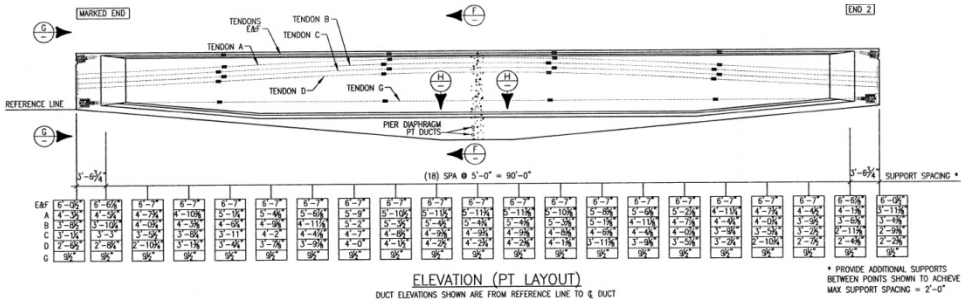
Spliced Precast Bulb Tee Girder Bridges





Design

Variable Depth Pier Girders

- TX82 to 130” deep Section
- Supplemental Post Tensioning in Top Flange
- Web Tendons harped to high point over pier
- 6’ long tapered End Blocks in Pier Girders
- Steel Corbels embedded in End Blocks to support adjacent girders during erection
- Corbels replace conventional strong backs and are permanently embed in splices

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Precast Girder Erection
2013/07/21 21:23

Bridge Completed in 2013

Dallas Horseshoe Bridges over the Trinity River, Dallas, Texas

Twin 1200’ span Arches support pedestrian bridges on either side of the project

Bridge Configuration

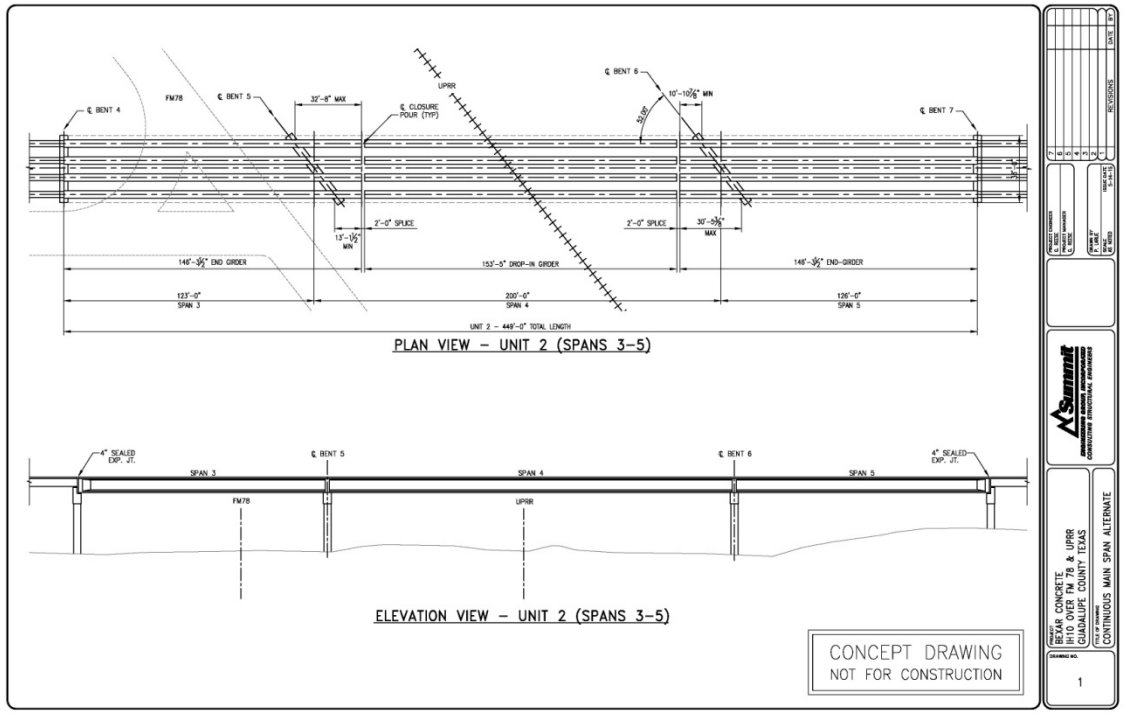
- 6 Bridges with Spliced Precast Concrete Superstructure and Simple Span approaches.
- Continuous 4 span Spliced Girder Units
- Typical Span Arrangements
  - 240’ – 260’ – 260’ – 240’
  - 250’ – 250’ – 250’ – 250’
  - 240’ – 270’ – 270’ - 240’
- Variable Pier Girders
- Multiple Column Bents with Pot and Expansion Bearings
- Cast-in-place Deck, Unshored.

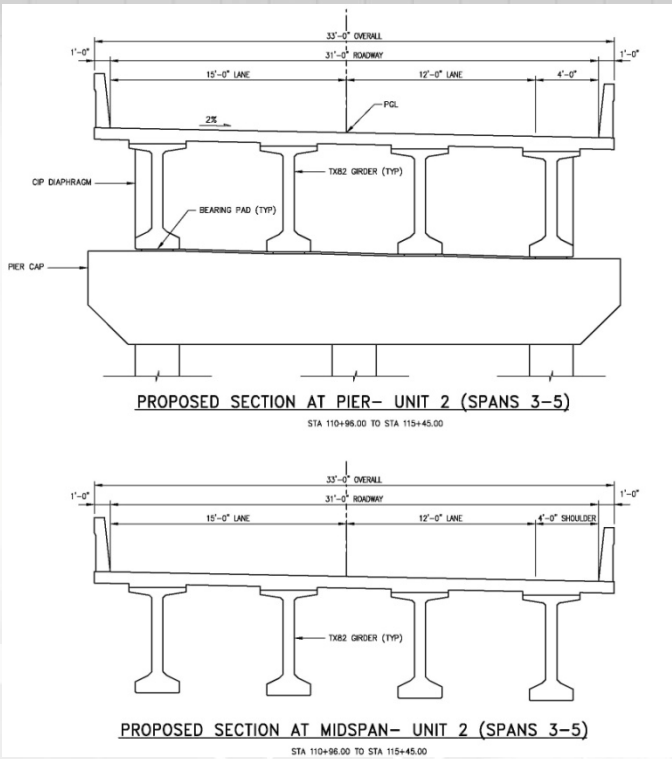

Construction Progress
Photos

Project Scheduled for Completion in 2017

New Bridge Design – Seguin Texas

Precaster Initiated Alternate Design

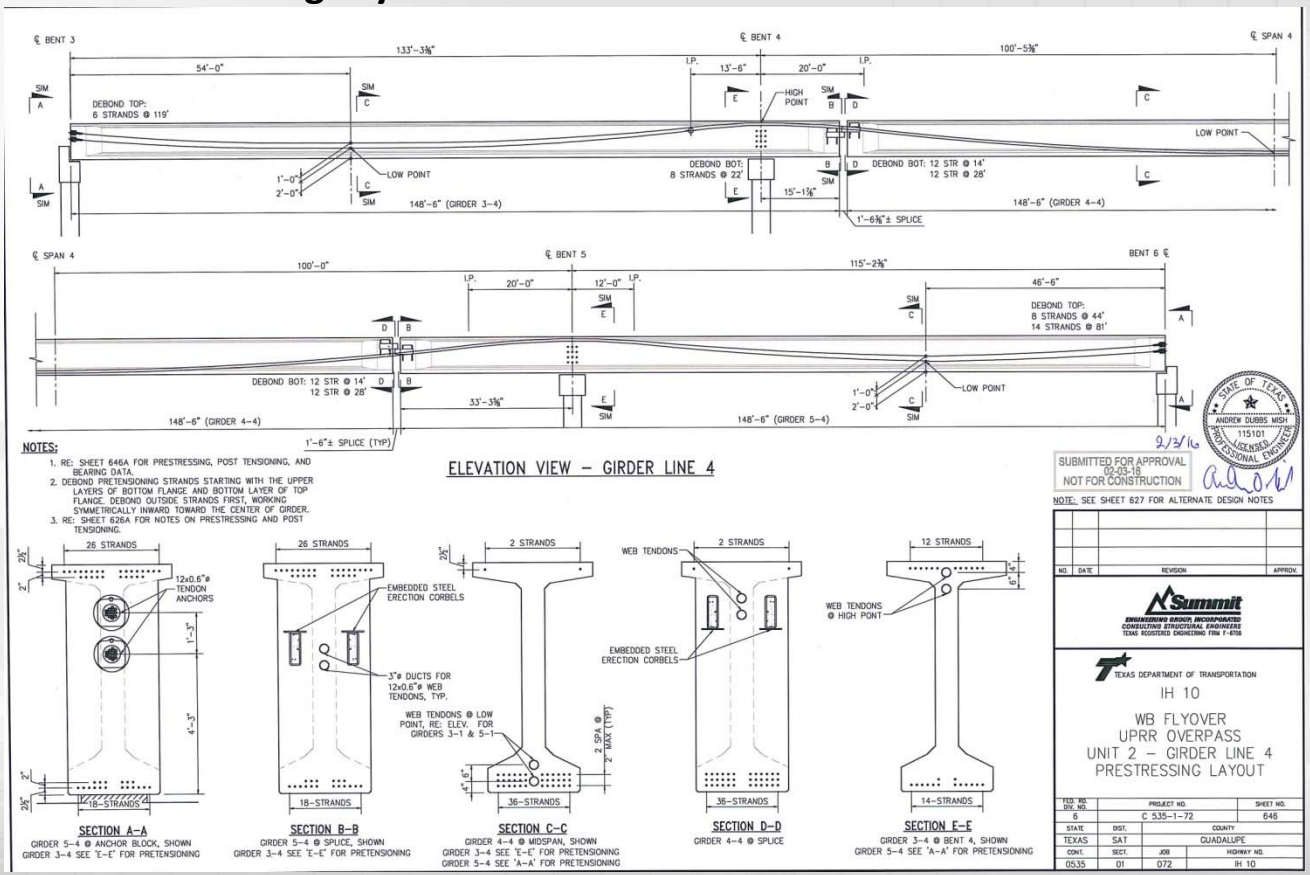




123', 200', 126 Simple Span arrangement converted to 3 span continuous unit using existing TX82 forms

All Girders are Constant Length and Depth

Post Tensioning Layout



Each Girders Line is Unique due to skewed Interior Piers

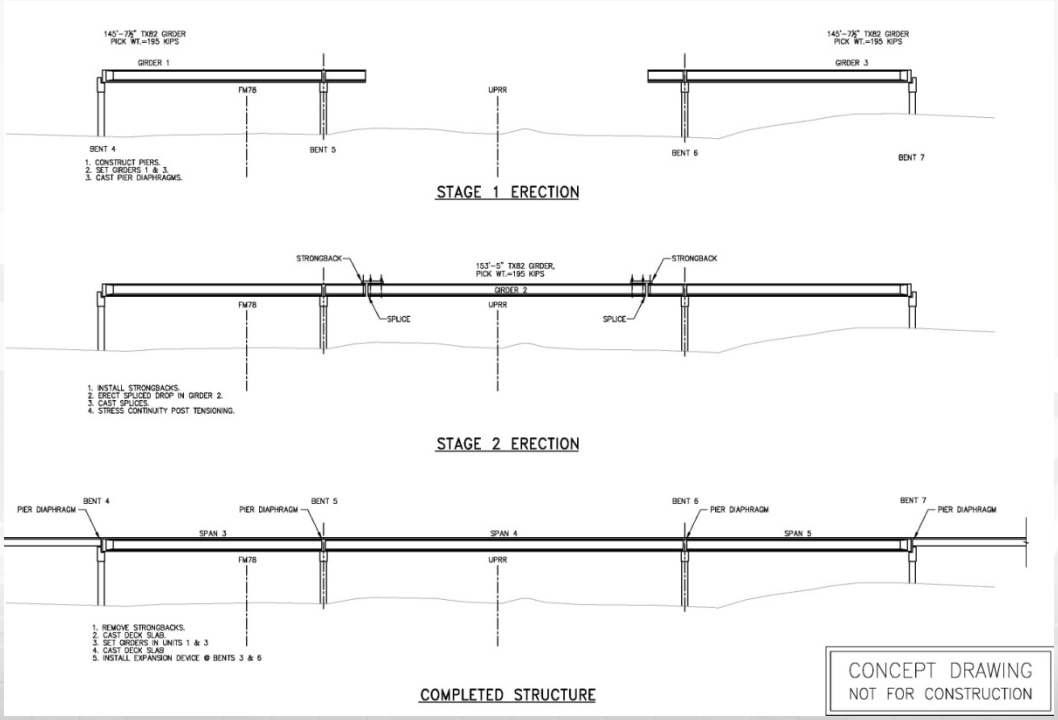
Design optimizes pretensioning and debonding in bottom and top flanges to minimize Post Tensioning.

