

**Spliced Precast Girder Bridges**



Boggy Creek Interchange – Orlando Florida

## 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**

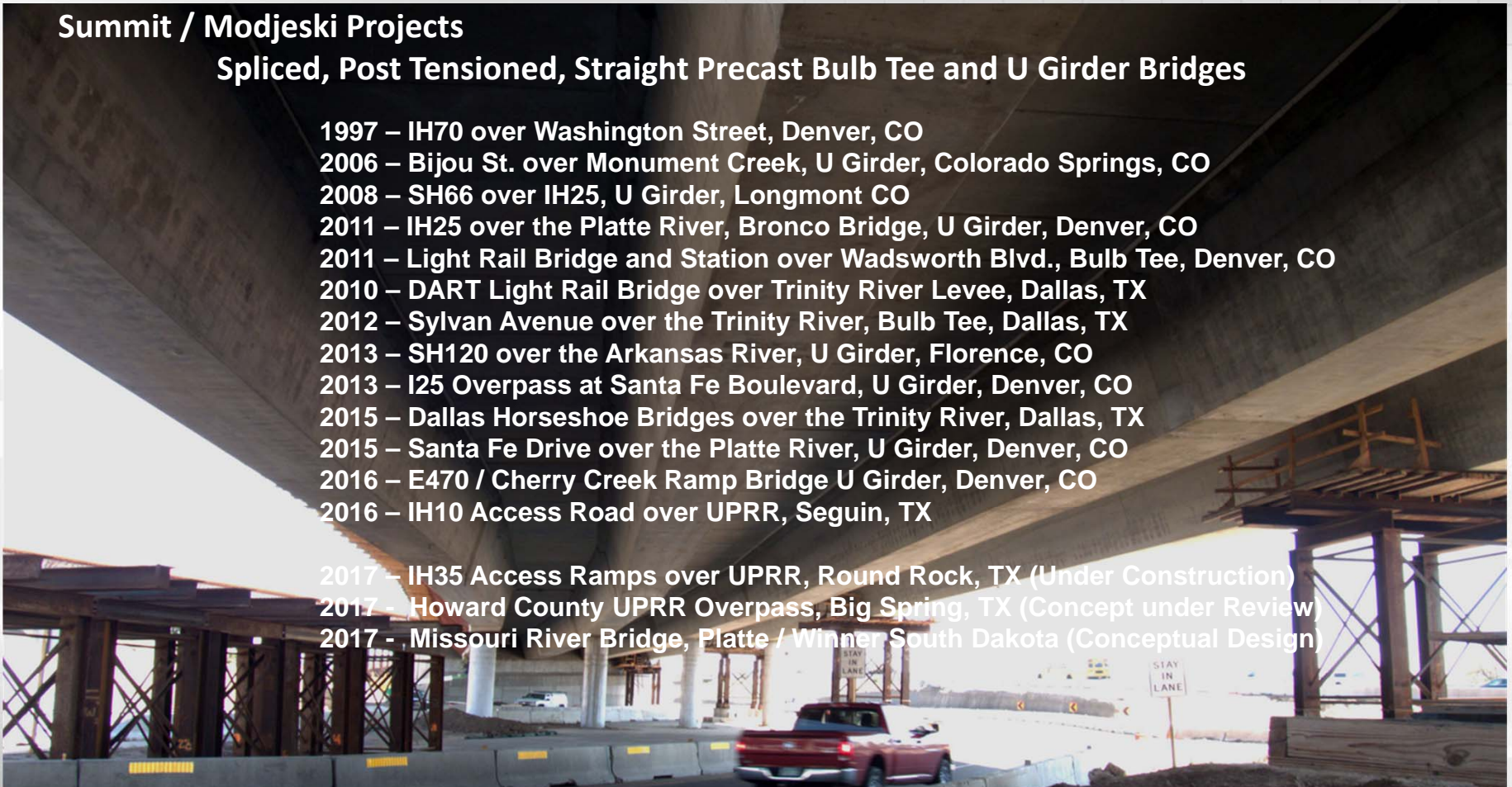
**Case Study: JT Butler  
Expressway in  
Jacksonville Florida**

**Sylvan Avenue over the Trinity River – Dallas Texas**

### 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)



## 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

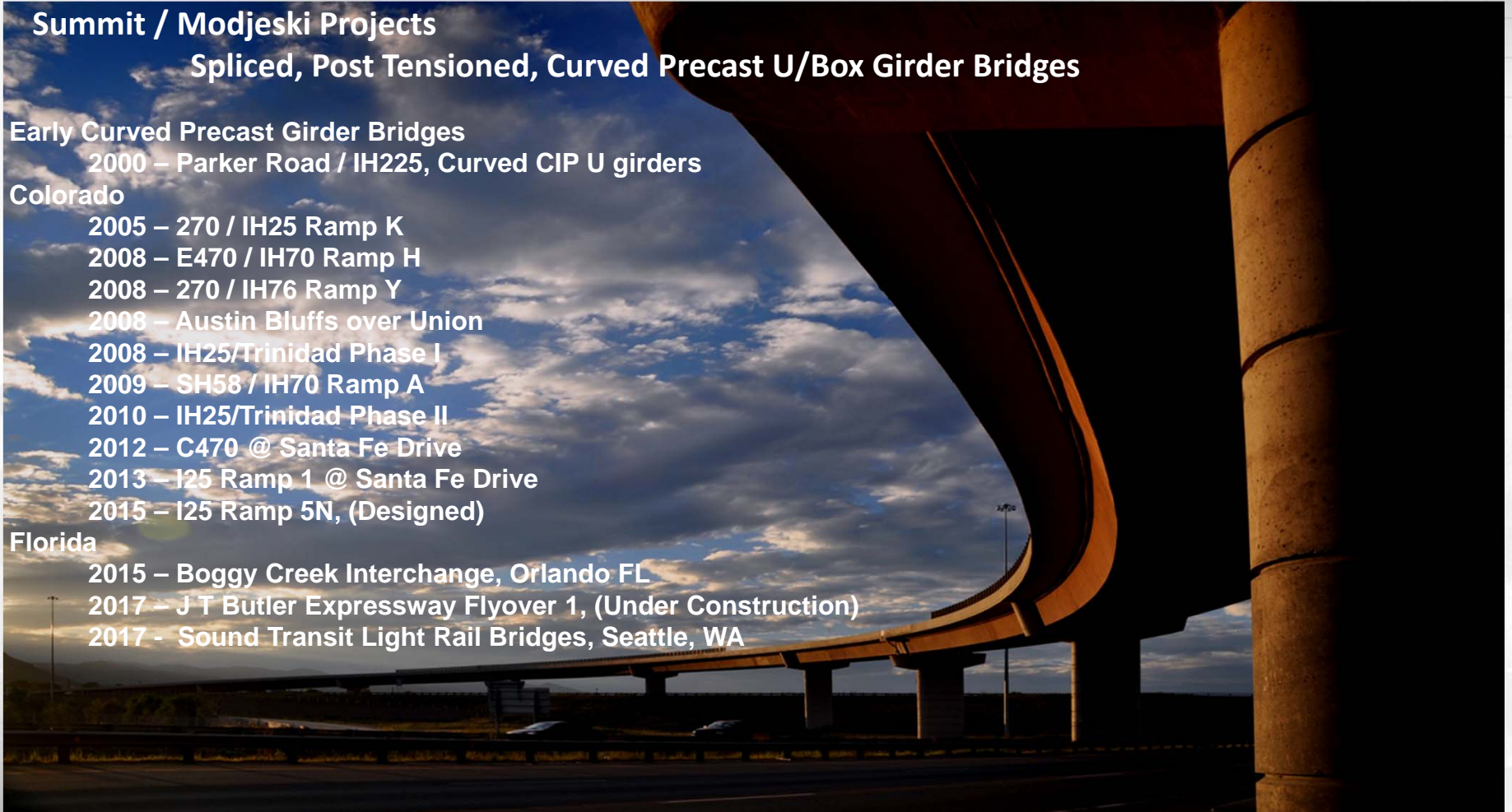
2015 – I25 Ramp 5N, (Designed)

#### 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



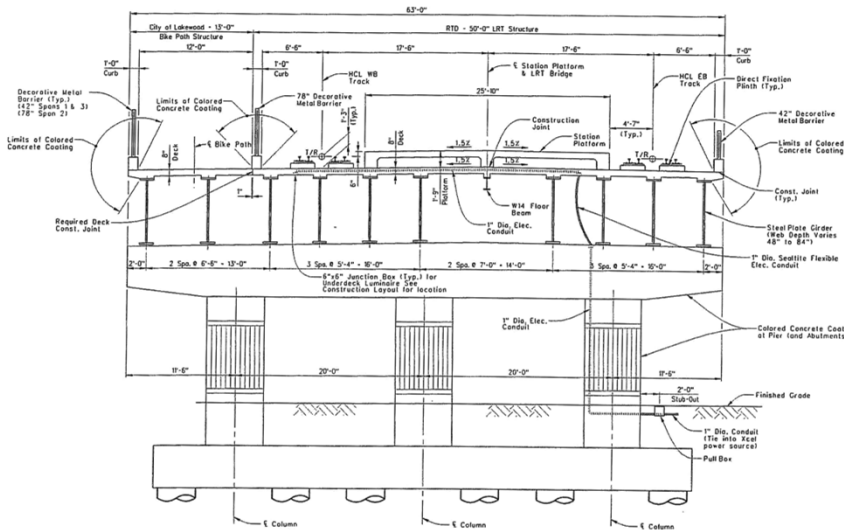
IH25 / Santa Fe Interchange, Denver CO

## Spliced Bulb Tee Bridges



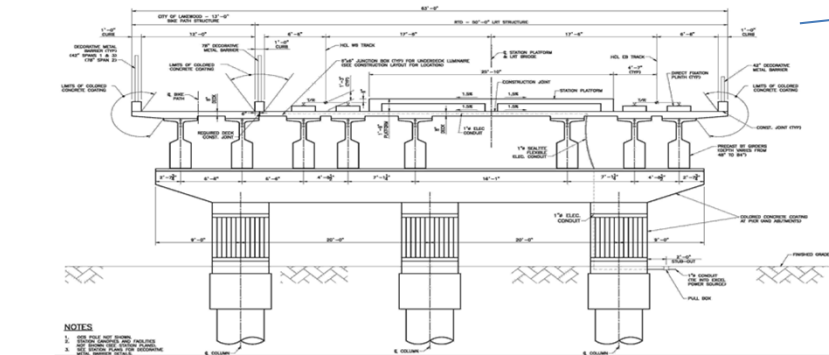
**Wadsworth Light Rail Bridge and Station, Denver Colorado**

## 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

## Spliced Precast Bulb Tee Girder Bridges

## 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

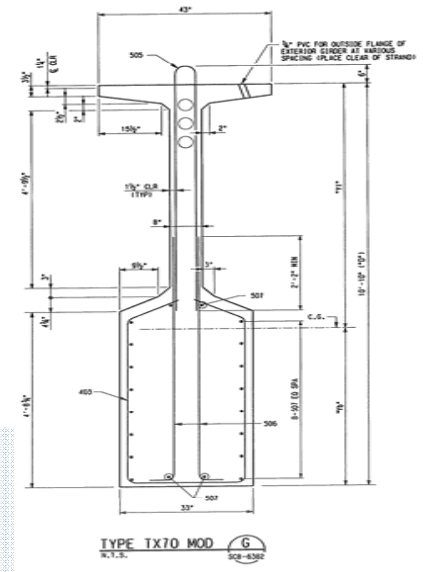
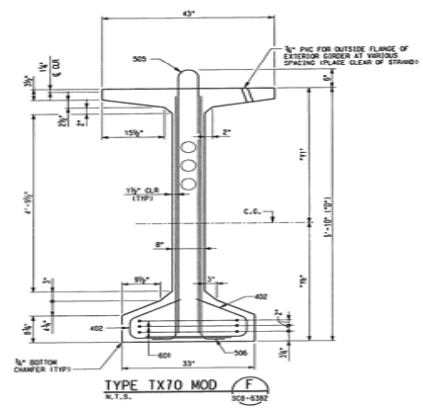
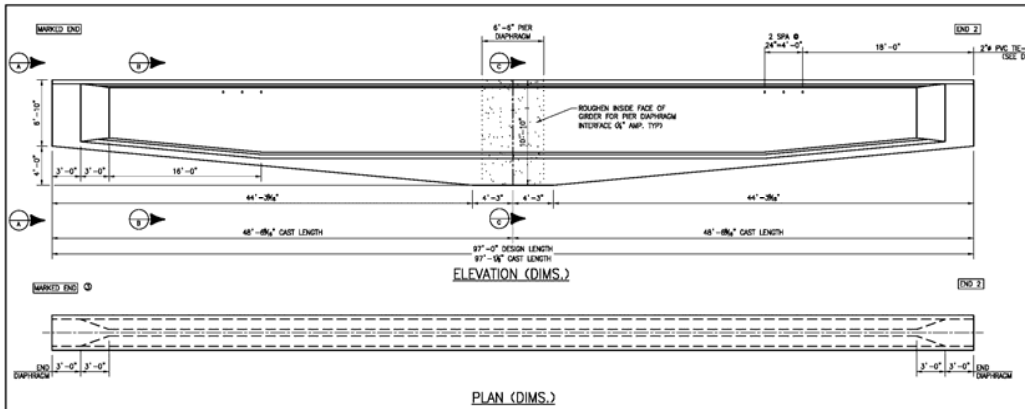
All projects from Design / Build and City Improvement Projects

Trinity River Corridor between Dallas and Fort Worth

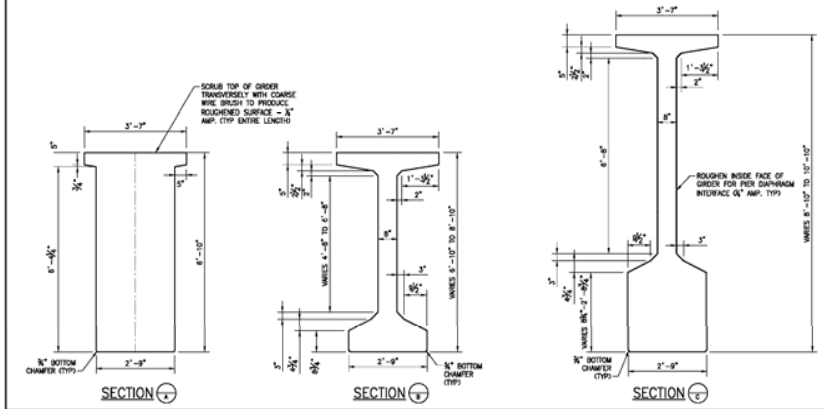
2 New Precaster initiated projects under way in Central Texas designed by M&M/Summit



**Precaster's Modified Pier Girder Cross Section:**



**Original Pier Girder Cross Section**



FOR APPROVAL  
JANUARY 11 2010  
BEKAR CONCRETE WORKS I, LTD.

