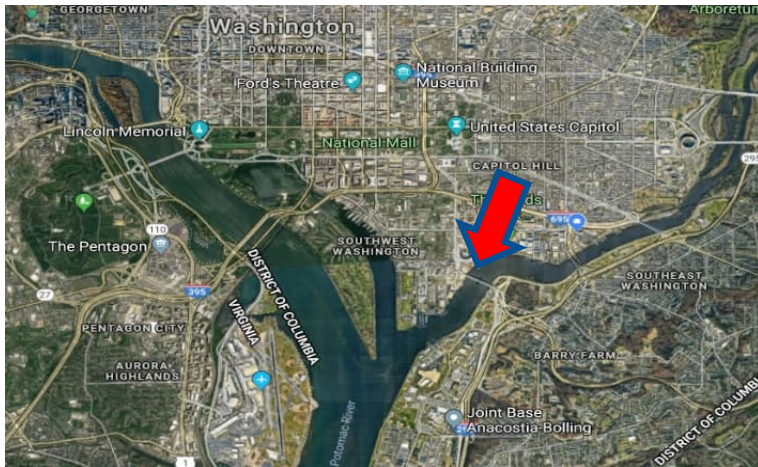


DESIGN AND ERECTION ANALYSIS OF THE NEW FREDERICK DOUGLASS MEMORIAL BRIDGE

NATHAN PORTER, P.E., AECOM, Richmond, VA



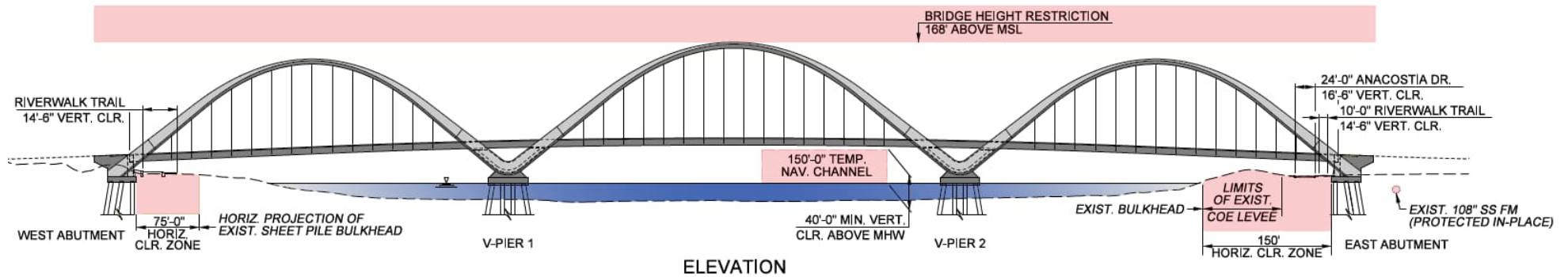
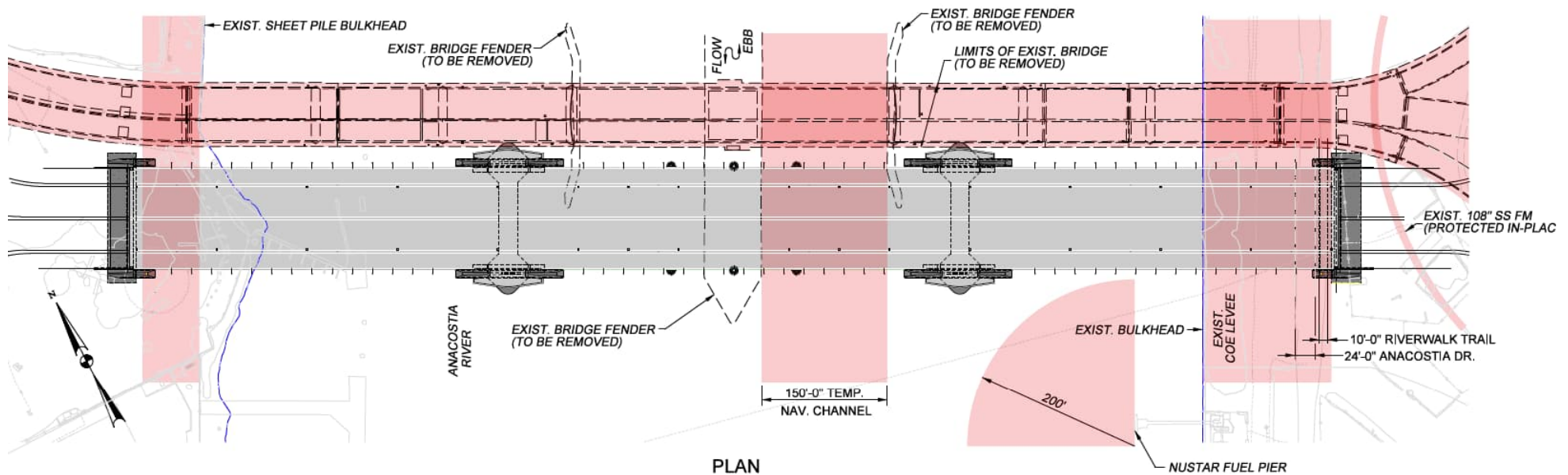
Project Overview