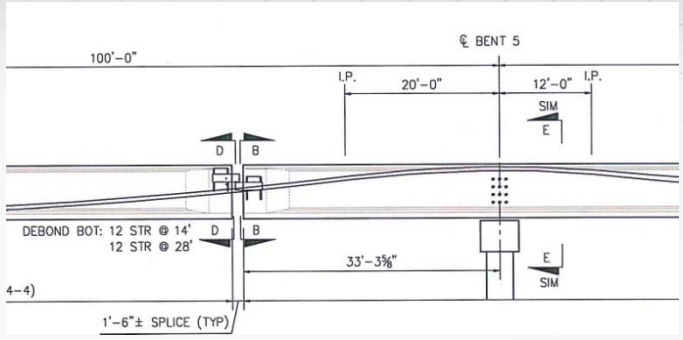
Only 2 – 12 strand tendons per web necessary.

Construction Sequencing

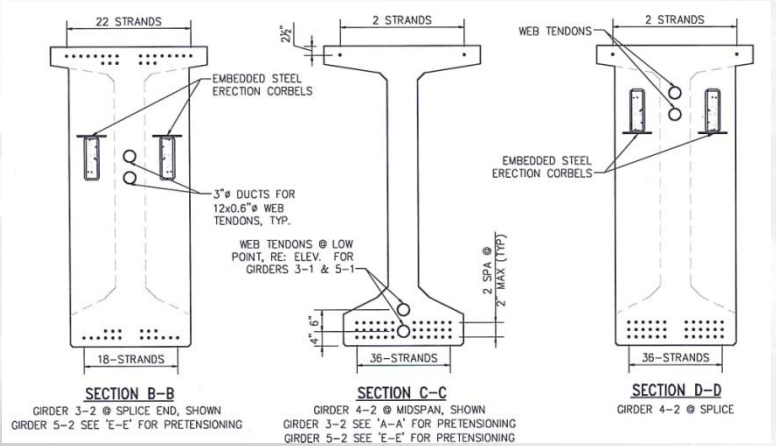
End Girders Set on Piers, Drop In Girders Set on Erection Corbels

No Shoring Required





Erection Corbels Details at Splices



IH25 Bronco Bridge over the Platte River

Construction Schedule

Phase	Start Date	End Date	Duration
1	Nov. 22, 2011	May 4, 2012	164
2	May 7, 2012	Aug. 19, 2012	104
3	Aug. 23, 2012	Dec. 3, 2012	102
4	Dec. 4, 2012	April 4, 2013	121

Precast Piers and Full Depth Precast Deck

IH25 Bronco Bridge over the Platte River

Deck panels set on girder flanges.

Precast Piers Erected on Shoring

Precast Piers and Full Depth Precast Deck

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IH25 Bronco Bridge over the Platte River

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Fully Precast Bridge with No Bearings

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IH25 and Santa Fe Drive
Intersection Bridges

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Ramp 1 Flyover

IH25 Overpass at Santa Fe Drive

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IH25 Overpass at Santa Fe Drive

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Straight U Girders kinked to accommodate curved alignment

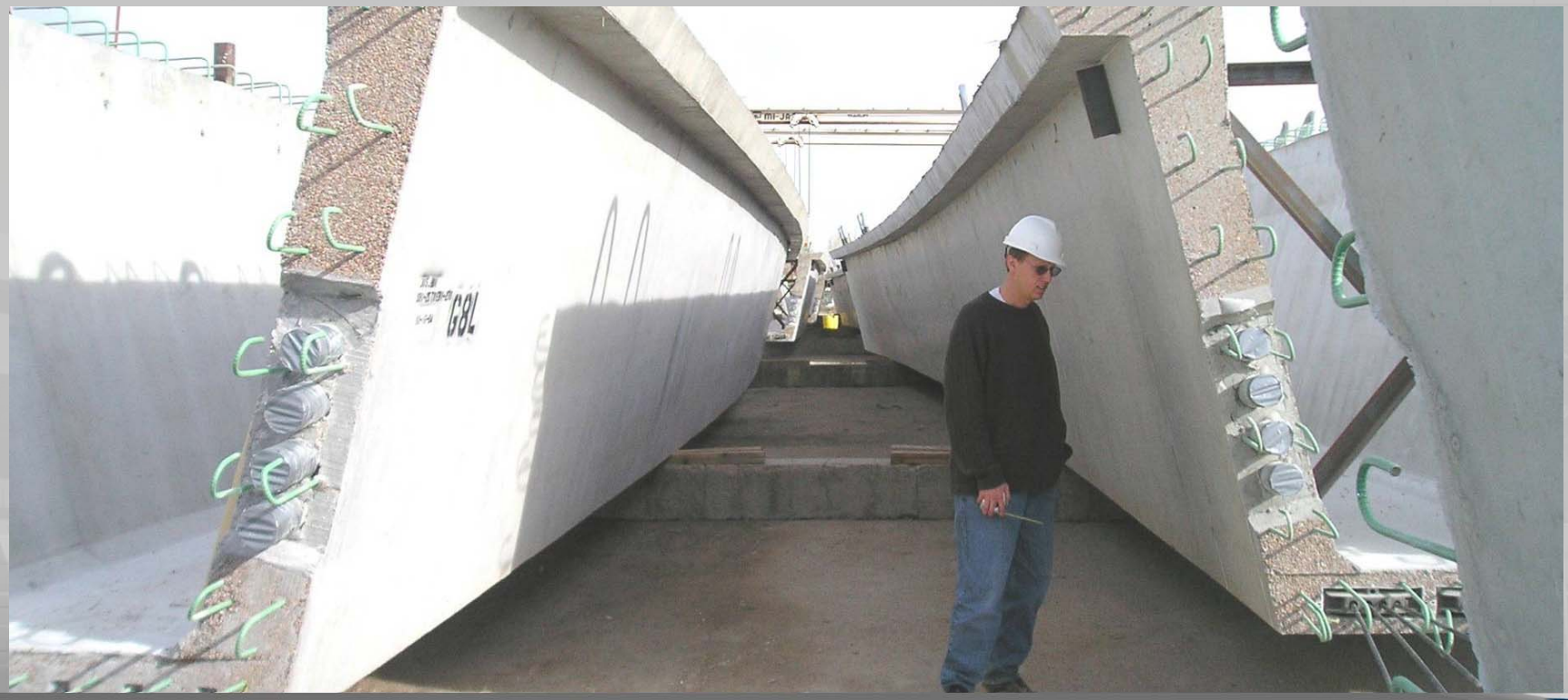
Curved Precast U Girder Bridges

IH25 SB Ramp K, Denver CO

SH58 / IH70 Ramp A Flyover, Golden, CO

Reinforcing Cage in Curved U Girder Forms Prior to Casting

Curved U84 Girders in Storage Area



Design Features of Bijou St. Bridge

- *Thickened Bottom Slab over Piers*
- *Varying Web Thickness*
- *Cantilever PT Anchors in Webs*
- *Shoring Support Slabs*

▲ **Completed Bridge featuring enhanced aesthetics.**
All Structural enhancements not visible

Girder Transportation

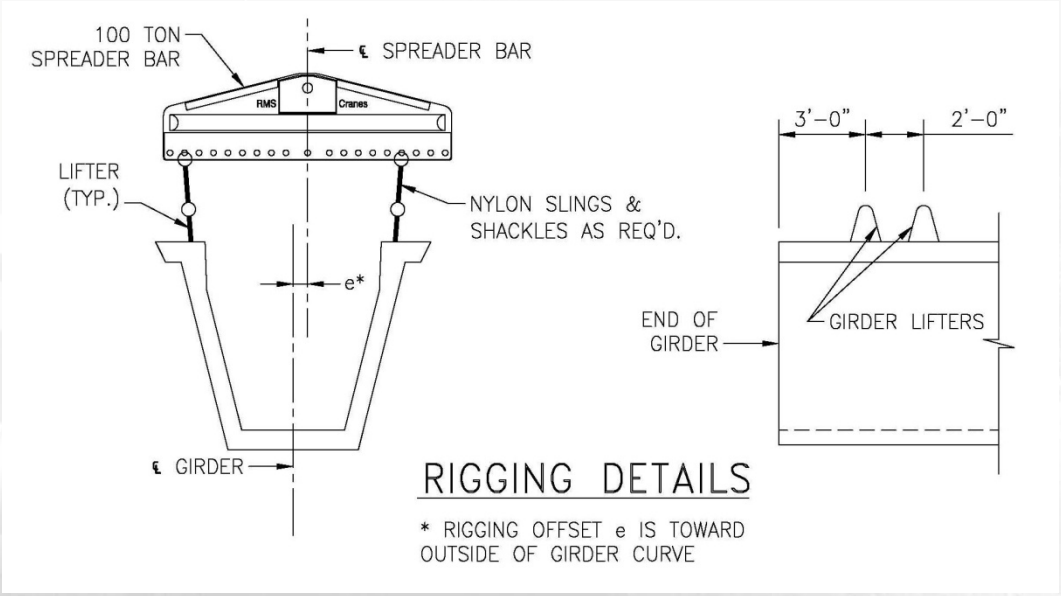
- Shipped to job site on high load, steerable trailers

Girder Erection

- Girders Set on Temporary Shoring with Hydraulic and Crawler Cranes
- Curved Girders Braced to Shoring