TYPE T&D MODIFIED GIRDER MARK	= T&D-7
GIRDER QUANTITY THIS SHEET	= 1
UNITARY FOOTAGE THIS SHEET	= 97.09
CONCRETE RELEASE STRENGTH, f <sub>r</sub>	= 8000psi
CONCRETE 28 DAY STRENGTH, f <sub>c</sub>	= 8000psi

GIRDER 7 FABRICATION SHEET (1 OF 5)  
FABRICATOR/PREPARED BY: BEKAR CONCRETE WORKS I, LTD. BOON # 3600  
CONTRACTOR: KSWRP

STATE	FEDERAL REGION	STATE	PROJECT
6	TEXAS	1-35	TRINITY RIVER ADRIAL STRUCTURE 1-1
COUNTY	CONTROL SECTION	JOB	HIGHWAY
COLLIN	1-35	1-35	1-35
DRAWN BY	CHECKED BY	DATE	SHEET
TLF	GAR	1-11-10	Tx82-7A

**Girder Cross section modified to reduce shipping weight**

**Spliced Precast Bulb Tee Girder Bridges**

## Sylvan Avenue Bridge, Dallas Texas

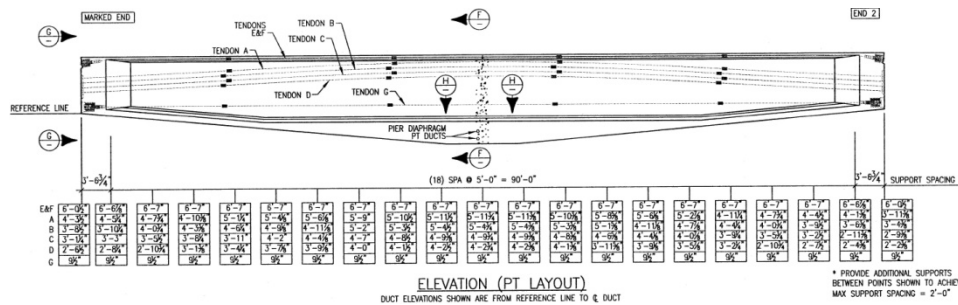
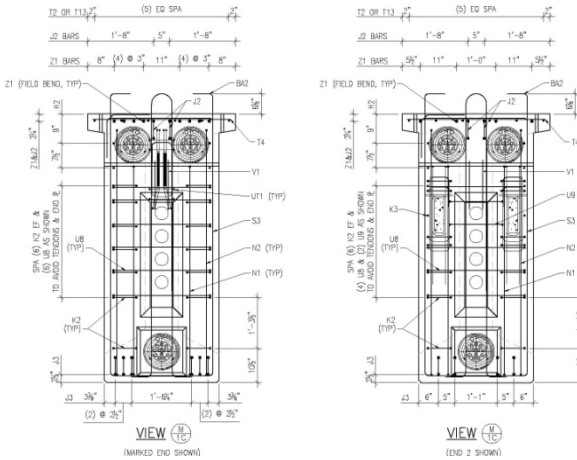


**Spliced Precast Bulb Tee Girder Bridges**

## 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



## Spliced Precast Bulb Tee Girder Bridges



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



Spliced Precast Bulb Tee Girder Bridges



## 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.

Spliced Precast Bulb Tee Girder Bridges

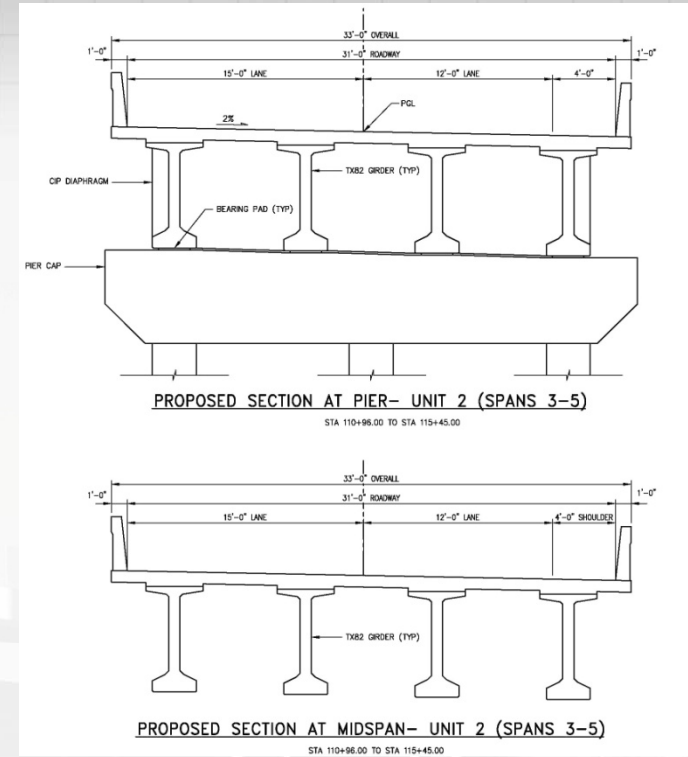
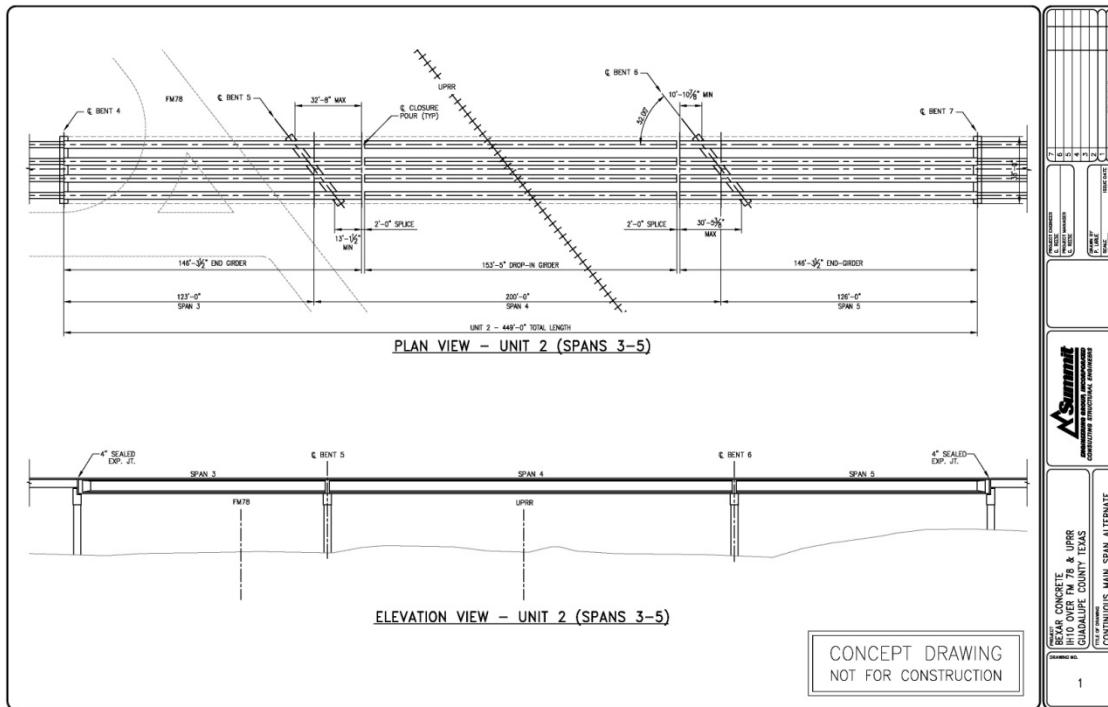


Construction Progress  
Photos

## Project Scheduled for Completion in 2017



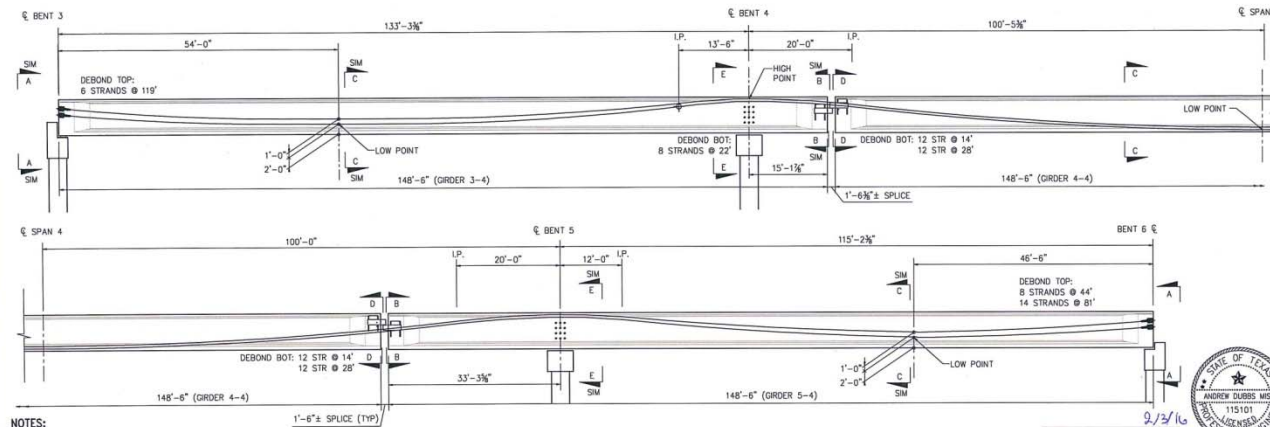
## New Bridge Design – Seguin Texas Precaster Initiated Alternate Design



**123', 200', 126 Simple Span arrangement converted to  
3 span continuous unit using existing TX82 forms  
All Girders are Constant Length and Depth**

**Spliced Precast Bulb Tee Girder Bridges**

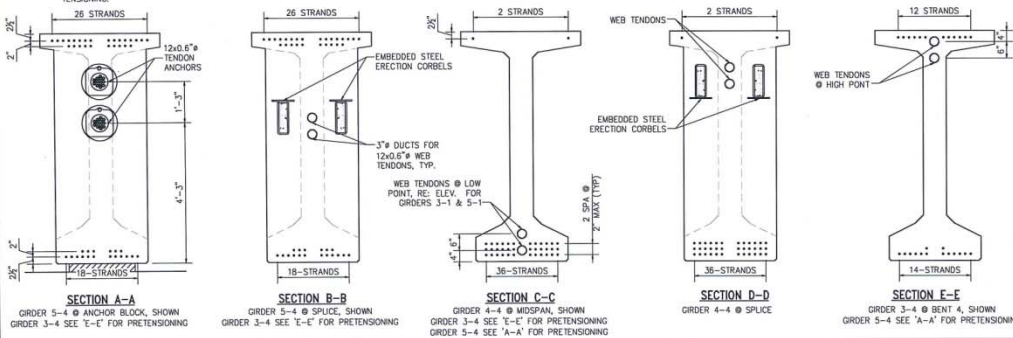
## Post Tensioning Layout



- NOTES:**
1. RE: SHEET 646A FOR PRESTRESSING, POST TENSIONING, AND BEARING DATA.
  2. DEROND PRETENSIONING STRANDS STARTING WITH THE UPPER LAYERS OF BOTTOM FLANGE AND BOTTOM LAYER OF TOP FLANGE. DEROND OUTSIDE STRANDS FIRST, WORKING SYMMETRICALLY INWARD TOWARD THE CENTER OF GIRDER.
  3. RE: SHEET 626A FOR NOTES ON PRESTRESSING AND POST TENSIONING.