- Key Elements
 - Build new six-lane bridge
 - Reconstruct Suitland Parkway & I-295 Interchange
 - Build two new traffic ovals
 - Enhance bicycle and pedestrian mobility
 - Contract Value \$442M
- Schedule
 - Design: August 2017 to November 2018
 - Bridge open to traffic: May 2021
 - Project Completion: Fall 2022



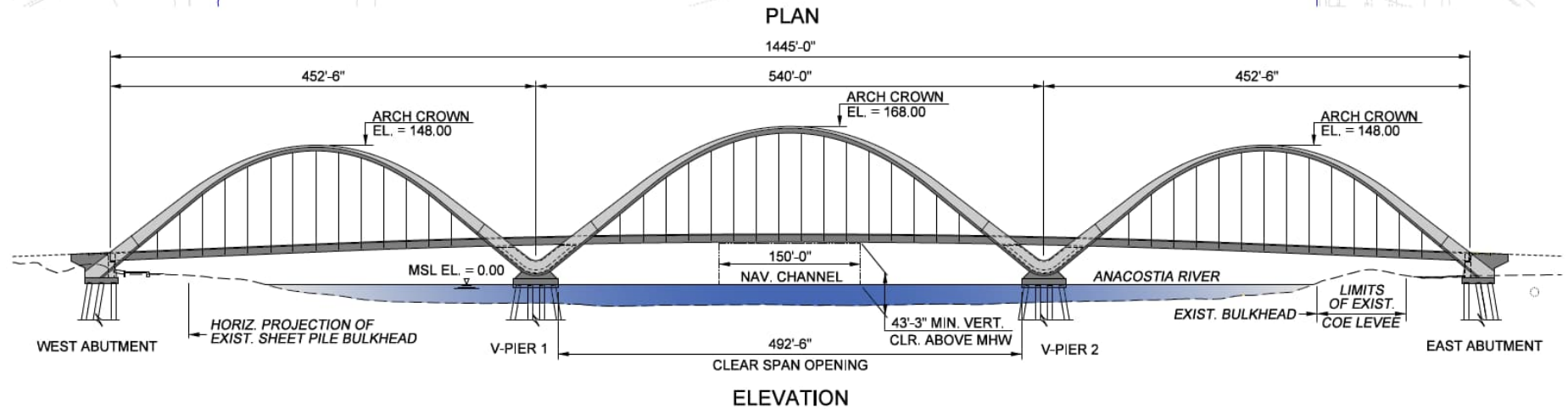
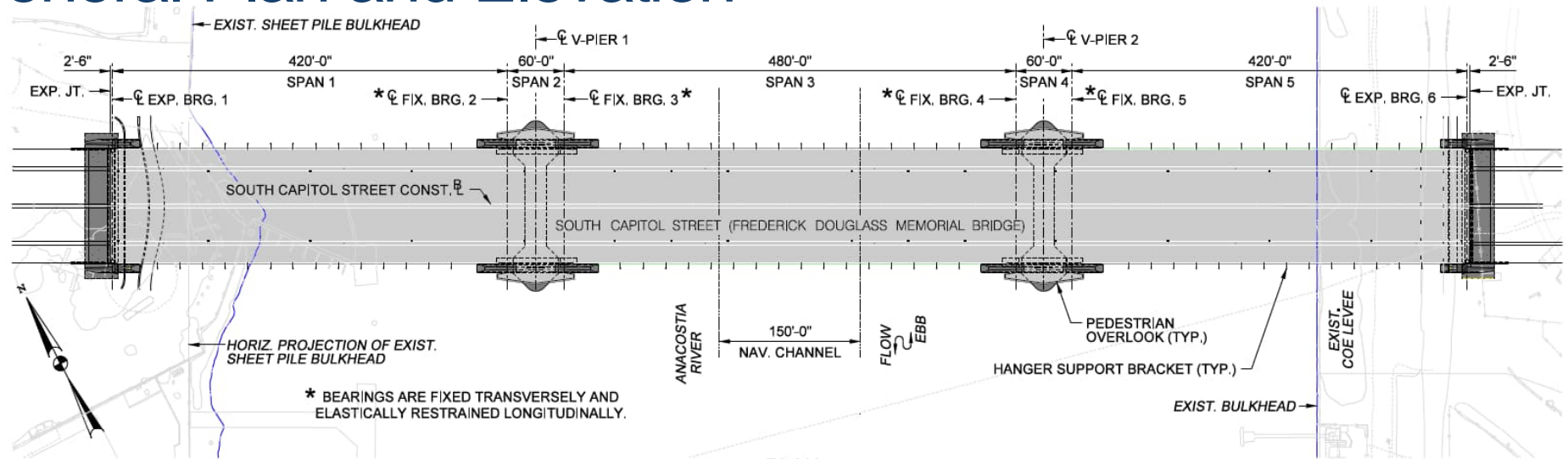
Clearance Requirements