Girder Erection

- Curved Girders Lifted with offset spreader bar to balance roll



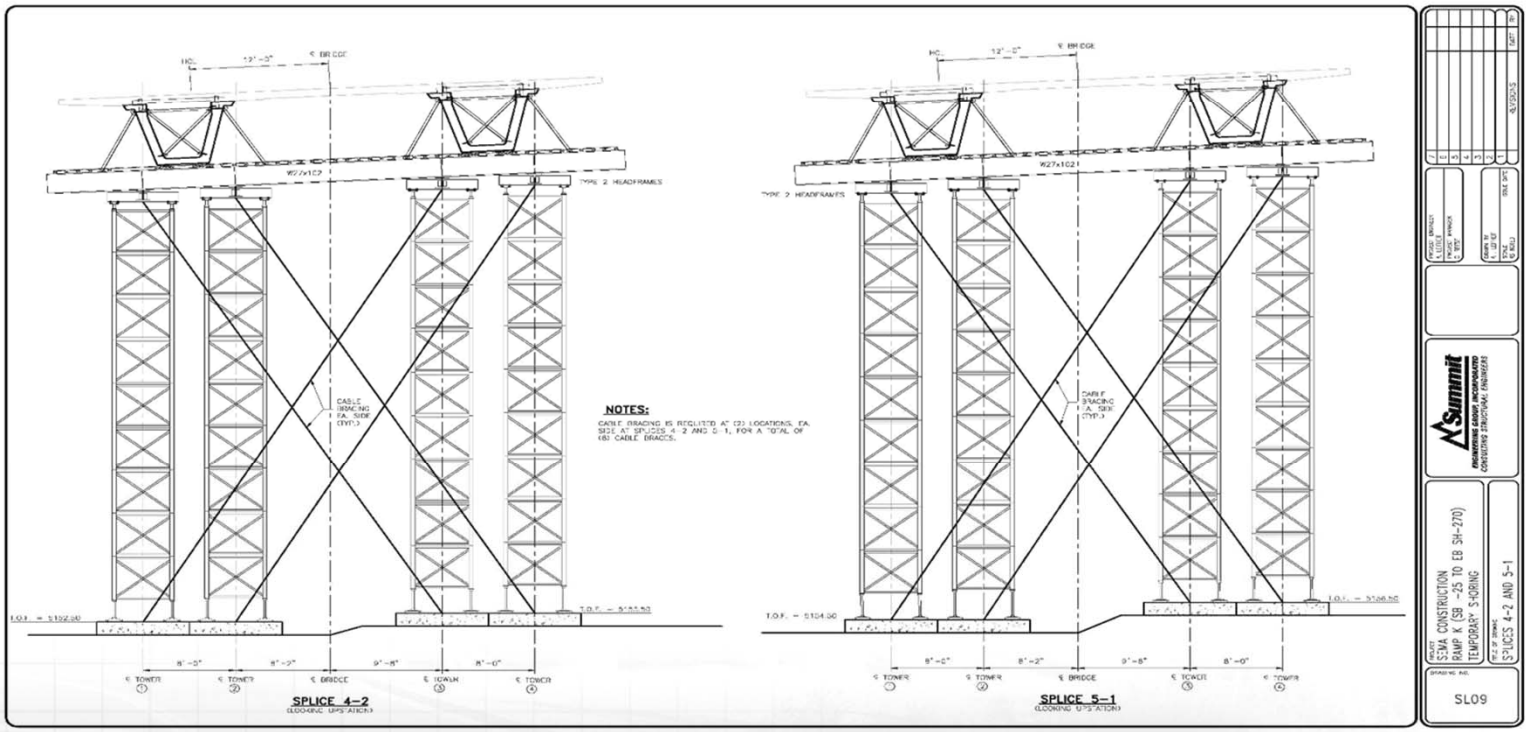
Erection Mishap in 2007
Crane Boom Failure,
Girder Fell 20' hitting Crane
Crane was totaled
U Girder was placed on Abutments with minor repair to top flange

Engineered Temporary Shoring

- Falsework Towers and Straddle Bents

- Ramp K on 45’ Tall Falsework Towers @ Pier 5

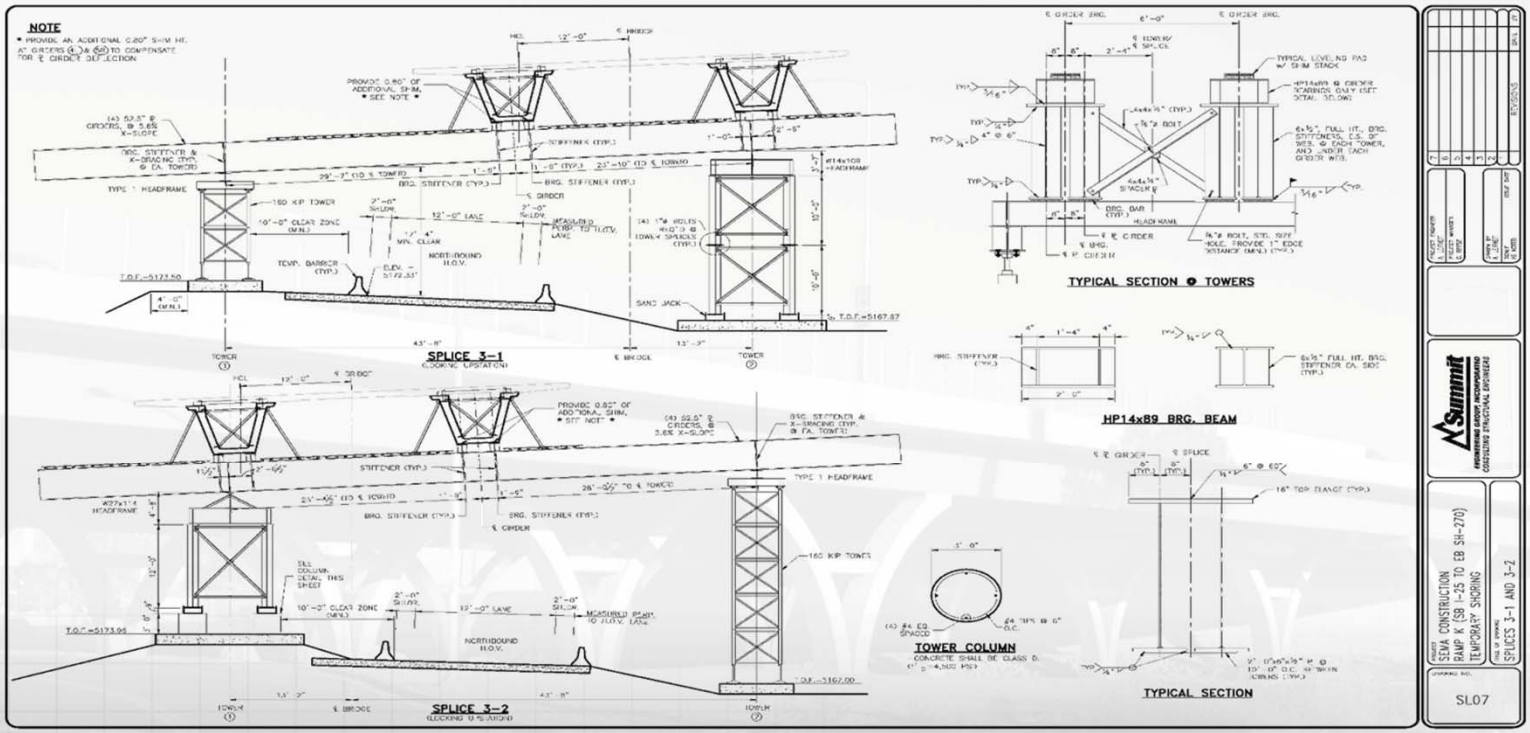
Construction Engineering – Temporary Shoring



Temporary Shoring During Construction

- Ramp K Girders supported on Straddle Bents
- HOV lanes open during construction

Temporary Shoring – Straddle Bents



Construction Engineering - Temporary Shoring

- Majority of Projects Constructed Over Existing Interchanges on Curved Alignment

Temporary Shoring During Construction

- Ramp Y Safety Rail protecting
- Falsework Bents Adjacent to IH76 Traffic

Temporary Shoring During Construction – Strong Backs

- Ramp K Erection completed using strong backs over IH25 and 270 Bridge

Erection of Precast U-Girders

- Only Vertical Temporary Shoring required
- Adaptable to variable site conditions
- Able to accommodate Maintenance of Traffic

Maintenance-Of-Traffic – UPRR Rail Yard

- Bijou Street Bridge Erection used Strongbacks to avoid ground supported falsework

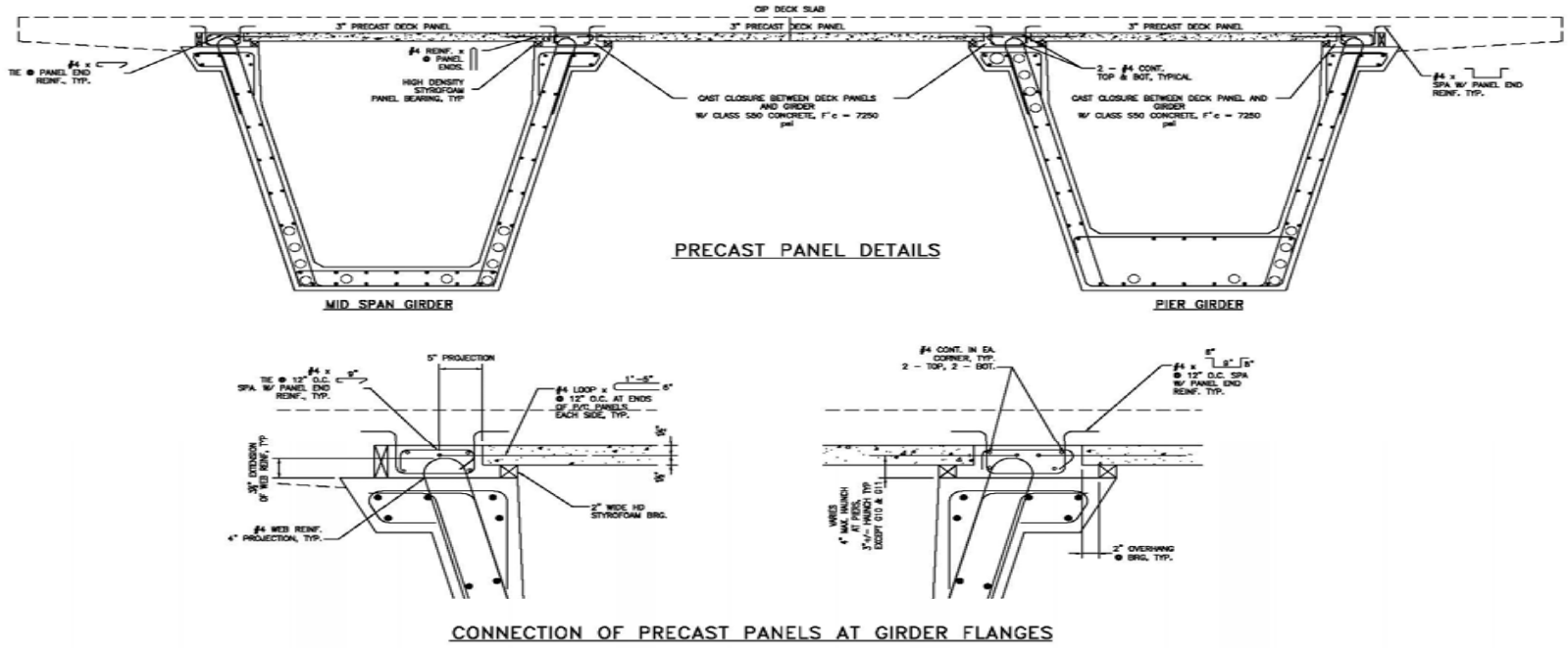
Maintenance-Of-Traffic – UPRR Rail Yard

- Bijou Street Bridge Erection of Span 3 over Rail Yard during continuous rail traffic