**ELEVATION VIEW - GIRDER LINE 4**

SUBMITTED FOR APPROVAL  
10/06/16  
NOT FOR CONSTRUCTION  
NOTE: SEE SHEET 627 FOR ALTERNATE DESIGN NOTES



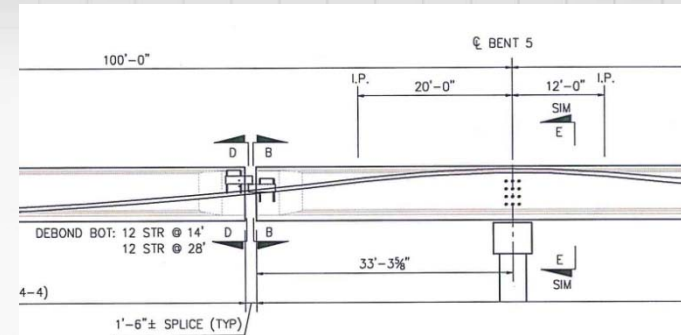
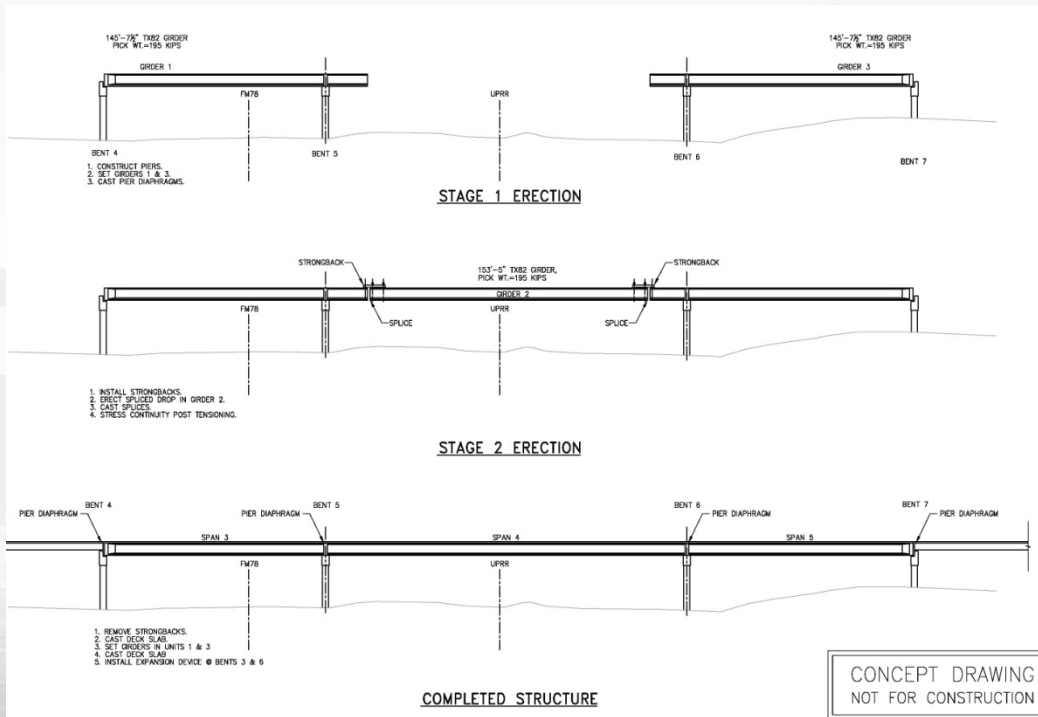
NO.	DATE	REVISION	APPROVAL
 <b>Summit</b> ENGINEERING BRIDGE RECONSTRUCTION CONSULTING STRUCTURAL ENGINEERS TEXAS REGISTERED ENGINEERING FIRM # 4703			
TEXAS DEPARTMENT OF TRANSPORTATION IH 10 WB FLYOVER UPRR OVERPASS UNIT 2 - GIRDER LINE 4 PRESTRESSING LAYOUT			
DES. NO.	PROJECT NO.	SHEET NO.	
6	C 535-1-72	646	
STATE	DIST.	COUNTY	
TEXAS	SAT	QUADALPPE	
CONTR.	SECT.	JOB	HIGHWAY NO.
0535	01	072	IH 10

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.

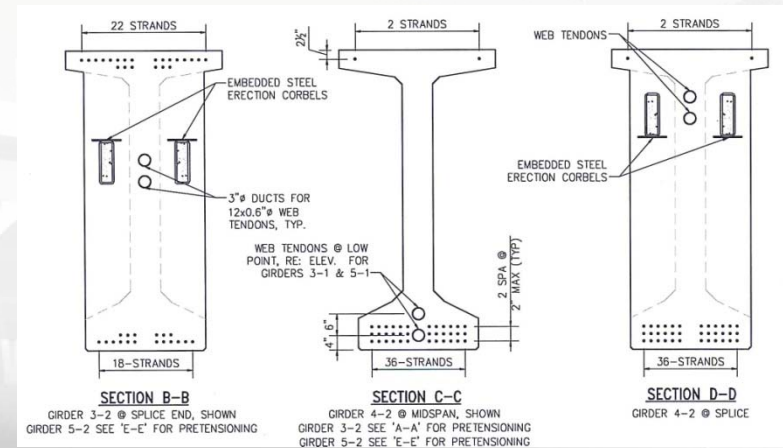
## Spliced Precast Bulb Tee Girder Bridges

## Construction Sequencing

End Girders Set on Piers, Drop In Girders Set on Erection Corbels  
No Shoring Required



**Erection Corbels Details at Splices**



## Spliced Precast Bulb Tee Girder Bridges

## 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**

## IH25 Bronco Bridge over the Platte River



**Fully Precast Bridge with No Bearings**



## IH25 and Santa Fe Drive Intersection Bridges



Ramp 1 Flyover

IH25 Overpass at Santa Fe Drive

## IH25 Overpass at Santa Fe Drive



**Straight U Girders kinked to accommodate curved alignment**



IH25 SB Ramp K, Denver CO

# Curved Precast U Girder Bridges

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

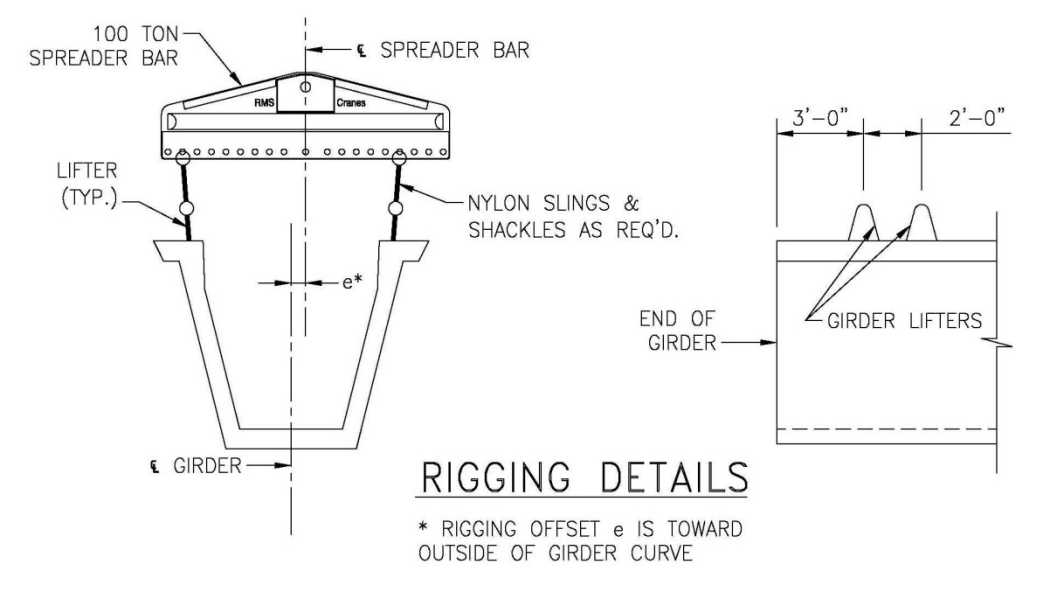
- > Girders Set on Temporary Shoring with Hydraulic and Crawler Cranes
- > Curved Girders Braced to Shoring

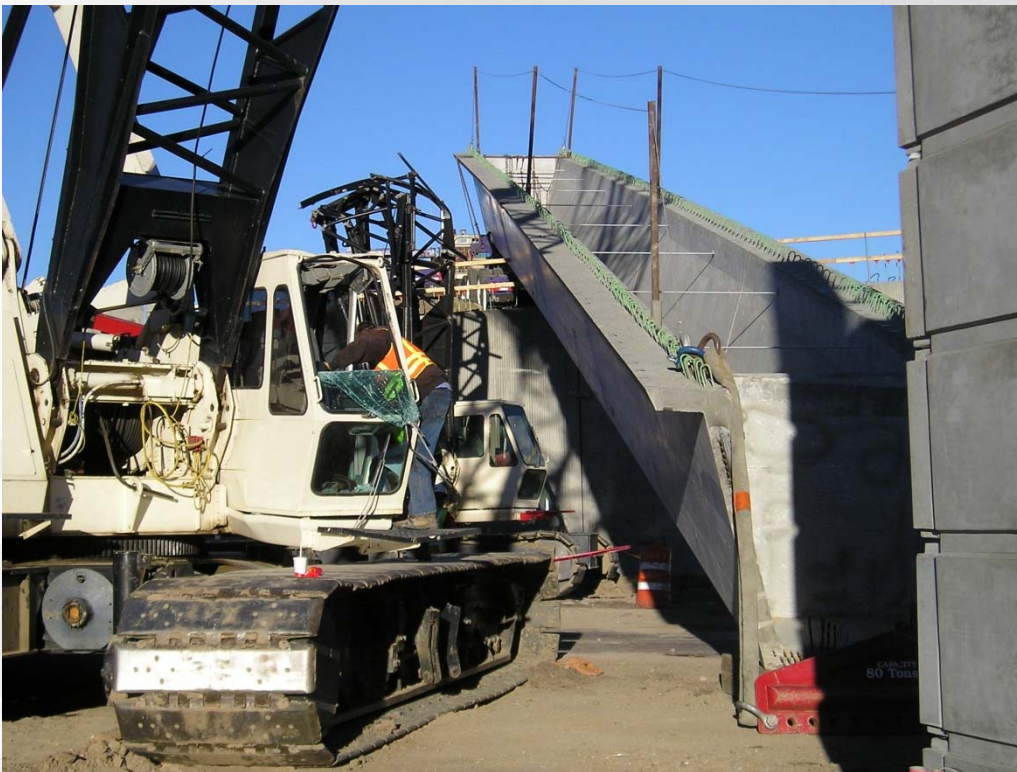




# Girder Erection

- > 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

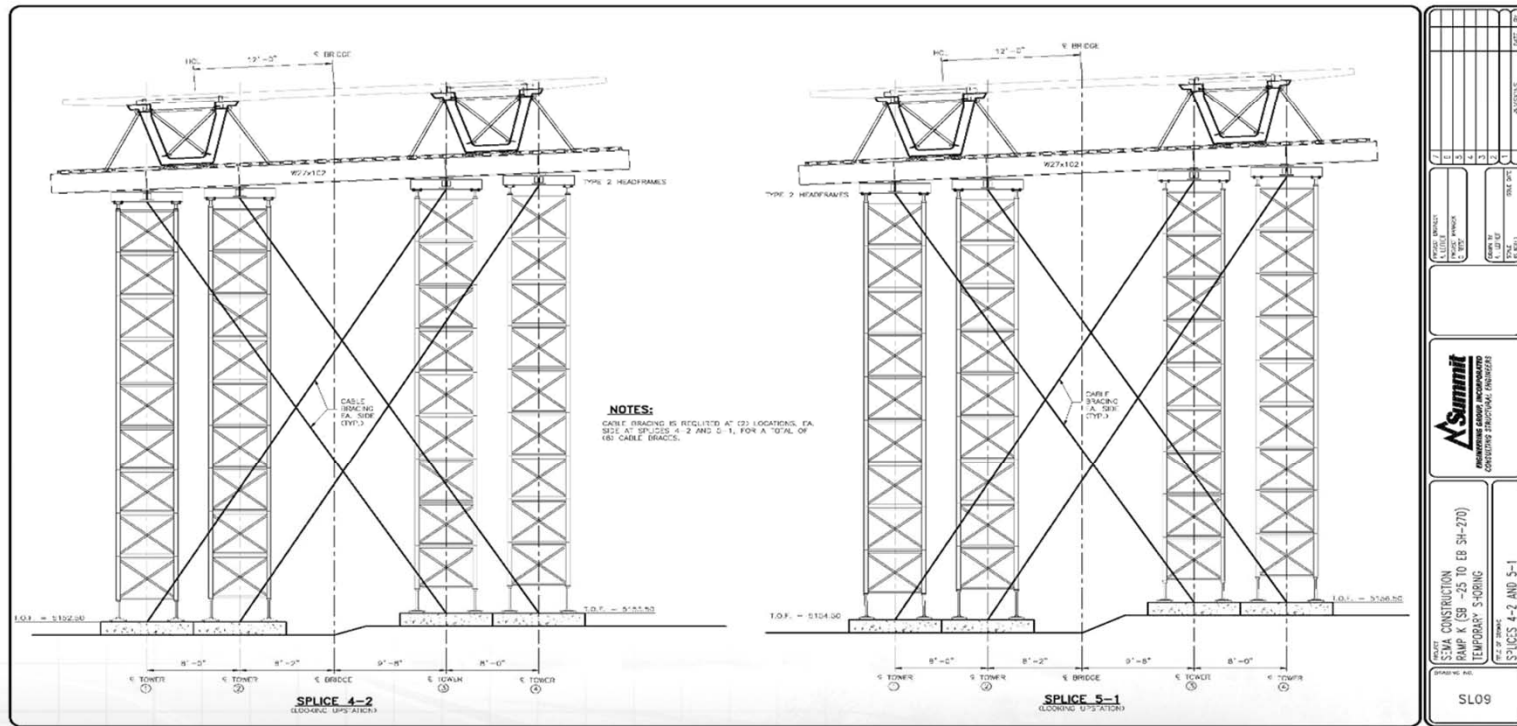
### > Falsework Towers and Straddle Bents