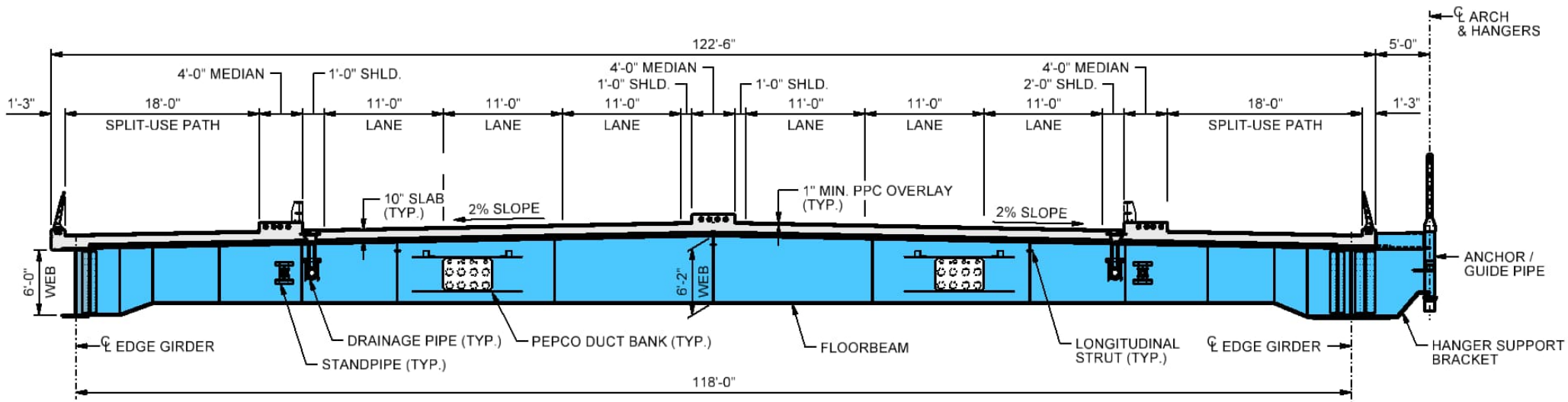
Controlling Design Parameters

- Corrosion Protection Plan
 - Non-replaceable components: 100-year min. service life
 - Replaceable components : 30 to 75-year min. service life
- River Scour
 - Design scour: 200-year return period (22.2 feet at V-Piers)
 - Check flood: 500-year return period (27.5 feet at V-Piers)
- Wind and Pedestrian Comfort Study & Testing
 - Structural design: 100-year return period
 - Aeroelastic stability: 1000-year return period