Maintenance-Of-Traffic

- Bijou Street Bridge Span 3 set over Rail Yard, 148’ Clear Opening

Casting of Lid Slab - Precast U-Girders

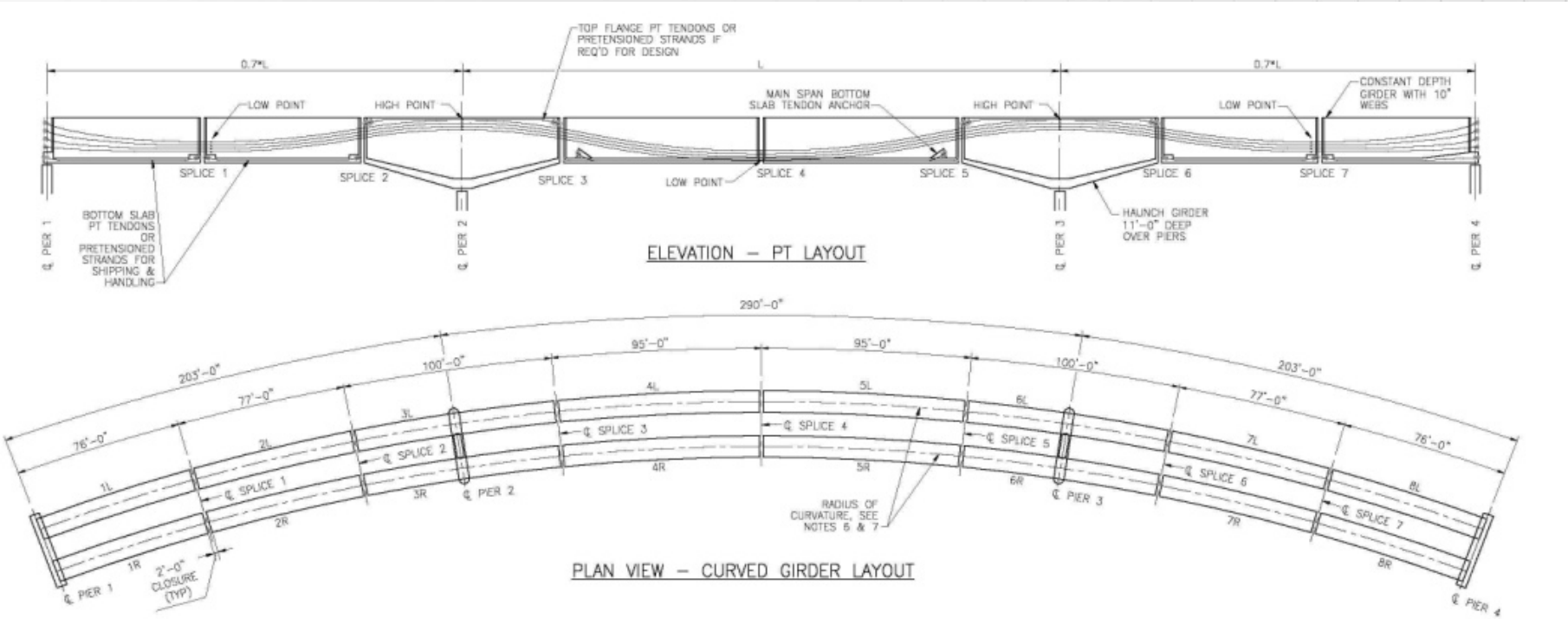


- Lid Slab Cast Prior to Stressing Longitudinal PT
- Creates a Closed Cell Box to increase Torsional Strength and Rigidity

Erection of Precast U-Girders

- Lid Slab can be CIP or use Precast Deck Panels
- Diaphrams at Piers and Abutments cast prior to stressing longitudinal PT

Longitudinal Post Tensioning Layout



- Lid Slab Cast Prior to Stressing Longitudinal PT
- Creates a Closed Cell Box to increase Torsional Strength and Rigidity

Post Tensioning of Girder Lines

- Expansion Pier Diaphragm cast at Abutment w/ PT Anchorages

Designed for Future Deck Replacement

- Falsework Removed
- Post Tensioning Stressed
- No intermediate diaphragms
- Decks cast in unshored condition

Casting of Deck Slab

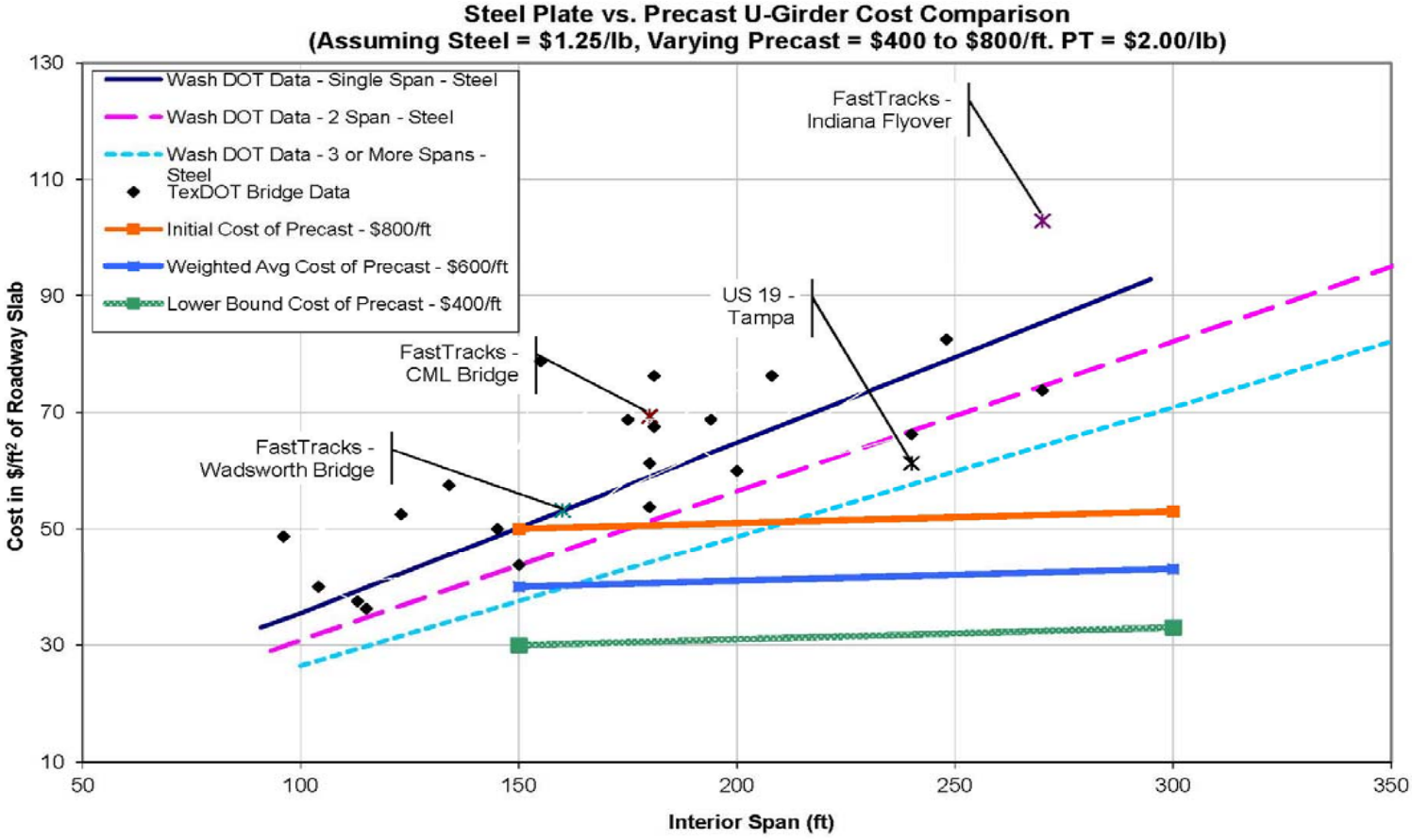
- Overhang Forms Graded,
- Deck Reinforcing places
- Deck Slab Cast

Deck Cast and Project Complete – SH58 Ramp A Bridge, Golden Colorado

Project Cost Savings – Steel vs. Concrete

270 Ramp Y Cost Data

Item	Steel Design	Curved Precast
Girder Costs	$5,125,000	$3,086,240
Erection Costs	$1,025,000	$890,000
Falsework Costs	$50,000	$250,000
Post-Tensioning Costs	$0	$506,000
Total	$6,200,000	$4,732,240
Cost/Ft.	$1,393/Ft.	$1,063/Ft/



Superstructure Costs Based on Average Values and Actual Data

Innovative Use of Precast Members

PennDOT Standards for Precast U Girders


INTRODUCTION

GENERAL NOTES

INDEX OF DRAWINGS

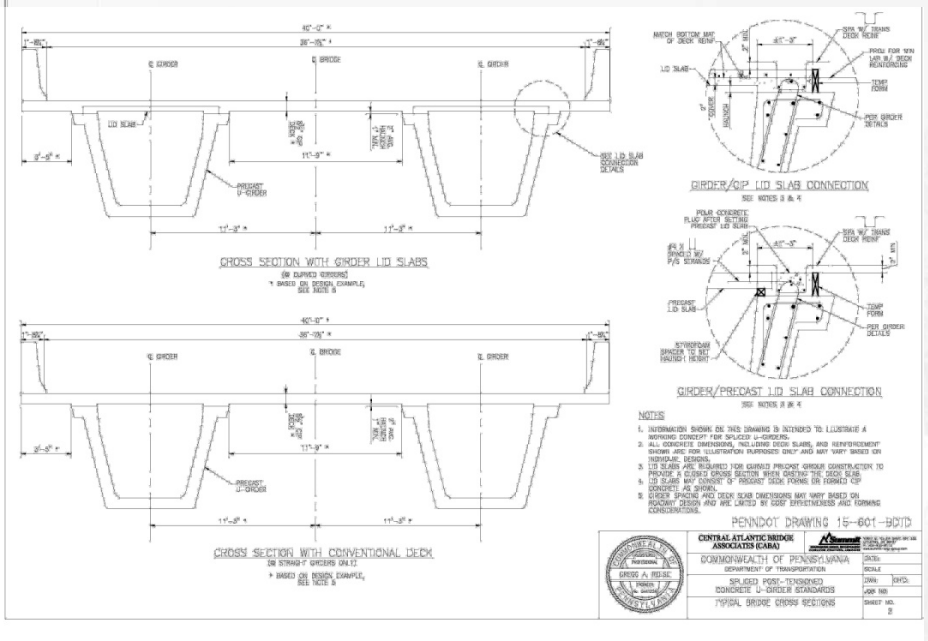
PENNDOT DRAWING 15-601-BDTD

CENTRAL ATLANTIC BRIDGE ASSOCIATES (CABA)

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

SPLICED POST-TENSIONED CONCRETE U-GIRDER STANDARDS

OVERVIEW OF SYSTEM, INSTRUCTIONS GENERAL NOTES


CROSS SECTION WITH GIRDER LID SLABS

CROSS SECTION WITH CONVENTIONAL DECK

GIRDER/QIP LID SLAB CONNECTION

GIRDER/PRECAST LID SLAB CONNECTION

NOTES

PENNDOT DRAWING 15-601-BDTD

CENTRAL ATLANTIC BRIDGE ASSOCIATES (CABA)