### > Ramp K on 45' Tall Falsework Towers @ Pier 5



# Construction Engineering – Temporary Shoring



NO.	REV.	DATE	BY	CHKD.	DESCRIPTION
<b>Summit</b> ENGINEERING ARCHITECTURE INTERIORS CONSULTING STRUCTURAL ENGINEERS					
GREAT CONSTRUCTION RAMP K (SB -25 TO SB 34-270) TEMPORARY SHORING SHEET NO. SPLICES 4-2 AND 5-1					
SLO9					

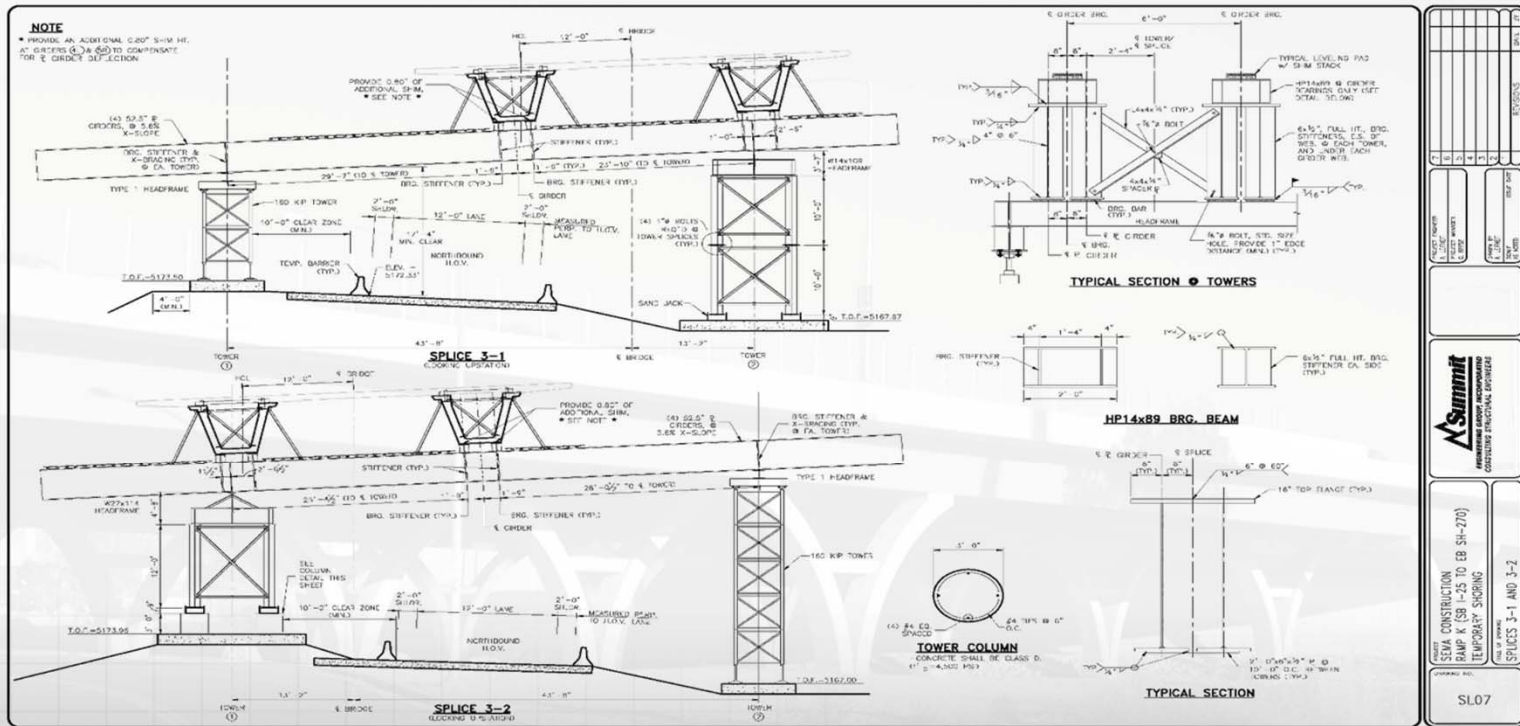


## Temporary Shoring During Construction

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



# Temporary Shoring – Straddle Bents



PROJECT NUMBER	17-0000	DATE	02/17/17
CLIENT	SEVA CONSTRUCTION	DESIGNED BY	AS
LOCATION	RAMP K (SB I-25 TO EB SH-70)	CHECKED BY	AS
DATE	02/17/17	APPROVED BY	AS
SCALE	AS SHOWN	PROJECT ENGINEER	AS
<b>Summit</b> ENGINEERING ARCHITECTURE CONSULTING STRUCTURAL ENGINEERS		PROJECT NO. 17-0000 SHEET NO. 17-0000-01 DATE 02/17/17	
SEVA CONSTRUCTION RAMP K (SB I-25 TO EB SH-70) TEMPORARY SHORING		SPICES 3-1 AND 3-2	
SL07			



## 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

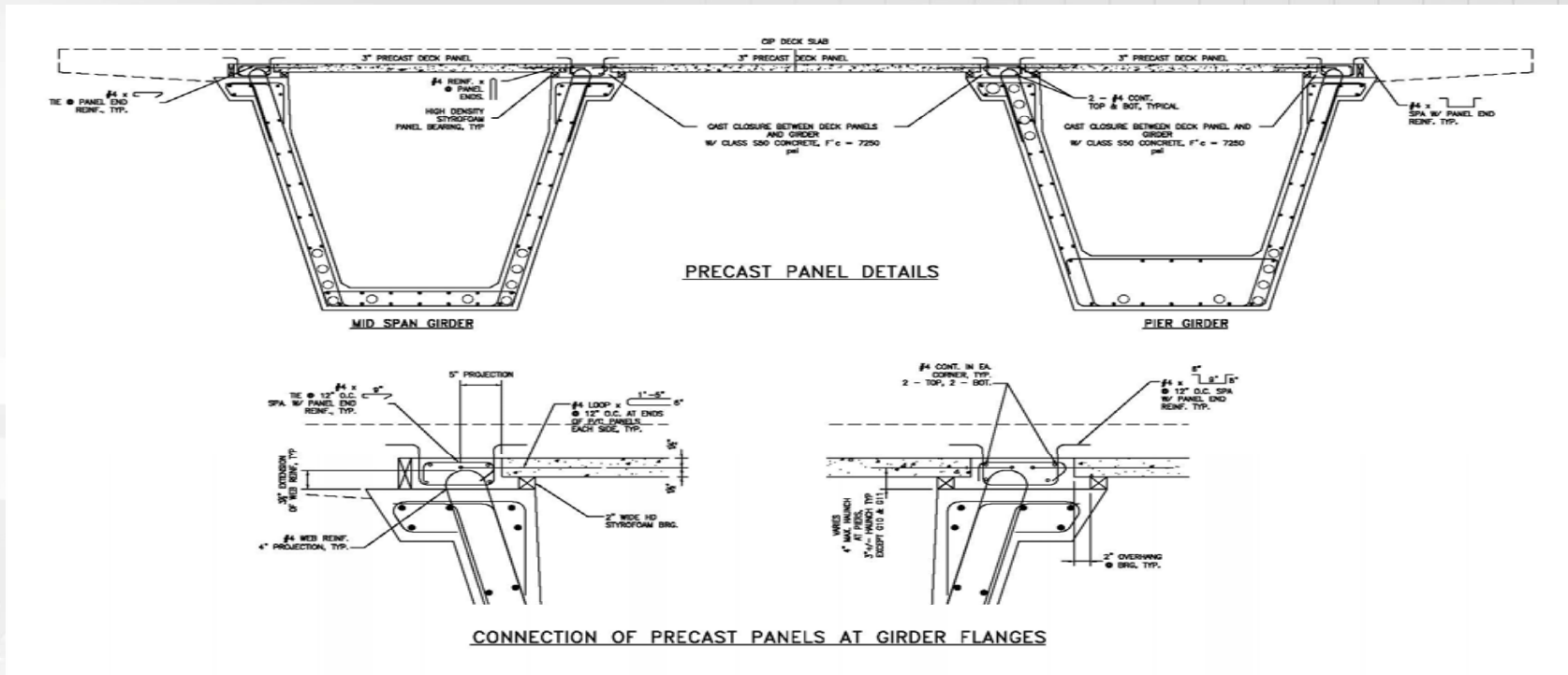


## Maintenance-Of-Traffic

- 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

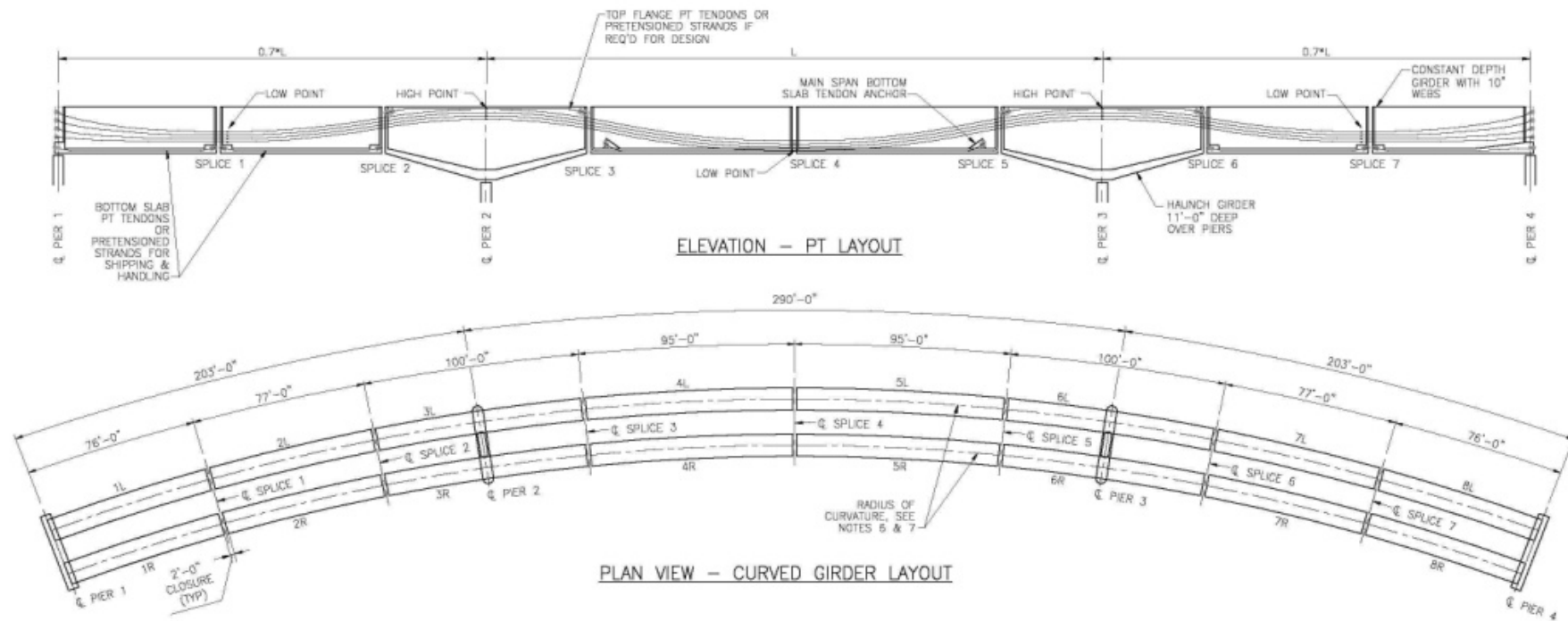


## Erection of Precast U-Girders

- Lid Slab can be CIP or use Precast Deck Panels
- Diaphragms 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