General Plan and Elevation



Superstructure Typical Section

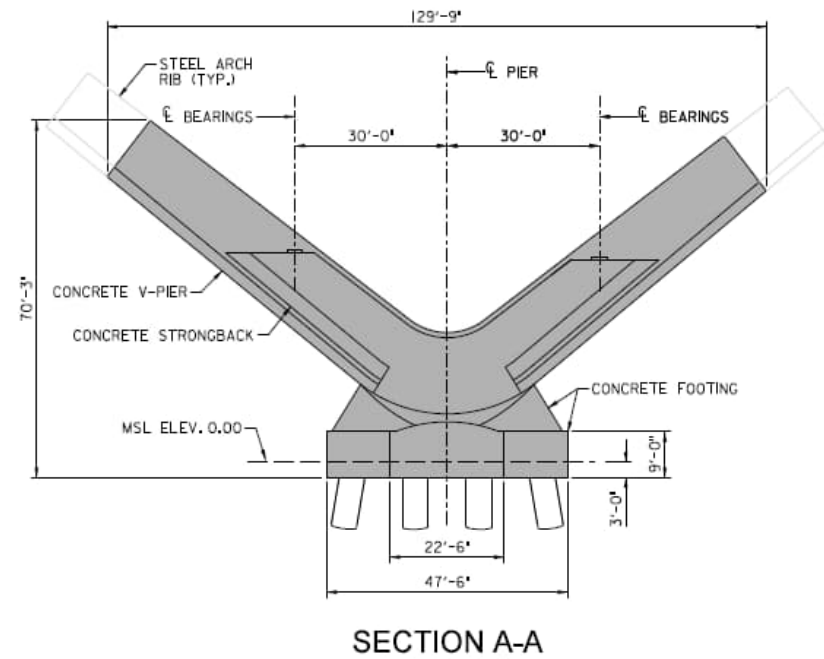
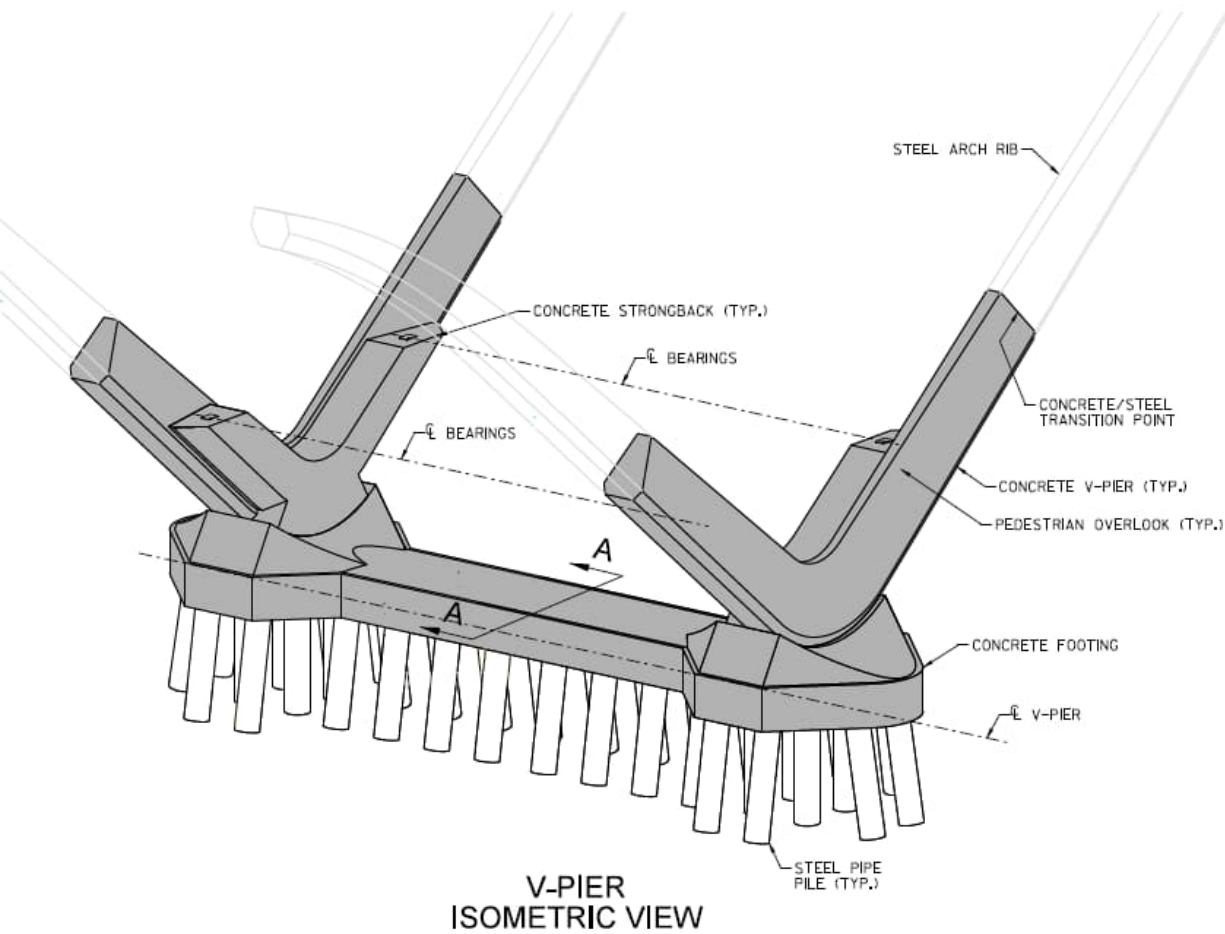