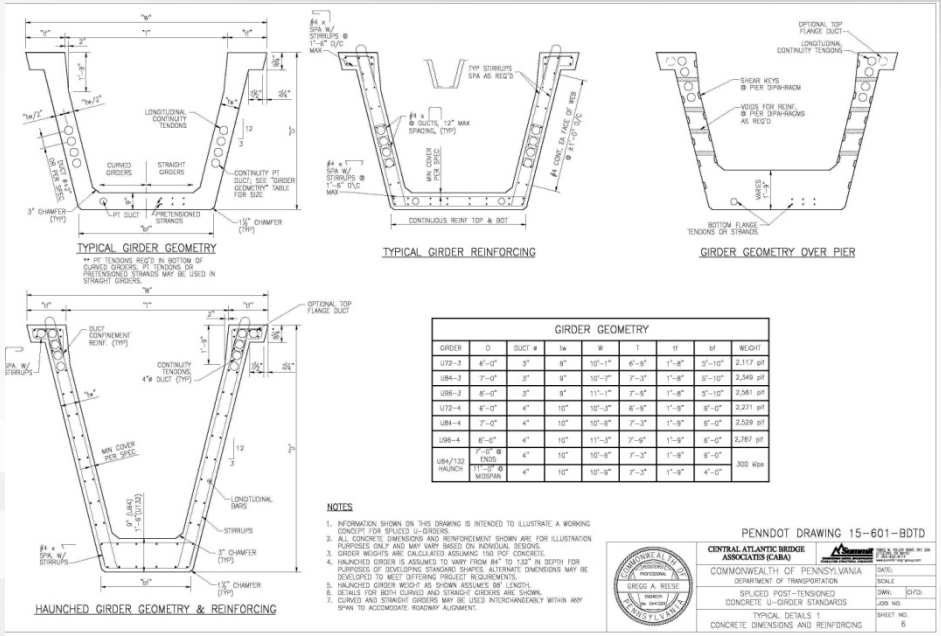
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

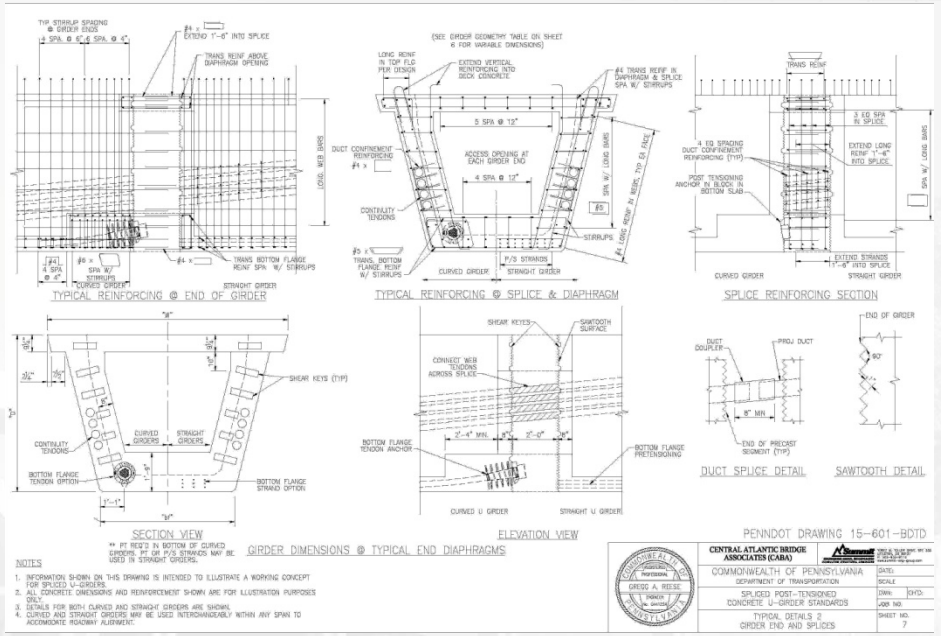
SPLICED POST-TENSIONED CONCRETE U-GIRDER STANDARDS

TYPICAL BRIDGE CROSS SECTIONS

- 21 Drawings and Supporting Calculations
- 3 Span Configurations Represented
- Approved and Adopted, Summer 2016

Reinforcing Details for Developed for Various Design Conditions





Constant Depth and Haunched Cross Sections

PennDOT U Girder Standards

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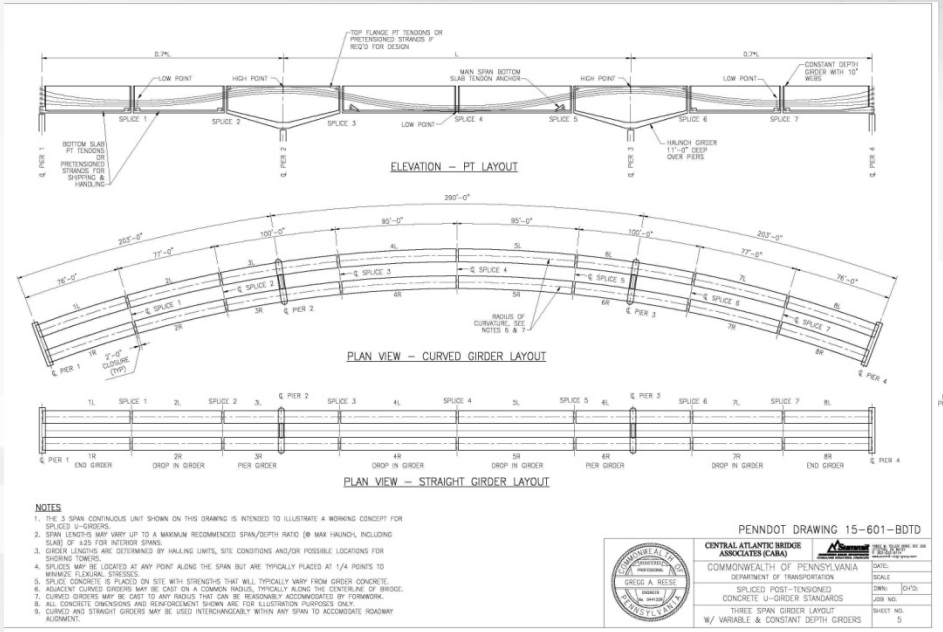
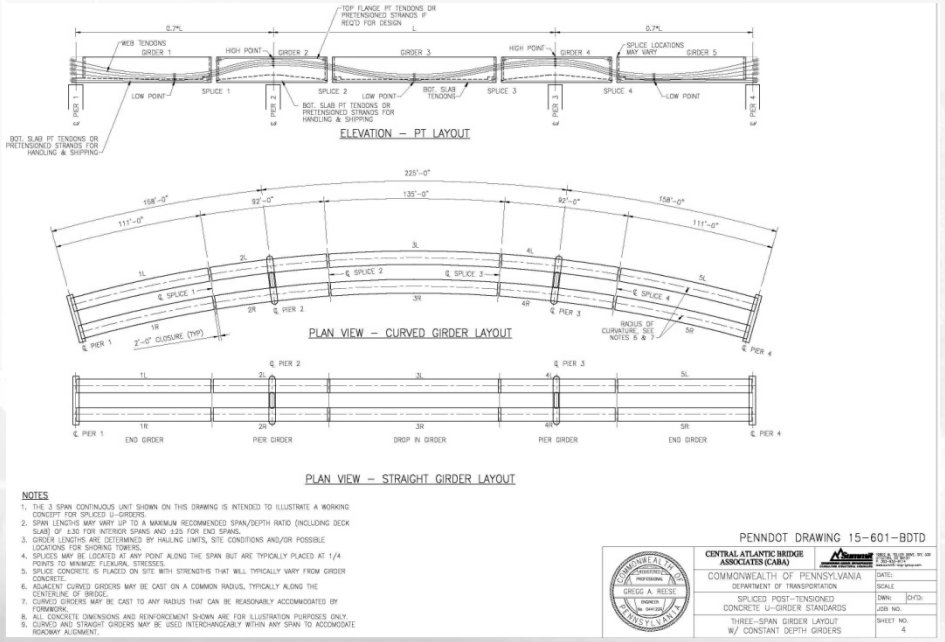
PennDOT U Girder Standards