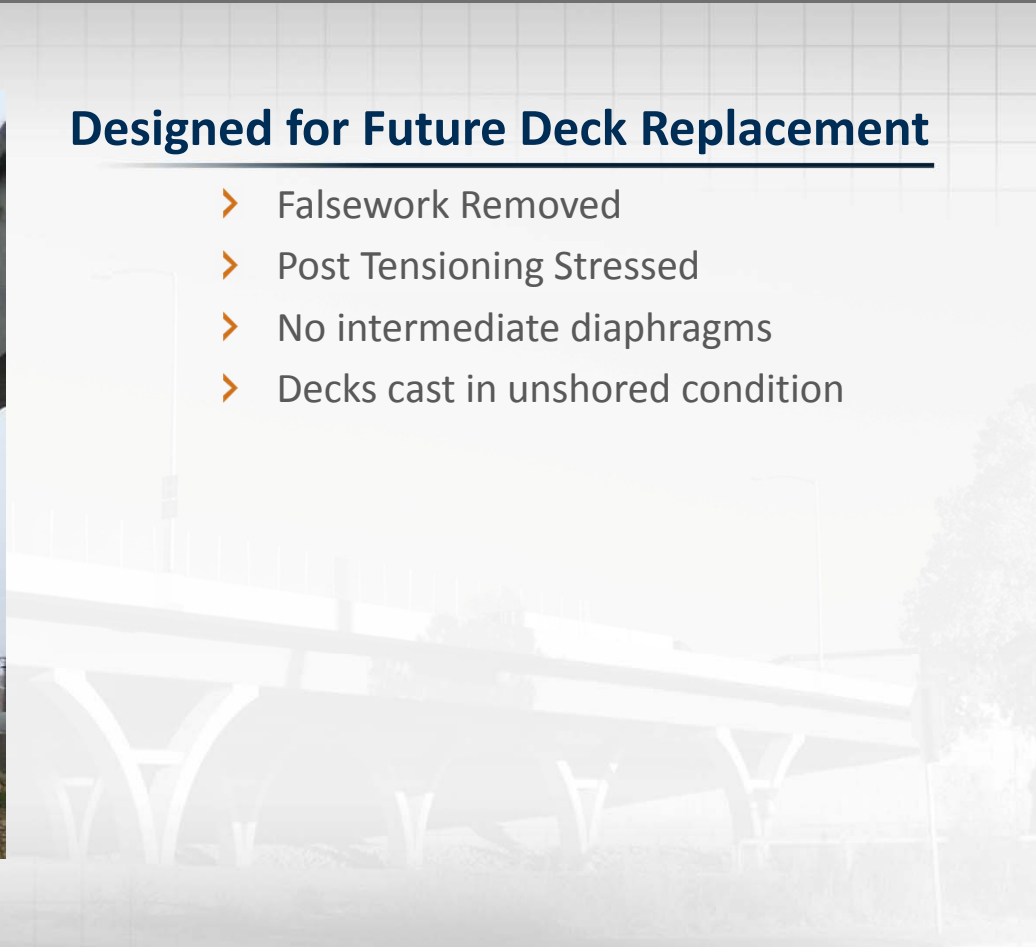
- Expansion Pier Diaphragm cast at Abutment w/ PT Anchorages





## 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

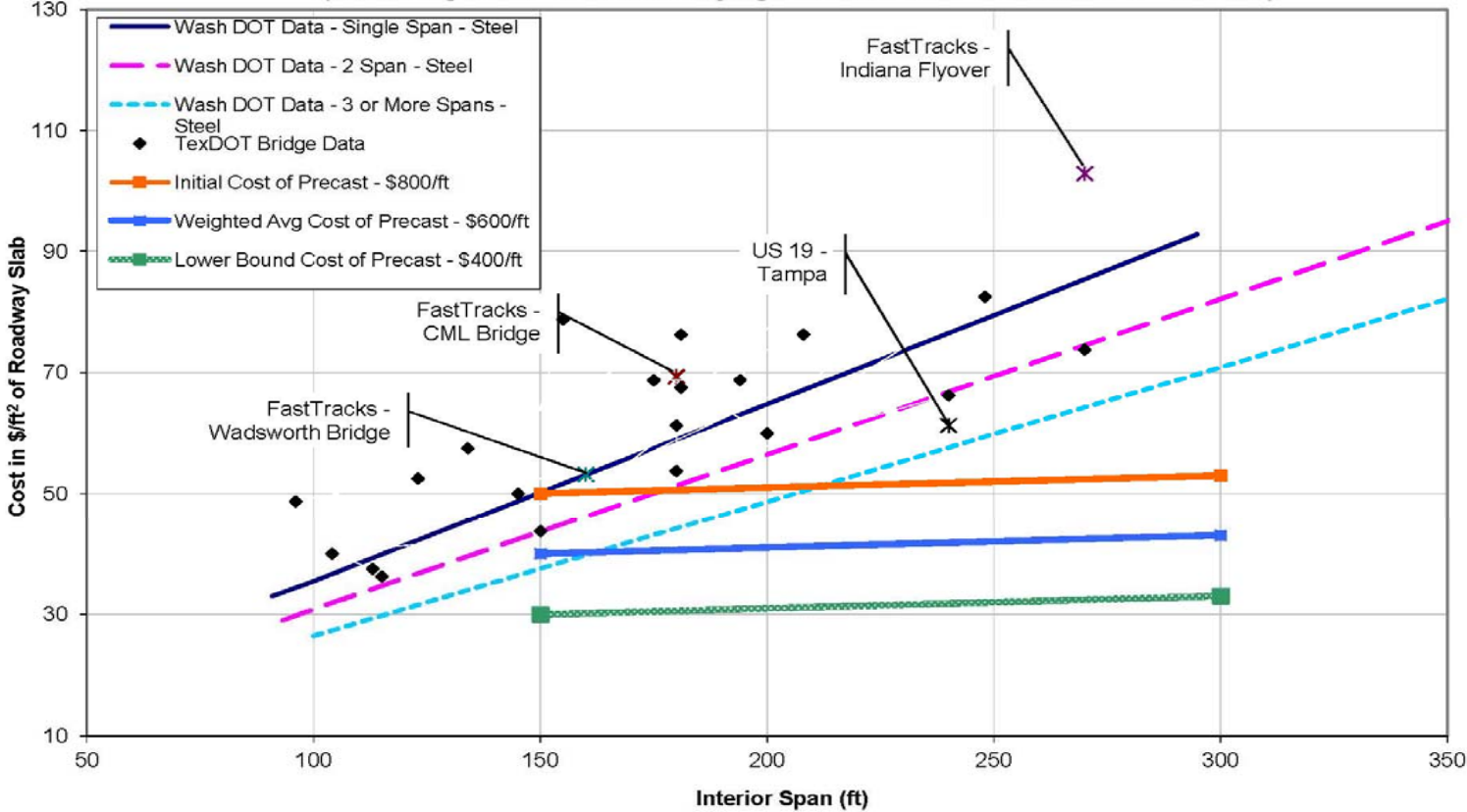


### 270 Ramp Y Cost Data

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
<b>Total</b>	<b>\$6,200,000</b>	<b>\$4,732,240</b>
<b>Cost/Ft.</b>	<b>\$1,393/Ft.</b>	<b>\$1,063/Ft/</b>



**Steel Plate vs. Precast U-Girder Cost Comparison**  
 (Assuming Steel = \$1.25/lb, Varying Precast = \$400 to \$800/ft. PT = \$2.00/lb)



Superstructure Costs Based on Average Values and Actual Data





# Reinforcing Details for Developed for Various Design Conditions

**TYPICAL GIRDER GEOMETRY**

**TYPICAL GIRDER REINFORCING**

**GIRDER GEOMETRY OVER PIER**

GIRDER	D	SLUIT #	SA	W	T	ST	ST	WT
US2-2	8'-0"	3"	9"	10'-11"	6'-8"	1'-8"	3'-10"	2,117 lb
US4-2	7'-0"	3"	9"	10'-7"	7'-3"	1'-8"	3'-10"	2,348 lb
US6-2	6'-0"	3"	9"	11'-11"	7'-3"	1'-8"	3'-10"	2,681 lb
US2-3	8'-0"	4"	10"	10'-3"	6'-8"	1'-8"	3'-0"	2,071 lb
US4-3	7'-0"	4"	10"	10'-5"	7'-3"	1'-8"	3'-0"	2,059 lb
US6-3	6'-0"	4"	10"	11'-3"	7'-3"	1'-8"	3'-0"	2,787 lb
US4/1/2 HAUNCH	7'-0" @ 11'-0" @ 10'-0"	4"	10"	10'-5"	7'-3"	1'-8"	3'-0"	300 W6

**NOTES**

1. INFORMATION SHOWN ON THIS DRAWING IS INTENDED TO ILLUSTRATE A WORKING CONCEPT FOR SPICED U-GIRDERS.
2. ALL CONCRETE DIMENSIONS AND REINFORCEMENT SHOWN ARE FOR ILLUSTRATION PURPOSES ONLY AND MAY VARY BASED ON INDIVIDUAL DESIGNS.
3. GIRDER WEIGHTS ARE CALCULATED ASSUMING 150 Pcf CONCRETE.
4. HAUNCHED GIRDER IS ASSUMED TO VARY FROM 84" TO 132" IN DEPTH FOR PURPOSES OF DEVELOPING STANDARD SHAPES. ALTERNATE DIMENSIONS MAY BE DEVELOPED TO MEET DIFFERING PROJECT REQUIREMENTS.
5. HAUNCHED GIRDER WEIGHT AS SHOWN ASSUMES 8' LENGTH.
6. DETAILS FOR BOTH CURVED AND STRAIGHT GIRDERS ARE SHOWN.
7. CURVED AND STRAIGHT GIRDERS MAY BE USED INTERCHANGEABLY WITHIN ANY SPAN TO ACCOMMODATE ROADWAY ALIGNMENT.

**PENNDOT DRAWING 15-601-BDTD**

**CENTRAL ATLANTIC BRIDGE ASSOCIATES (CABA)**

COMMUNITY OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

DESIGN A REEVE

SCALE: AS SHOWN  
DATE: 08/14/15  
DRAWN: JKH  
CHECKED: JKH  
SHEET NO. 6

## Constant Depth and Haunched Cross Sections

**TYPICAL REINFORCING @ END OF GIRDERS**

**TYPICAL REINFORCING @ SPLICE & DIAPHRAGM**

**SPLICE REINFORCING SECTION**

**DUCT SPLICE DETAIL**

**SAWTOOTH DETAIL**

**NOTES**

1. INFORMATION SHOWN ON THIS DRAWING IS INTENDED TO ILLUSTRATE A WORKING CONCEPT FOR SPICED U-GIRDERS.
2. ALL CONCRETE DIMENSIONS AND REINFORCEMENT SHOWN ARE FOR ILLUSTRATION PURPOSES ONLY.
3. DETAILS FOR BOTH CURVED AND STRAIGHT GIRDERS ARE SHOWN.
4. CURVED AND STRAIGHT GIRDERS MAY BE USED INTERCHANGEABLY WITHIN ANY SPAN TO ACCOMMODATE ROADWAY ALIGNMENT.