HALF TYPICAL SECTION

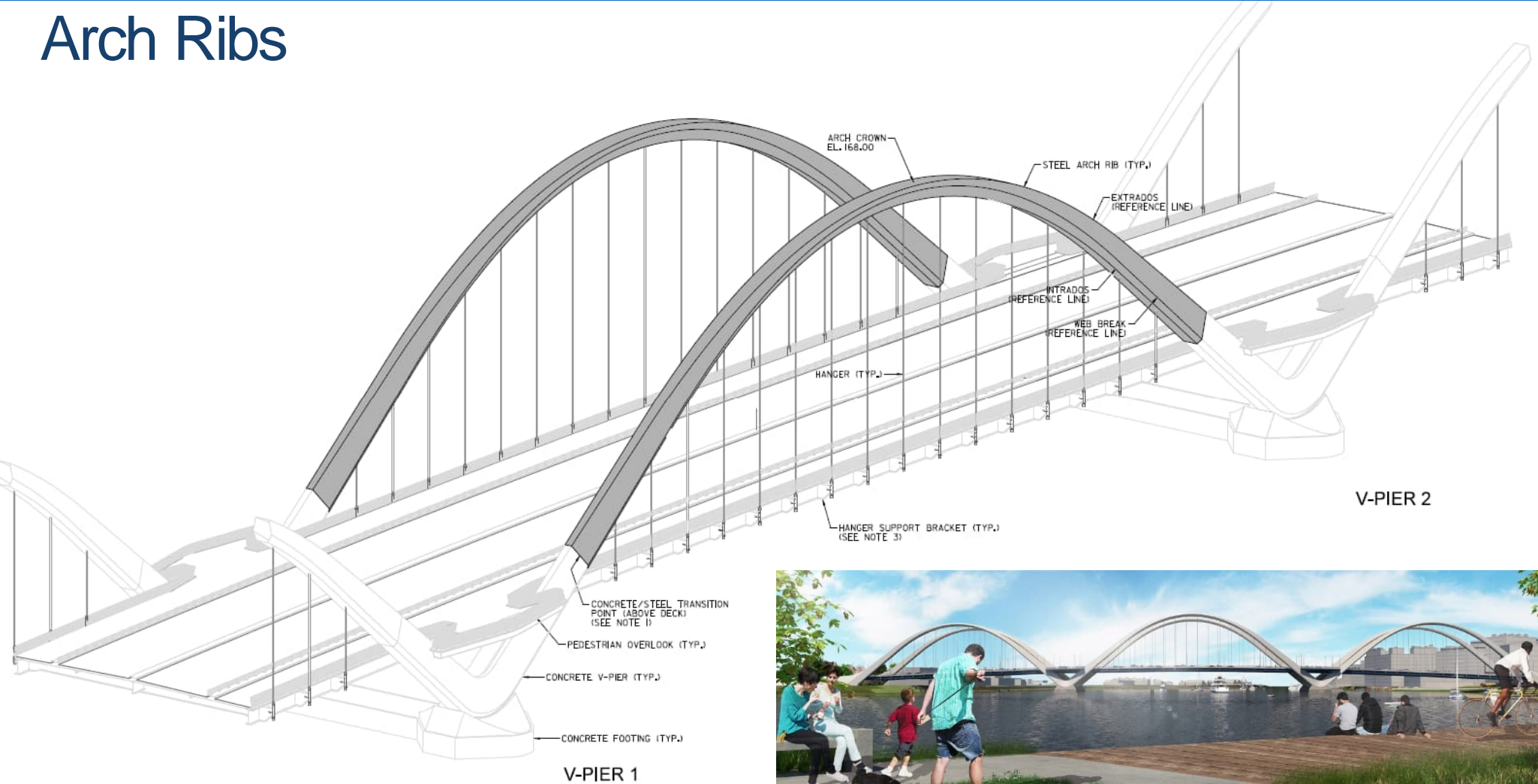
HALF SECTION AT HANGERS



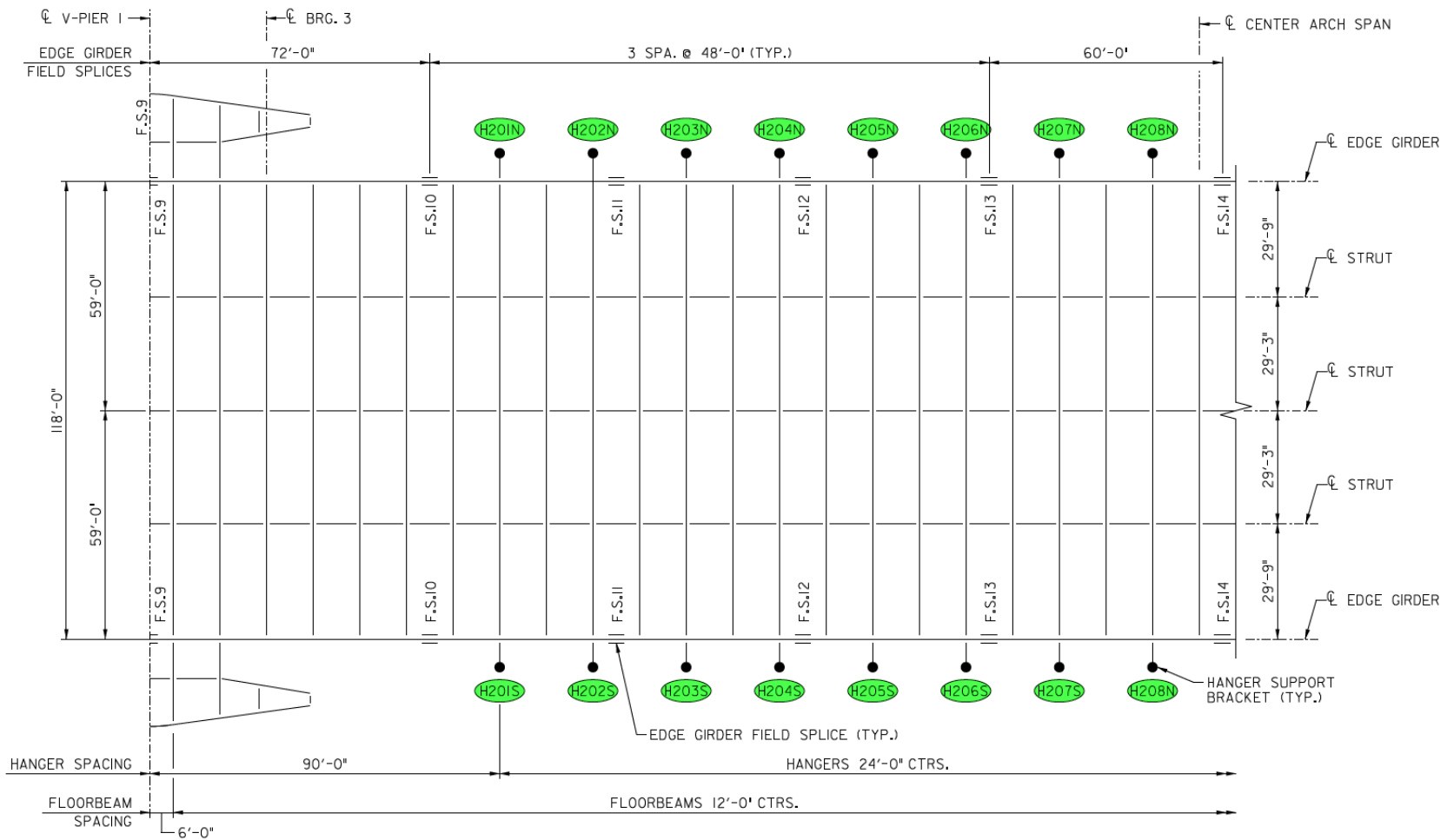