Prototype Girder and Post Tensioning Layouts

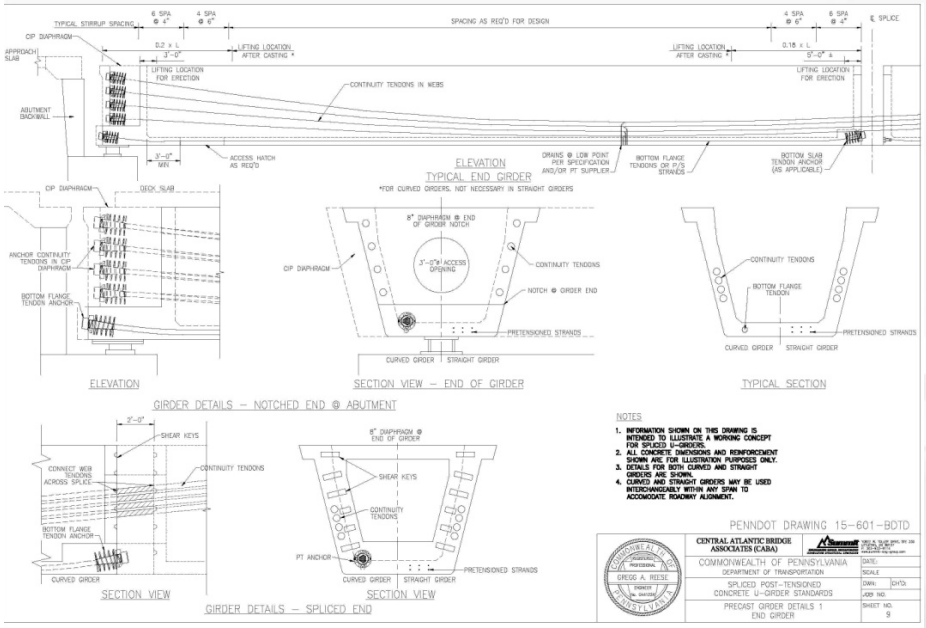


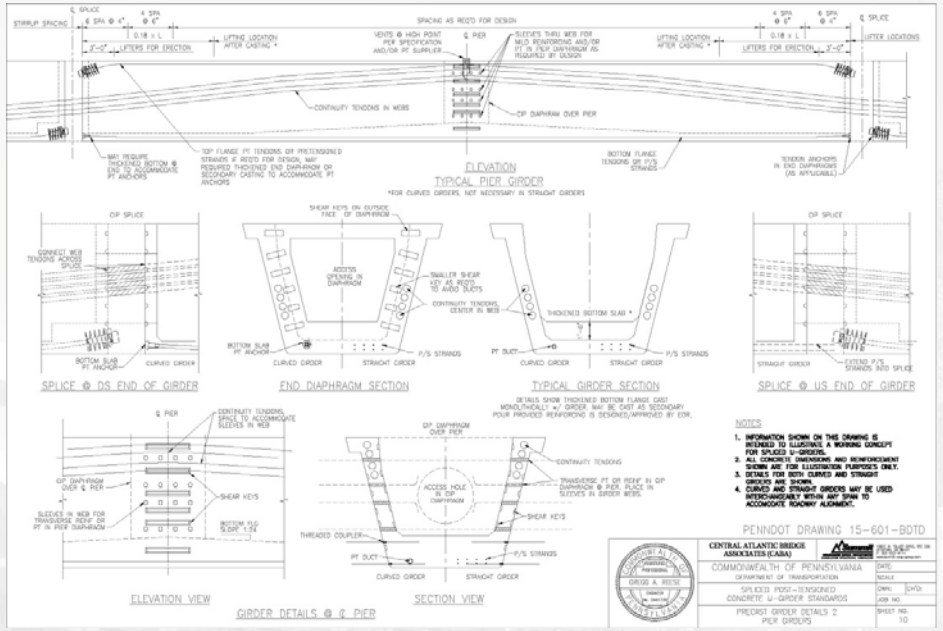


Span Ranges from 200’ to 300’
Curved and Straight Alignments

PennDOT U Girder Standards

Post Tensioned Layout Details

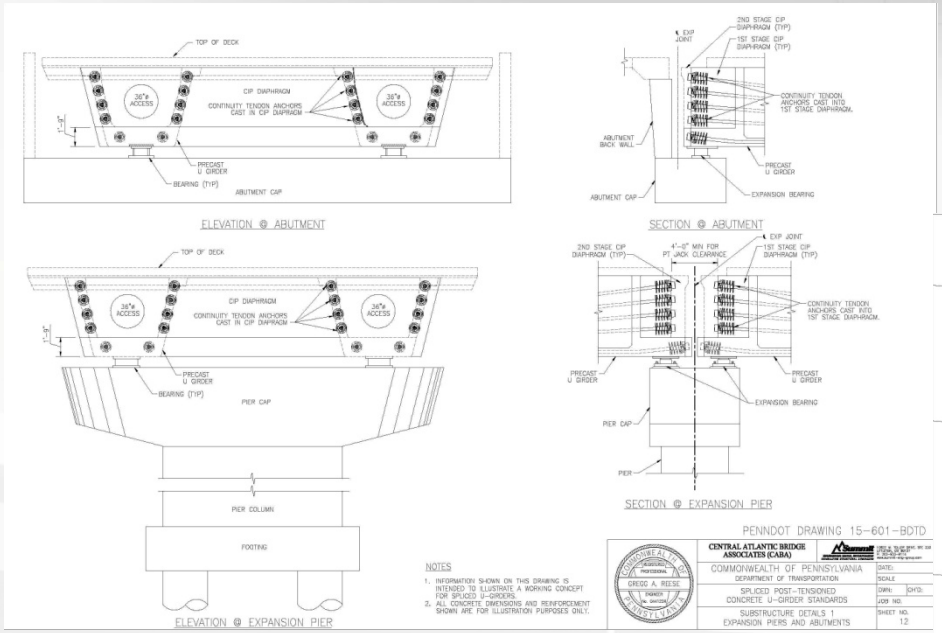


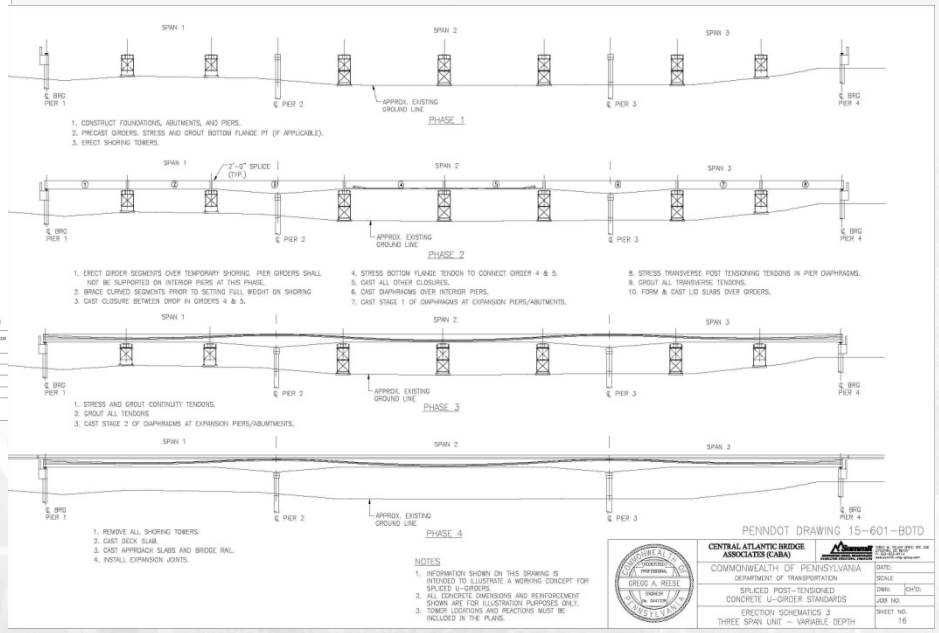


End Span and Pier Girder Conditions

PennDOT U Girder Standards

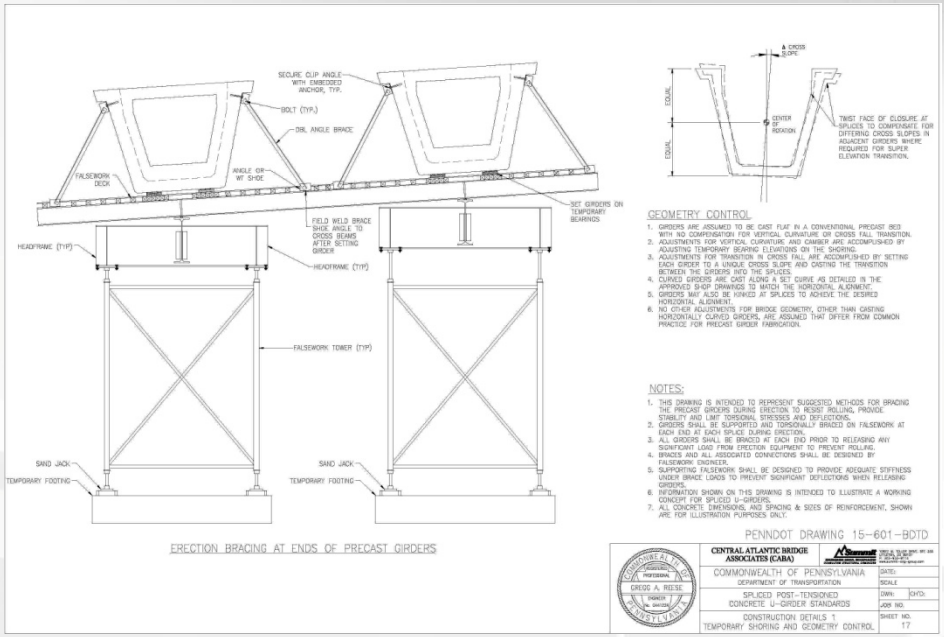
Example Erection Schematics

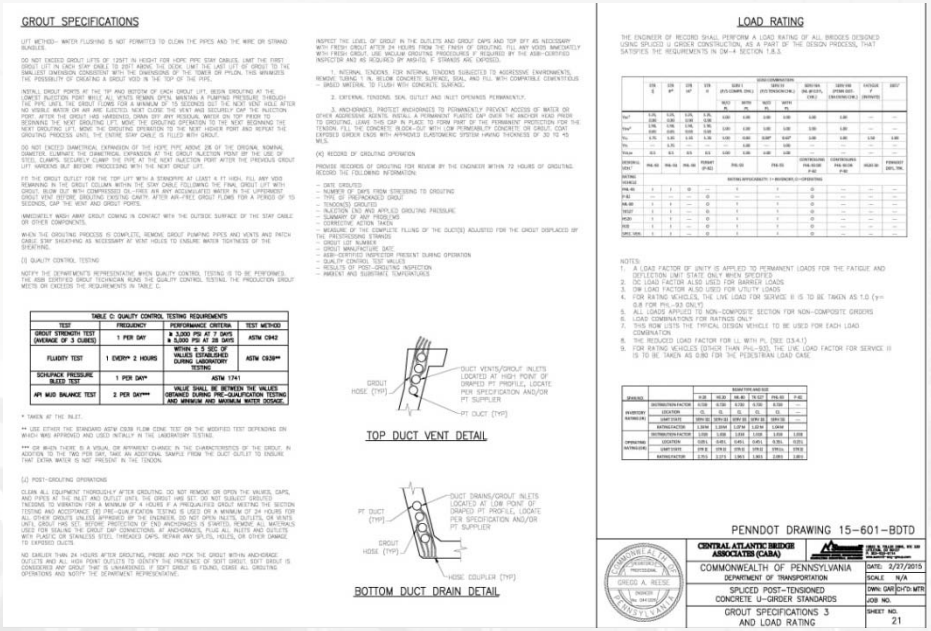




Pro Type Substructure / Superstructure Details

Detailed Grouting and Load Rating Procedures





Temporary Shoring and Erection Recommendations

PennDOT U Girder Standards

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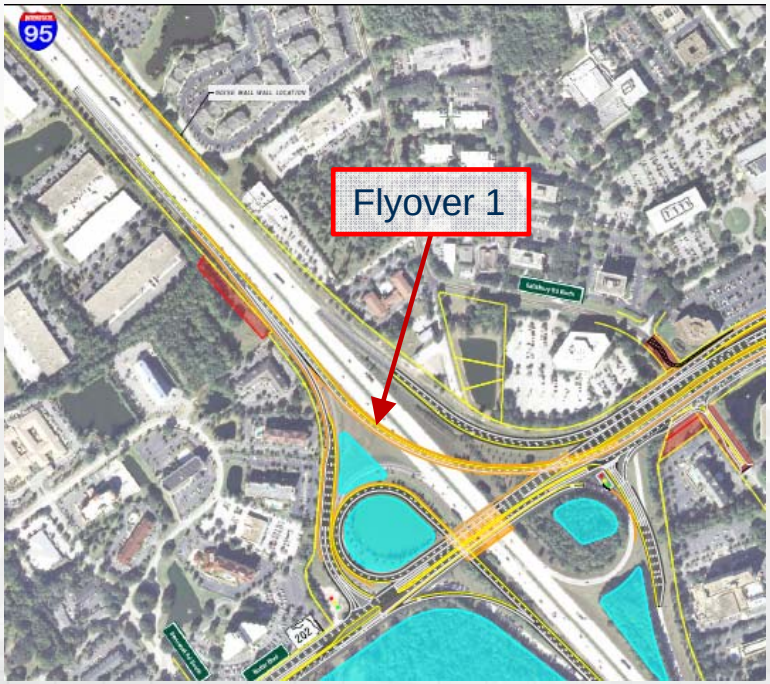
CASE STUDY | JT BUTLER EXPRESSWAY, JACKSONVILLE, FL.