**PENNDOT DRAWING 15-601-BDTD**

**CENTRAL ATLANTIC BRIDGE ASSOCIATES (CABA)**

COMMUNITY OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

DESIGN A REEVE

SCALE: AS SHOWN  
DATE: 08/14/15  
DRAWN: JKH  
CHECKED: JKH  
SHEET NO. 7

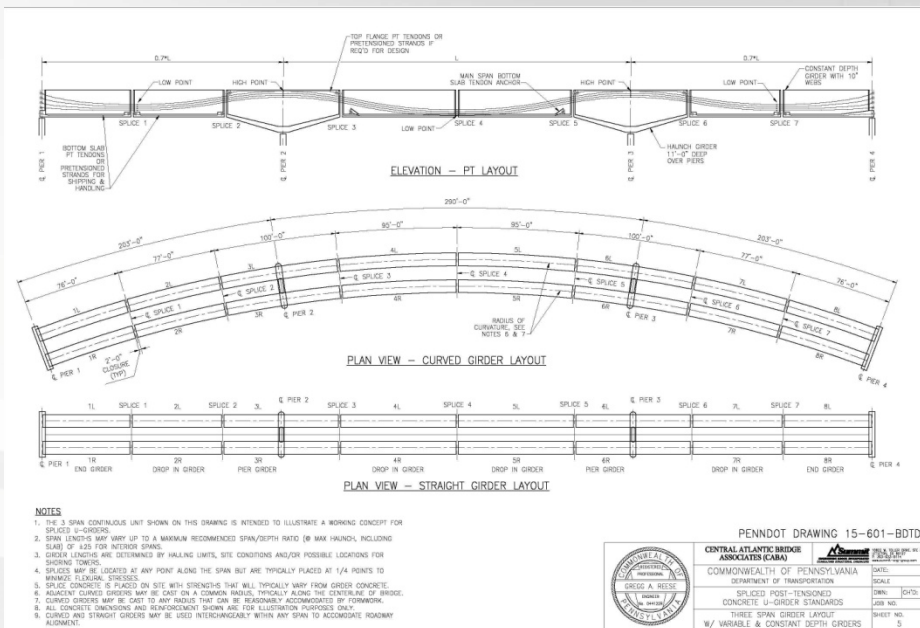


**PennDOT U Girder Standards**

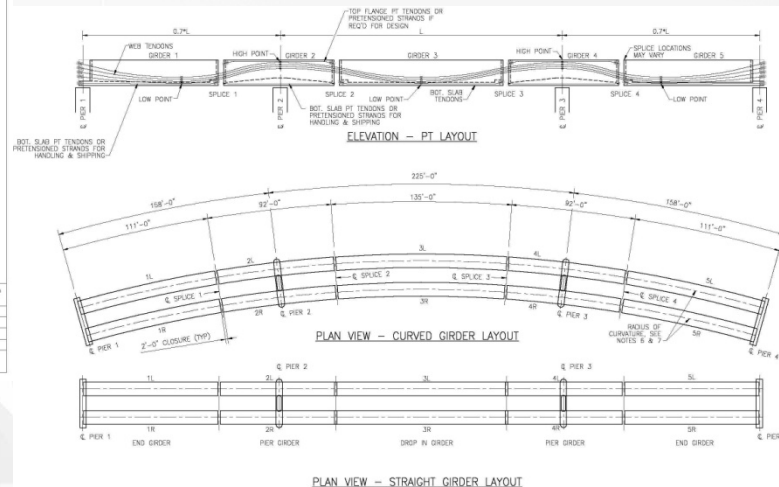


# PennDOT U Girder Standards

## Prototype Girder and Post Tensioning Layouts

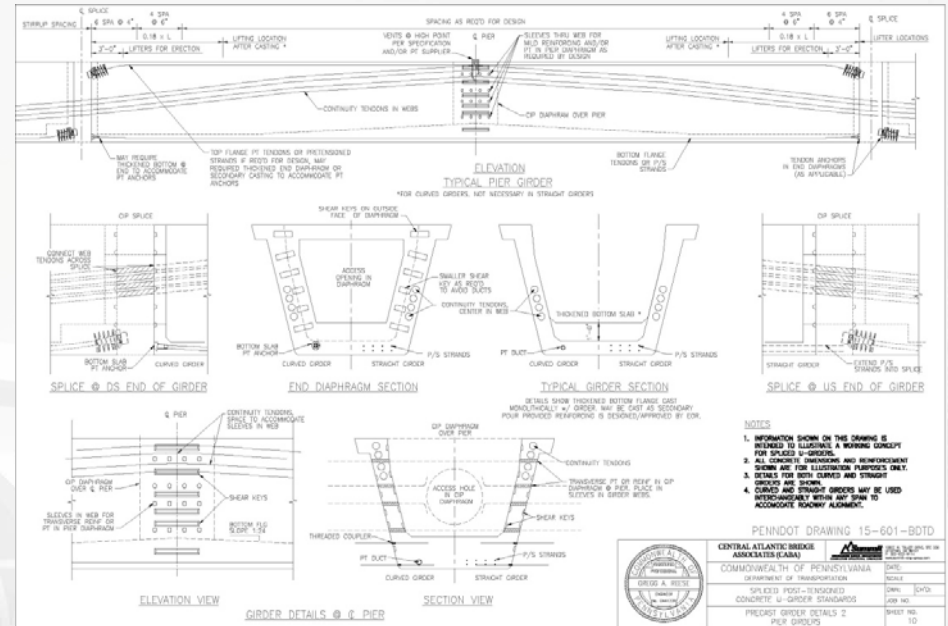
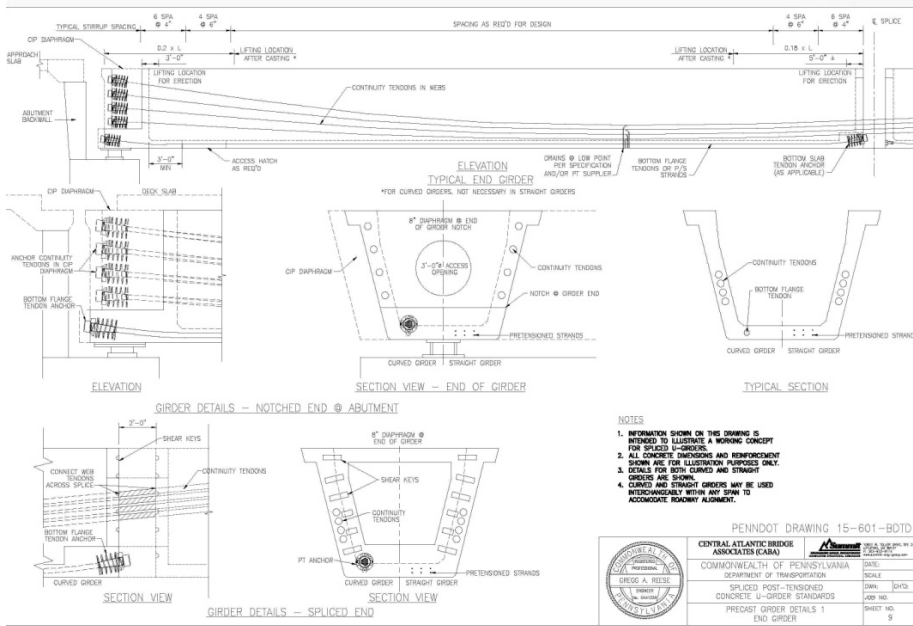


Span Ranges from 200' to 300'  
Curved and Straight Alignments



# PennDOT U Girder Standards

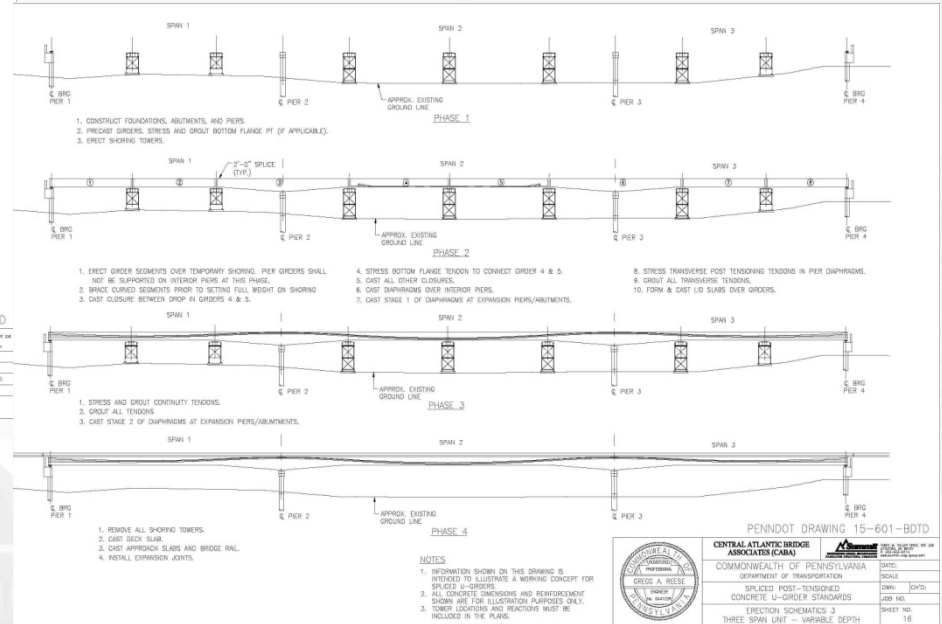
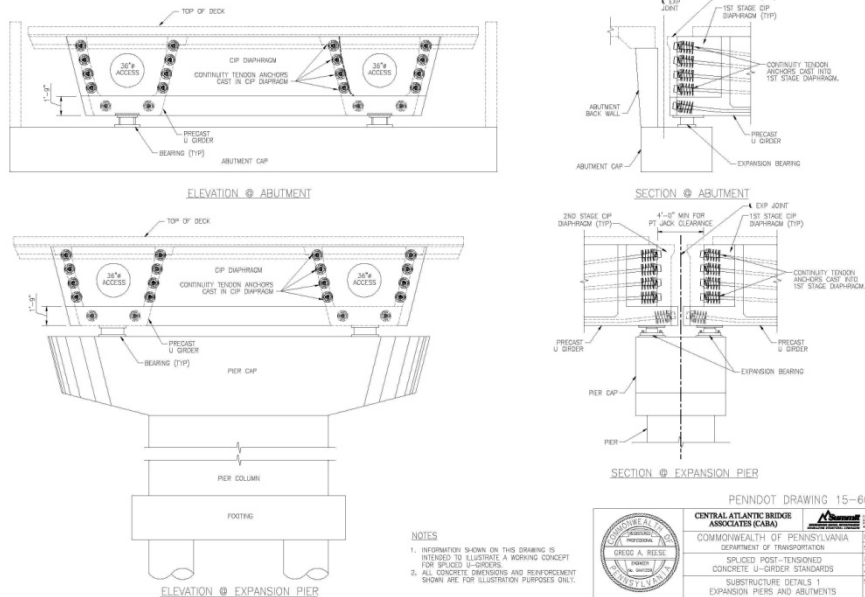
## Post Tensioned Layout Details



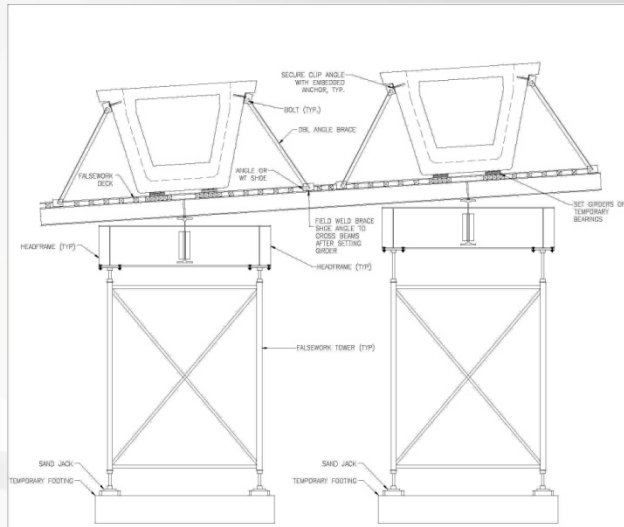
## End Span and Pier Girder Conditions

# PennDOT U Girder Standards

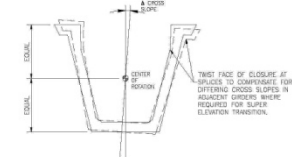
## Example Erection Schematics



## Pro Type Substructure / Superstructure Details



ERECTION BRACING AT ENDS OF PRECAST GIRDERS



**GEOMETRY CONTROL**

- GIRDERS ARE ASSUMED TO BE CAST FLAT IN A CONVENTIONAL PRECAST BED WITH NO COMPENSATION FOR VERTICAL CURVATURE OR CROSS FALL TRANSITION. ADJUSTMENTS FOR VERTICAL CURVATURE AND CHAMBER ARE ACCOMPLISHED BY ADJUSTING TEMPORARY BEARING ELEVATIONS ON THE BRACING.
- ADJUSTMENTS FOR TRANSITION IN CROSS FALL ARE ACCOMPLISHED BY SETTING EACH GIRDER TO A SINGLE CROSS SLURR AND CASTERING THE TRANSITION BETWEEN THE GIRDERS INTO THE BRACES.
- CURVED GIRDERS ARE CAST ALONG A SET CURVE AS DETAILLED IN THE APPROVED SHOP DRAWINGS TO MATCH THE HORIZONTAL ALIGNMENT.
- GIRDERS MAY ALSO BE TAPERED AT SPICES TO AVOID THE GEOMETRIC HORIZONTAL ALIGNMENT.
- NO CORRECTIONS FOR BRIDGE GEOMETRY OTHER THAN CASTERING HORIZONTALLY CURVED GIRDERS, ARE ASSUMED THAT DIFFER FROM COMMON PRACTICE FOR PRECAST UNDER FRAMEWORK.

**NOTES:**

- THIS DRAWING IS INTENDED TO REPRESENT SUGGESTED METHODS FOR BRACING THE PRECAST GIRDERS DURING ERECTION IN ORDER TO MAINTAIN PROPER STABILITY AND LIMIT TORSIONAL STRESSES AND DEFLECTIONS.
- GIRDERS SHALL BE SUPPORTED AND TORSIONALLY BRACED ON FALSEWORK AT EACH END AT EACH SPICE DURING ERECTION.
- ALL GIRDERS SHALL BE BRACED AT EACH END PRIOR TO RELEASED ANY SIGNIFICANT LOAD FROM ERECTION EQUIPMENT TO PREVENT PULLING.
- BRACES AND ALL ASSOCIATED CONNECTIONS SHALL BE DESIGNED BY FALSEWORK ENGINEER.
- SUPPORTING FALSEWORK SHALL BE DESIGNED TO PROVIDE ADEQUATE STIFFNESS UNDER BRACE LOADS TO PREVENT SIGNIFICANT DEFLECTIONS WHILE RELEASED GIRDERS.
- INFORMATION SHOWN ON THIS DRAWING IS INTENDED TO ILLUSTRATE A WORKING CONCEPT FOR SPLICED U-GIRDERS.
- ALL CONCRETE DIMENSIONS AND SPACING & SIZES OF REINFORCEMENT, SHOWN ARE FOR ILLUSTRATION PURPOSES ONLY.

PennDOT DRAWING 15-601-BDTD

CENTRAL ATLANTIC BRIDGE ASSOCIATES (CARA)

COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

DATE: 2/27/2015

SCALE: 1/8"=1'-0"

SPLICED POST-TENSIONED CONCRETE U-GIRDER STANDARDS

CONSTRUCTION DETAILS 1

TEMPORARY SHORING AND GEOMETRY CONTROL

SHEET NO. 17

# Detailed Grouting and Load Rating Procedures

## GROUT SPECIFICATIONS

**UNIT METHOD** - WHEN FLOWING IS NOT PERMITTED TO CLEAN THE PORES AND THE WIRE OR STRAND BEARINGS.

DO NOT EXCEED 5000 LBS OF LOAD IN HEIGHT FOR EACH PORE FOUR CHAINS (UNTIL THE GROUT SETS) UP TO A MAXIMUM OF 10' ABOVE THE TOP OF THE LAST LIFT OF GROUT TO THE TOP OF THE NEXT GROUT LIFT. THE GROUTING OPERATOR SHALL BE RESPONSIBLE FOR THE PROPERLY PLACING THE GROUT INTO THE PORE.

**NORMAL GROUT** - SHALL BE A PORTLAND CEMENT GROUT WITH A MINIMUM OF 10% PORTLAND CEMENT. THE GROUT SHALL BE PLACED IN THE PORE WITHIN 10' OF THE TOP OF THE LAST LIFT OF GROUT. THE GROUT SHALL BE PLACED IN THE PORE WITHIN 10' OF THE TOP OF THE LAST LIFT OF GROUT. THE GROUT SHALL BE PLACED IN THE PORE WITHIN 10' OF THE TOP OF THE LAST LIFT OF GROUT.

**DO NOT PERMIT** DIMENSIONAL TOLERANCES OF THE U-GIRDER FROM THE DESIGNER'S INTENT. CORRECT THE DIMENSIONAL TOLERANCES OF THE GROUT BEFORE THE NEXT LIFT OF GROUT IS PLACED. CORRECT THE DIMENSIONAL TOLERANCES OF THE GROUT BEFORE THE NEXT LIFT OF GROUT IS PLACED.

**FOR THE GROUT** TO BE USED FOR THE TOP LIFT OF GROUT AT A 10' HEIGHT, THE GROUT SHALL BE PLACED IN THE PORE WITHIN 10' OF THE TOP OF THE LAST LIFT OF GROUT. THE GROUT SHALL BE PLACED IN THE PORE WITHIN 10' OF THE TOP OF THE LAST LIFT OF GROUT.

**QUALITY CONTROL** - TESTING IS TO BE PERFORMED AS DESCRIBED IN THE SPECIFICATIONS TO THE PENNDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION OF BRIDGES.

TEST	TABLE 3 QUALITY CONTROL TESTING REQUIREMENTS	TEST METHOD
STRENGTH TEST (SHEAR OF 3 GIRDERS)	1 PER DAY	PERFORMANCE CRITERIA
FLUIDITY TEST	1 EVERY 2 HOURS	• 1000 PSI AT 30 SECS
TEMPERATURE MEASUREMENT	1 PER DAY	• 1000 PSI AT 30 SECS
AIR VOID MEASUREMENT	1 PER DAY	• 1000 PSI AT 30 SECS

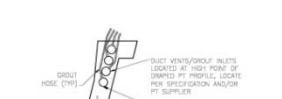
**NOTES:**

- THE LEVEL OF GROUT IN THE GULLETS AND GROUT CHAM AND TOP OFF AS NECESSARY WITH TESTS SHALL BE TAKEN FROM THE POINT OF GROUTING. ALL TESTS SHALL BE TAKEN WITH PRESSURE AND SHALL BE TAKEN FROM THE POINT OF GROUTING. ALL TESTS SHALL BE TAKEN WITH PRESSURE AND SHALL BE TAKEN FROM THE POINT OF GROUTING.
- REINFORCEMENT SHALL BE INSTALLED TO PREVENT SPALLS OF BRACE OR OTHER ADJACENT BEAMS. REINFORCEMENT SHALL BE INSTALLED TO PREVENT SPALLS OF BRACE OR OTHER ADJACENT BEAMS. REINFORCEMENT SHALL BE INSTALLED TO PREVENT SPALLS OF BRACE OR OTHER ADJACENT BEAMS.
- ADJUSTMENTS SHALL BE MADE TO PREVENT SPALLS OF BRACE OR OTHER ADJACENT BEAMS. REINFORCEMENT SHALL BE INSTALLED TO PREVENT SPALLS OF BRACE OR OTHER ADJACENT BEAMS.

**DO NOT PERMIT** DIMENSIONAL TOLERANCES OF THE U-GIRDER FROM THE DESIGNER'S INTENT. CORRECT THE DIMENSIONAL TOLERANCES OF THE GROUT BEFORE THE NEXT LIFT OF GROUT IS PLACED. CORRECT THE DIMENSIONAL TOLERANCES OF THE GROUT BEFORE THE NEXT LIFT OF GROUT IS PLACED.

**FOR THE GROUT** TO BE USED FOR THE TOP LIFT OF GROUT AT A 10' HEIGHT, THE GROUT SHALL BE PLACED IN THE PORE WITHIN 10' OF THE TOP OF THE LAST LIFT OF GROUT. THE GROUT SHALL BE PLACED IN THE PORE WITHIN 10' OF THE TOP OF THE LAST LIFT OF GROUT.

**QUALITY CONTROL** - TESTING IS TO BE PERFORMED AS DESCRIBED IN THE SPECIFICATIONS TO THE PENNDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION OF BRIDGES.



## LOAD RATING

THE ENGINEER OF RECORD SHALL PERFORM A LOAD RATING OF ALL BRIDGES DESIGNED UNDER SPLICED U-GIRDER CONSTRUCTION AS A PART OF THE DESIGN PROCESS, THAT SATISFIES THE REQUIREMENTS IN DIV-4 SECTION 1.8.5.

SPAN	SPLICED U-GIRDER		SPLICED U-GIRDER		SPLICED U-GIRDER		SPLICED U-GIRDER		SPLICED U-GIRDER	
	10'	12'	14'	16'	18'	20'	22'	24'	26'	28'
10'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
28'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

**NOTES:**

- A LOAD FACTOR OF UNITY IS APPLIED TO PERMANENT LOADS FOR THE FATIGUE AND DEFLECTION LIMIT STATE ONLY WHEN SPECIES 3.
- THE LOAD FACTOR ALSO APPLIED FOR SERVICE II.
- THE LOAD FACTOR ALSO APPLIED FOR SERVICE II.
- FOR ALL BRIDGES, THE USE LOAD FOR SERVICE II IS TO BE TAKEN AS 1.0 (9+)
- FOR ALL BRIDGES, THE USE LOAD FOR SERVICE II IS TO BE TAKEN AS 1.0 (9+)
- ALL LOADS APPLIED TO NON-COMPOSITE SECTION FOR NON-COMPOSITE GIRDERS.
- LOAD COMBINATIONS FOR FATIGUE ONLY.
- THIS DRAWING IS THE TYPICAL DESIGN VERIFICATION TO BE USED FOR EACH LOAD COMBINATION.
- THE REDUCED LOAD FACTOR FOR U-GIRDER (SEE 1.8.5.1)
- FOR BRIDGE SPANS GREATER THAN 100 FEET, THE USE LOAD FACTOR FOR SERVICE II IS TO BE TAKEN AS 0.9 FOR THE PRELIMINARY LOAD CASE.

SPAN	SPLICED U-GIRDER		SPLICED U-GIRDER		SPLICED U-GIRDER		SPLICED U-GIRDER		SPLICED U-GIRDER	
	10'	12'	14'	16'	18'	20'	22'	24'	26'	28'
10'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
28'	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

PennDOT DRAWING 15-601-BDTD

CENTRAL ATLANTIC BRIDGE ASSOCIATES (CARA)

COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

DATE: 2/27/2015

SCALE: 1/8"=1'-0"

SPLICED POST-TENSIONED CONCRETE U-GIRDER STANDARDS

CONSTRUCTION DETAILS 3

AND LOAD RATING

SHEET NO. 21



PennDOT U Girder Standards



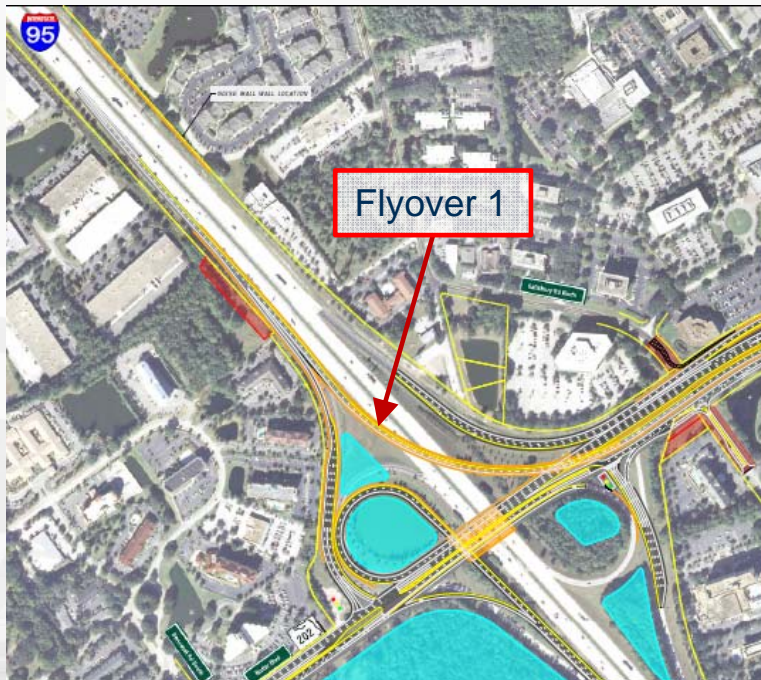


**Summit**  
ENGINEERING GROUP, INC.  
A MODJESKI and MASTERS COMPANY

**MODJESKI and MASTERS**  
Experience great bridges.

**CASE STUDY | JT BUTLER EXPRESSWAY, JACKSONVILLE, FL.**

## PROJECT BACKGROUND

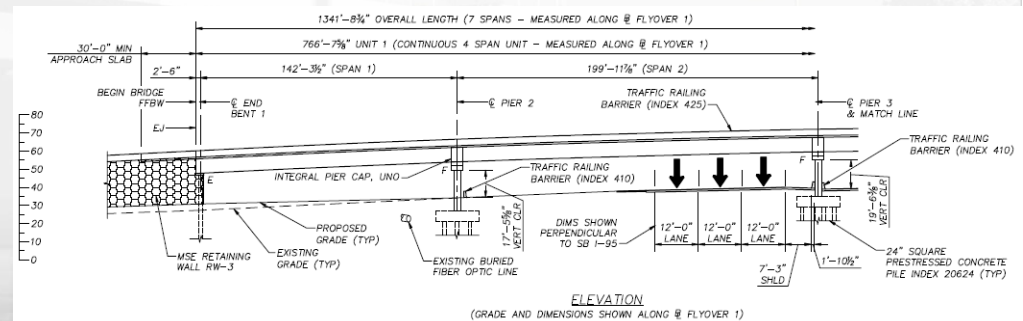
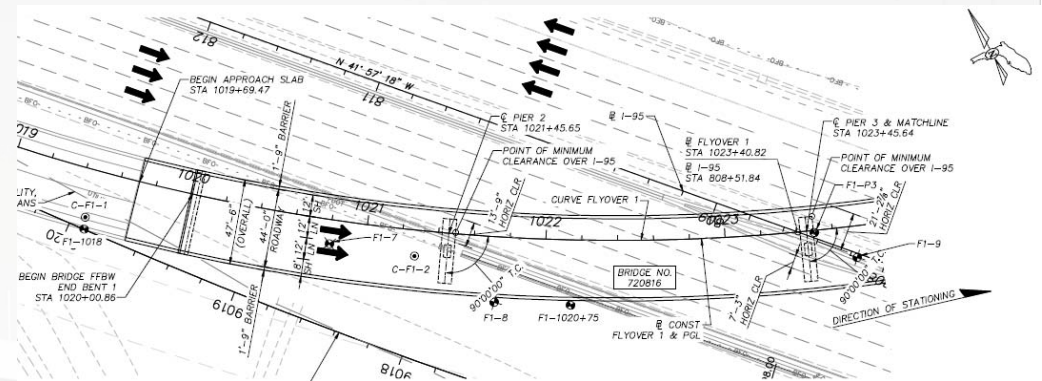


- Modjeski and Masters is the EOR for the Flyover 1 Bridge
- Modjeski is also serving as the construction engineer for SEMA
- Total Project Bid - \$66.7m