PROJECT BACKGROUND

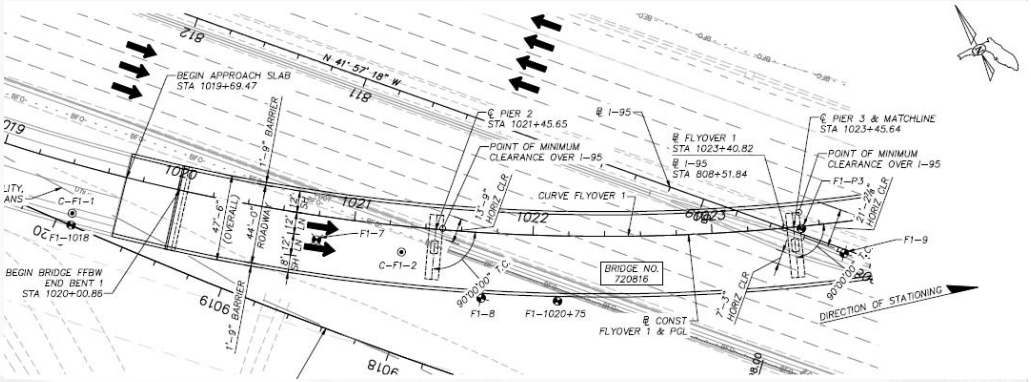


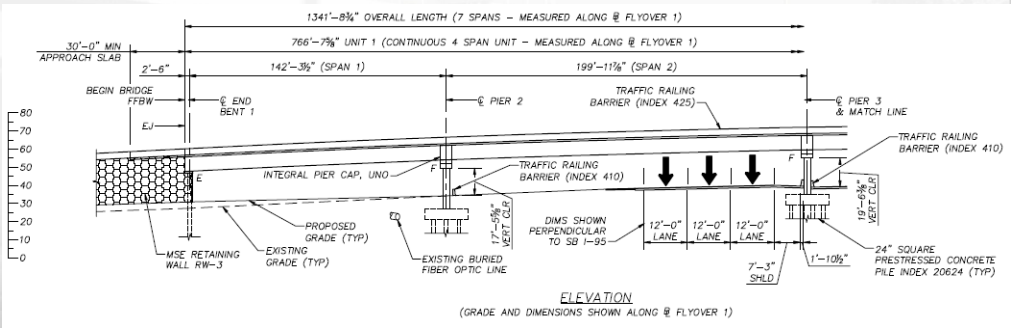
- Modjeski and Masters is the EOR for the Flyover 1 Bridge
- Modjeski is also serving as the construction engineer for SEMA
- Total Project Bid - $66.7m

Summit
A MODJESKI and MASTERS COMPANY

FLYOVER 1 BRIDGE

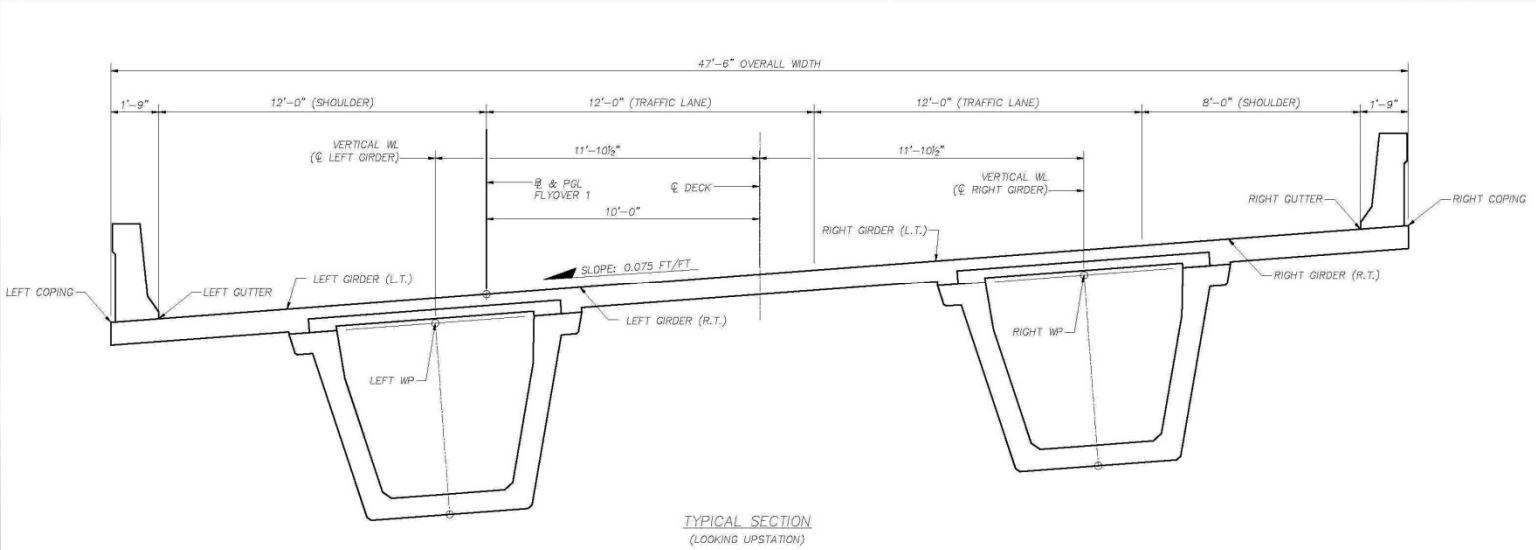
- Total structure length is 1342 ft
- Span lengths from 140’ to 230’
- 7 span structure
  - Unit 1 = 4 spans (767 ft)
  - Unit 2 = 3 spans (575 ft)
- Multiple traffic crossings with tight clearances





FLYOVER 1 – CROSS SECTION

- Constant radius = 1100 ft
- 2 girder lines, Spaced at 23’-9” o/c
- Deck width = 47’-6”, 7.5% cross slope



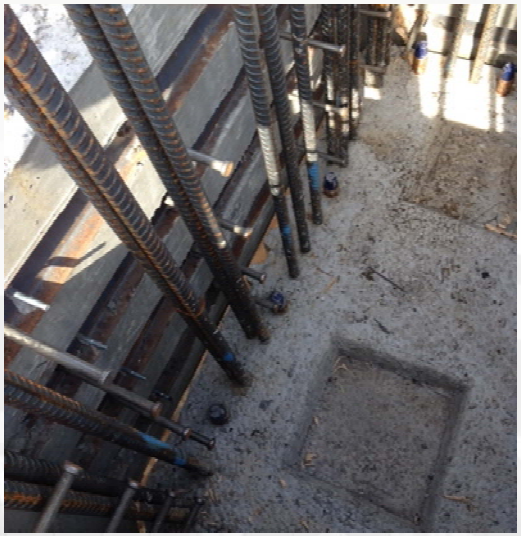
FLYOVER 1 CONSTRUCTABILITY

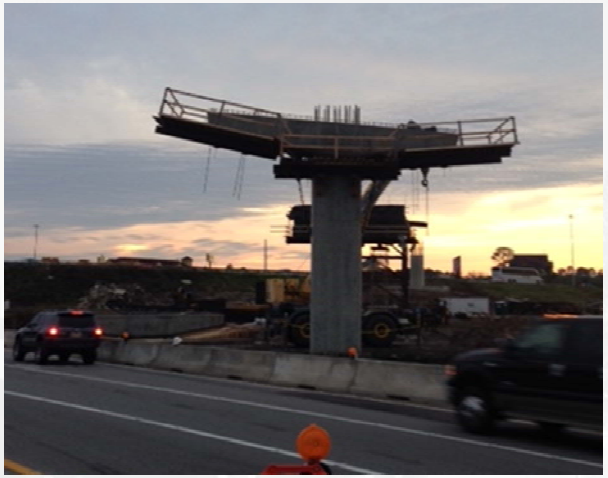
- Cantilevered Sections over Traffic
- Precast, post-tensioned pier caps
- Strongbacks
- Straddle Bents

CURVED PRECAST POST-TENSIONED U-GIRDERS

- Design considerations
  - Max girder length 115 ft
  - Max girder weight 320 kips.
  - PT anchors at cantilevered girder ends
  - Staged PT during handling and erection

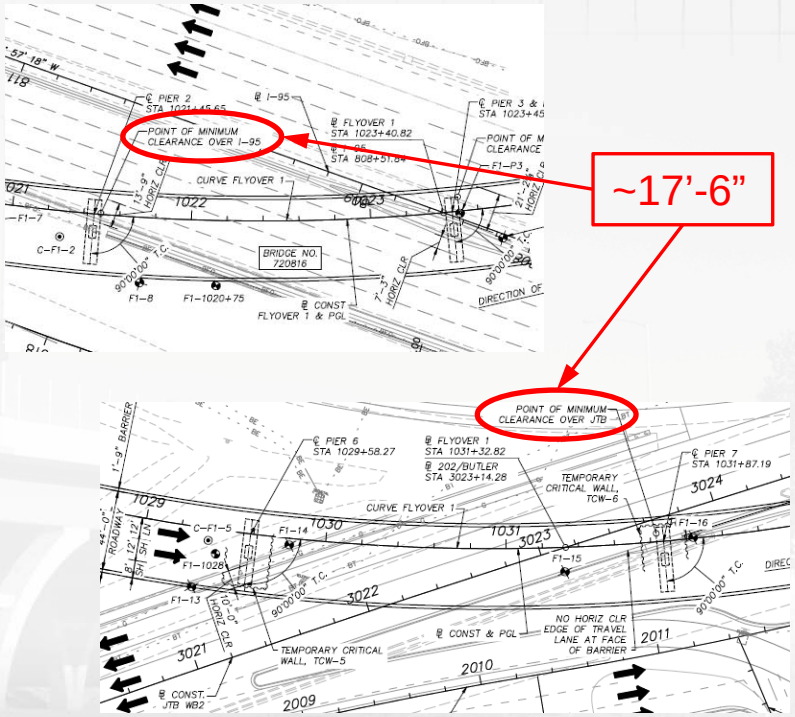
Precast Post-Tensioned Pier Caps





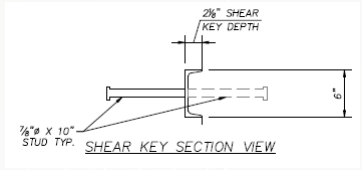
PRECAST POST-TENSIONED PIER CAPS

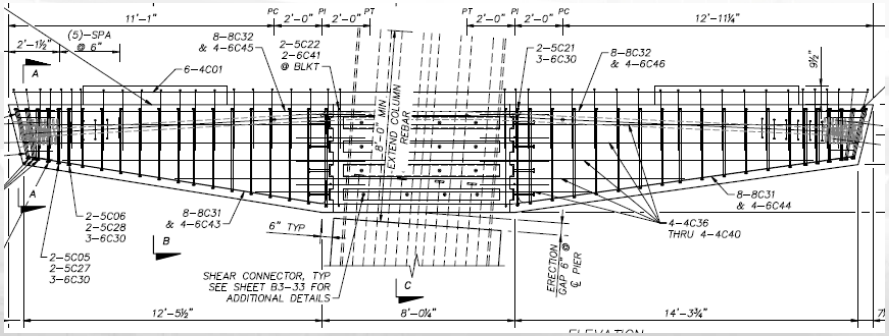
- Why precast the pier caps?
  - Piers 2, 3, 6, and 7 adjacent to and above traffic
  - Limited Vertical and Horizontal clearance during construction
  - No room for forming on site