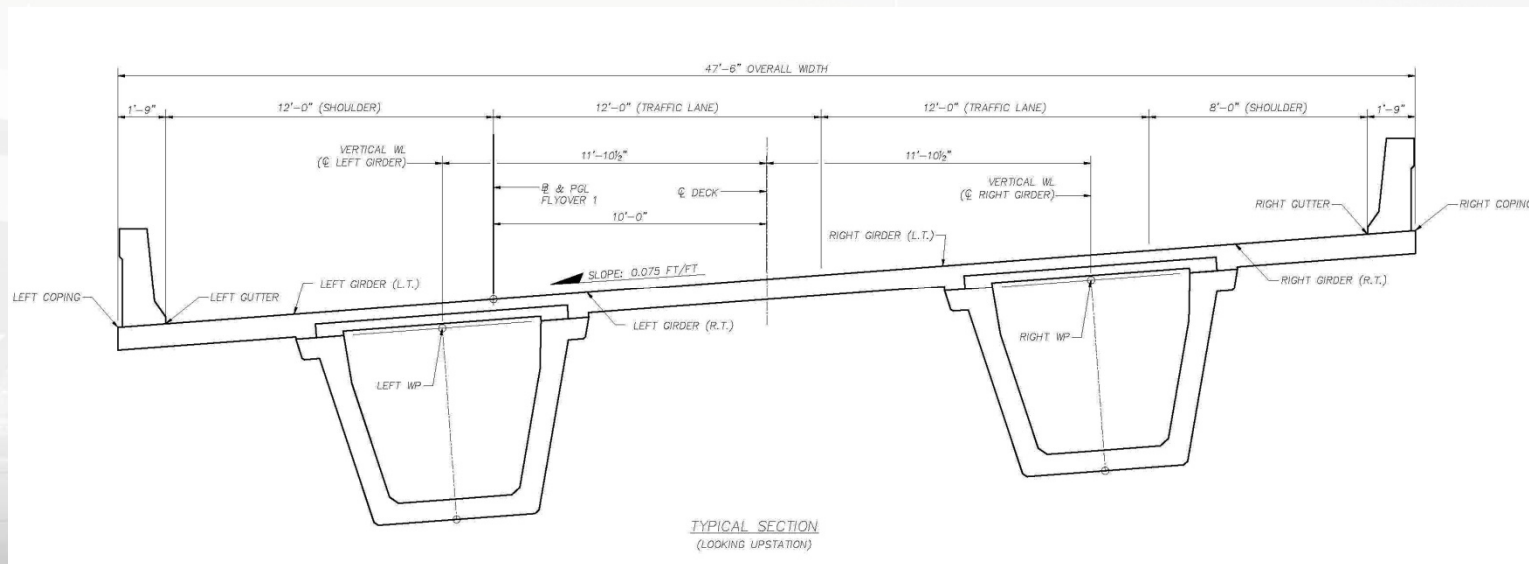
# FLYOVER 1 BRIDGE

- 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

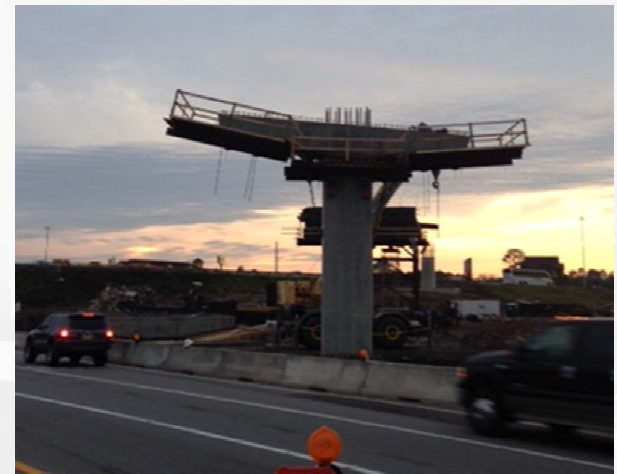




## CURVED PRECAST POST-TENSIONED U-GIRDERS

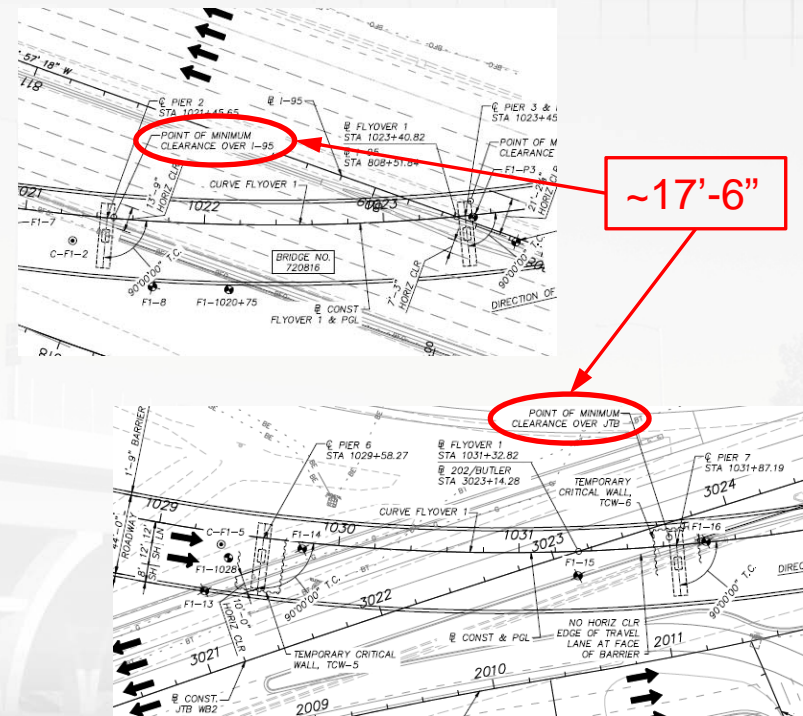
- Design considerations
  - Max girder length 115 ft
  - Max girder weight 320 kips.
  - PT anchors at cantilevered girder ends
  - Staged PT during handling and erection

# PRECAST POST-TENSIONED PIER CAPS



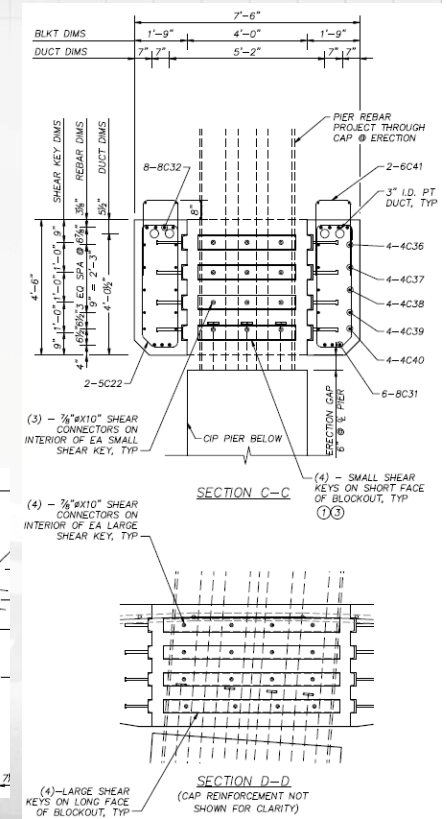
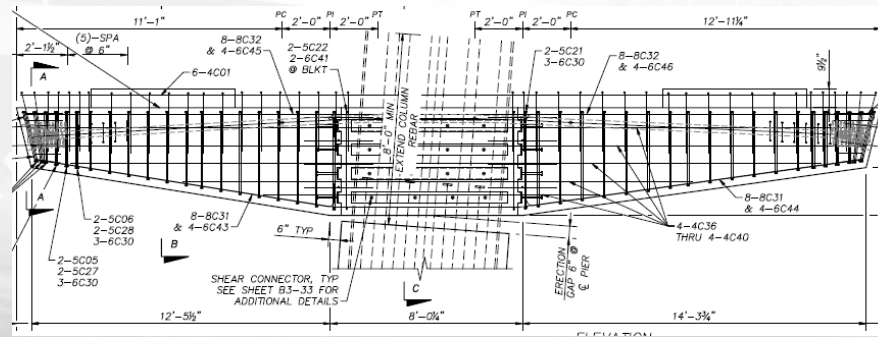
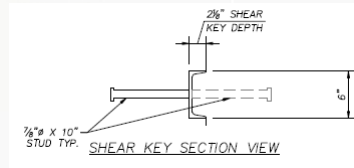
# PRECAST POST-TENSIONED PIER CAPS

- 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

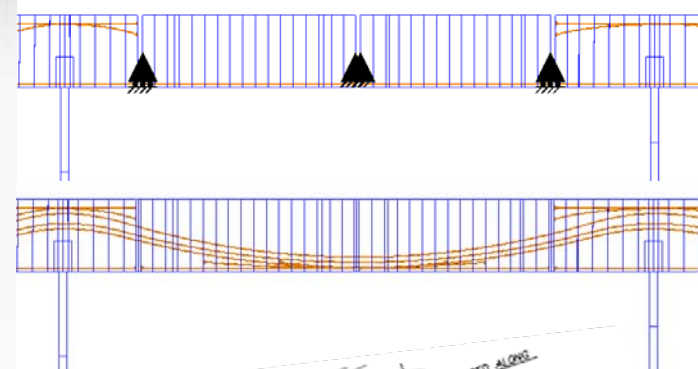


- Drop In Girders supported at each end from strong backs resting on ends of Pier Girders

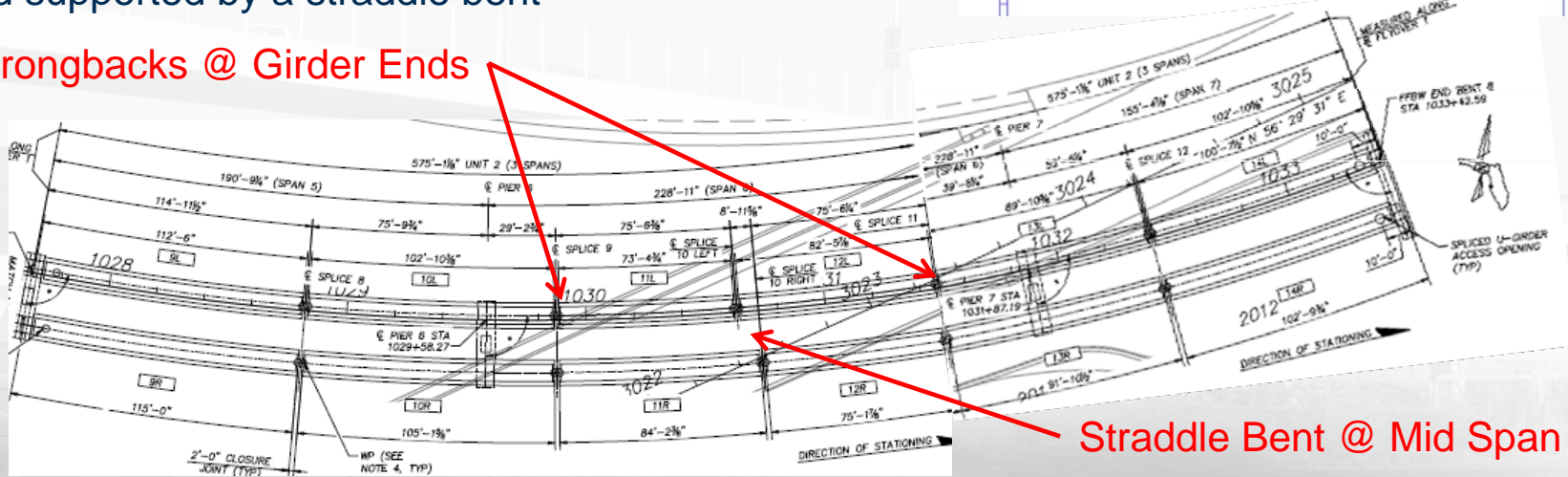


# POSITIVE MOMENT CROSSOVER TENDON

- 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

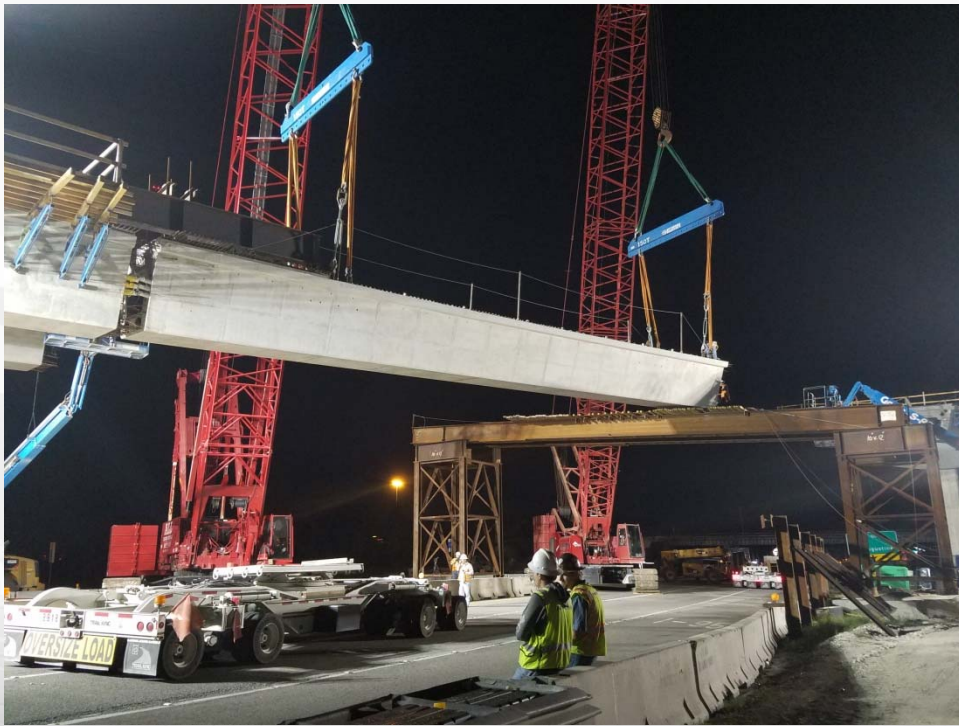


Strongbacks @ Girder Ends



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

# THANK YOU

## Questions?

**This concludes the educational content of this activity.**



***“Modjeski and Masters, Inc. has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.”***





## 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.