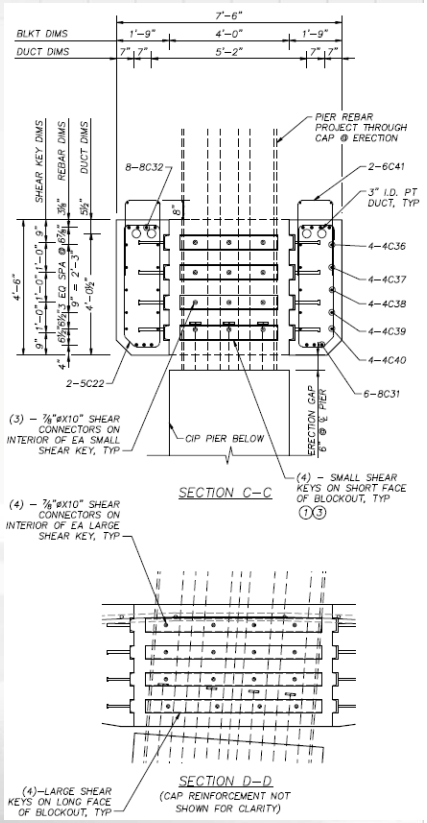


PRECAST CAPS

- Hammerhead Cap
- Full Continuity Connection to Pier
- Partial Depth supports girders
- CIP Diaphragm completes final cap







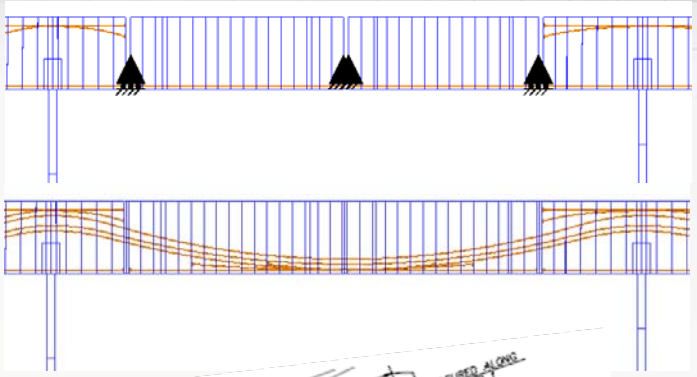
GIRDER ERECTION OVER IH95

- Drop In Girders supported at each end from strong backs resting on ends of Pier Girders

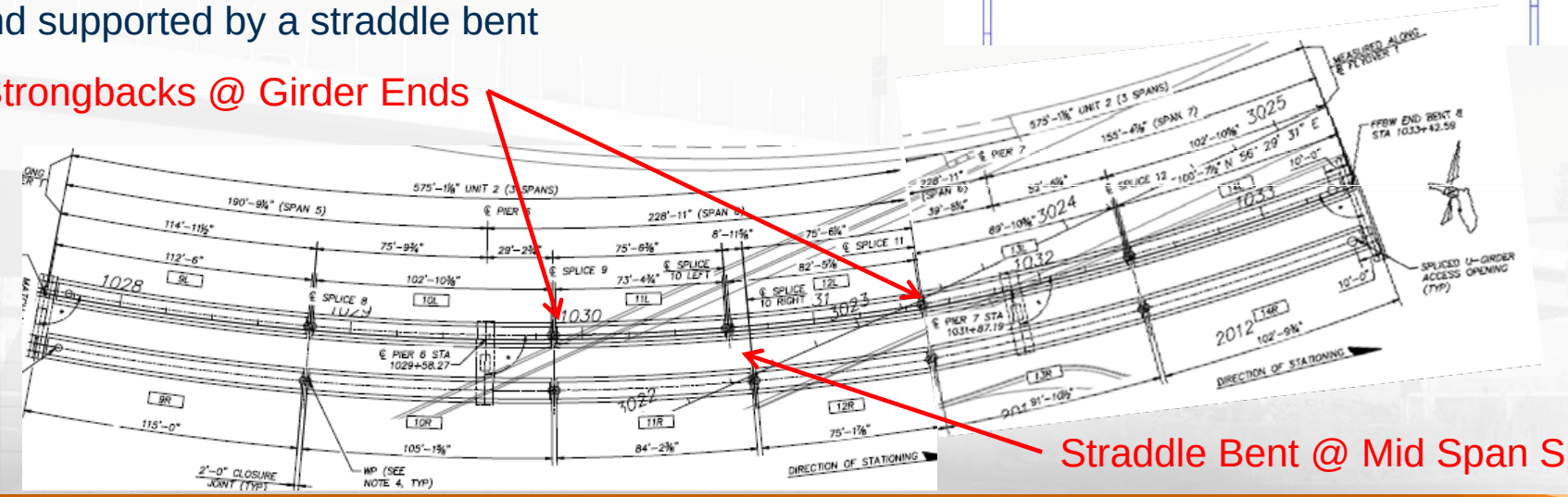
Positive Moment Crossover Tendon

- The combination of pier geometry and maximum girder lengths required that a splice be located in the positive moment region of span 6

- Splice 10 is located over traffic on SR-202 and supported by a straddle bent

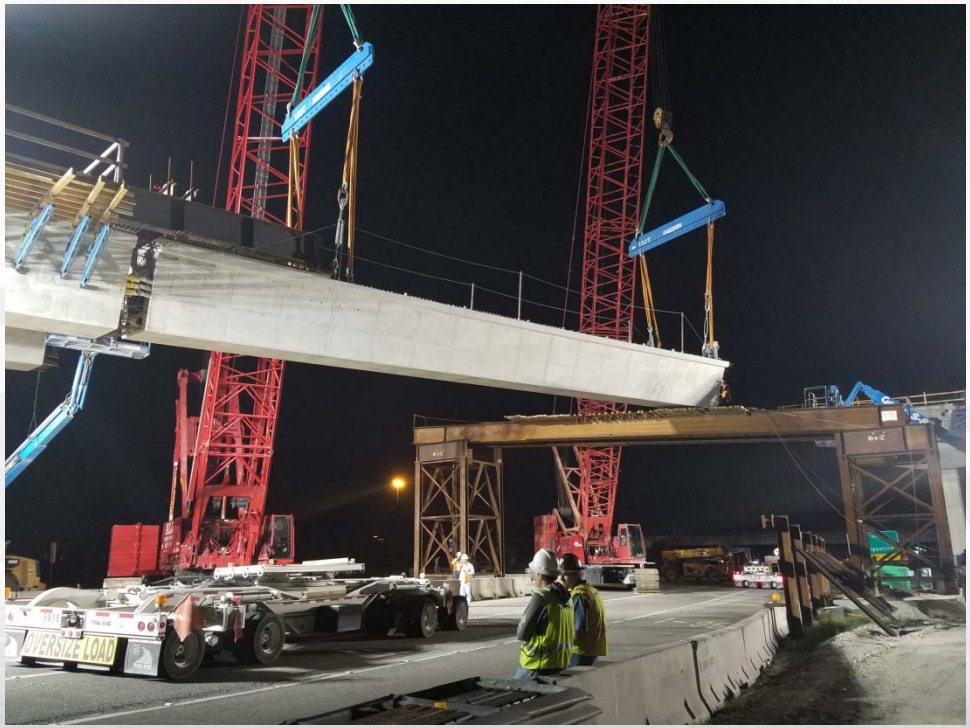


Strongbacks @ Girder Ends



Straddle Bent @ Mid Span Splice

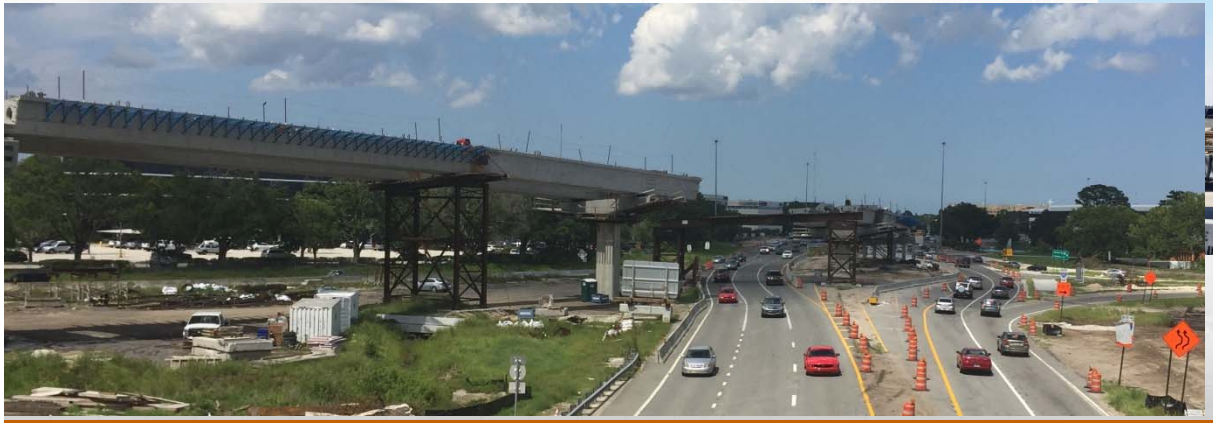
GIRDER ERECTION OVER SR202



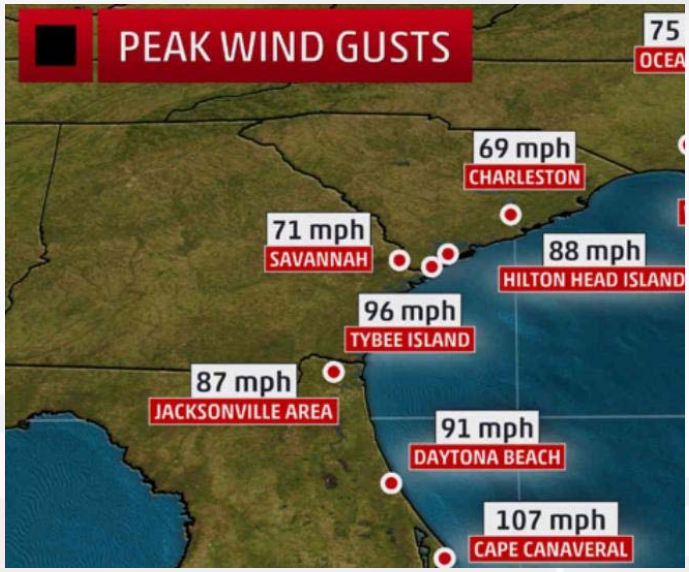
- Drop In Girders supported at one end from strong backs and mid span at Straddle Bent

JOB SITE PROGRESS AS OF SEPTEMBER 30, 2017

- Strongback girders erected over I-95, completing girder erection in Unit 1
- Final girder erection over JTB late October / early November
- Project completion early 2017



HURRICANE MATTHEW – OCTOBER 7, 2016



- Strong back girders erected 1 week before
- Closures cast 2.5 days prior to hurricane hitting Jacksonville area
- Contractor reported no damage to girders or falsework

Job Site Progress, Wednesday February 6, 2017

- All Girders Erected, All PT Stressed
- Deck Cast on Unit 1, Formed on Unit 2
- Project completion expected July 2017

Summary

- Aesthetically pleasing, durable structures
- Cost Effective Option with Less Maintenance
- Splicing makes longer spans feasible
- U Girders can be cast curved or straight
- Design Option for Complex Interchanges
-

Spliced Precast Bridges

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THANK YOU

Questions?

This concludes the educational content of this activity.

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Purpose and Learning Objectives

The purpose of this presentation is to inform the audience about current developments and projects using spliced precast beam and slab construction

At the end of this presentation, we hope that you will find the materials we have presented to be informative and interesting and will have a good appreciation of how this technology can be used on future projects.