V-Piers



Arch Ribs

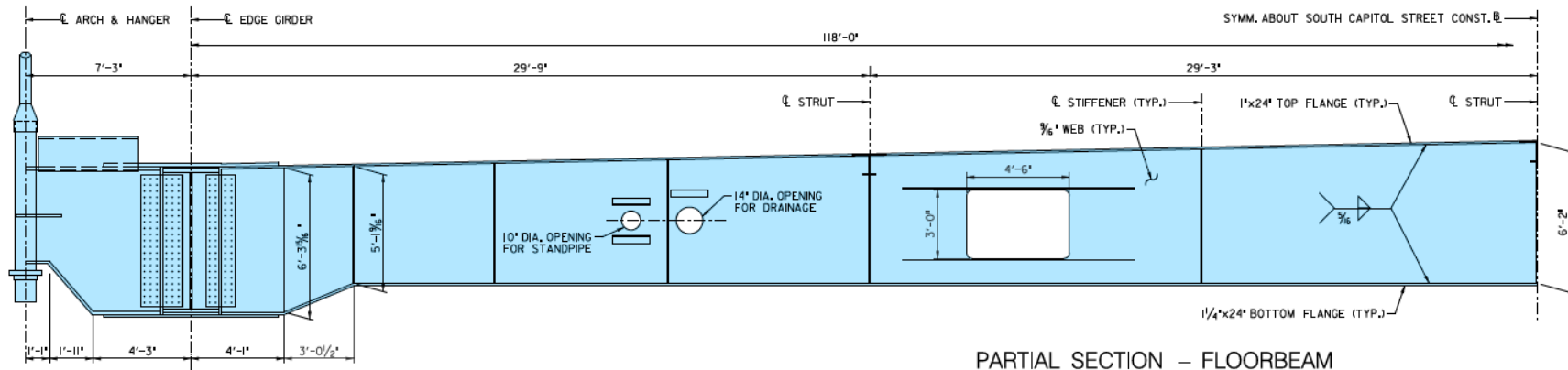


Superstructure – Framing Plan



PARTIAL DECK PLAN - STRUCTURAL STEEL FRAMING

Superstructure – Floorbeams

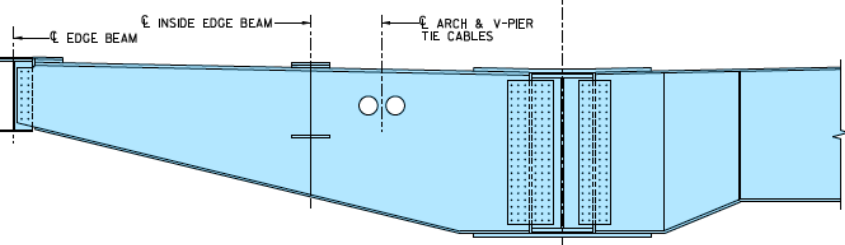


PARTIAL SECTION – FLOORBEAM

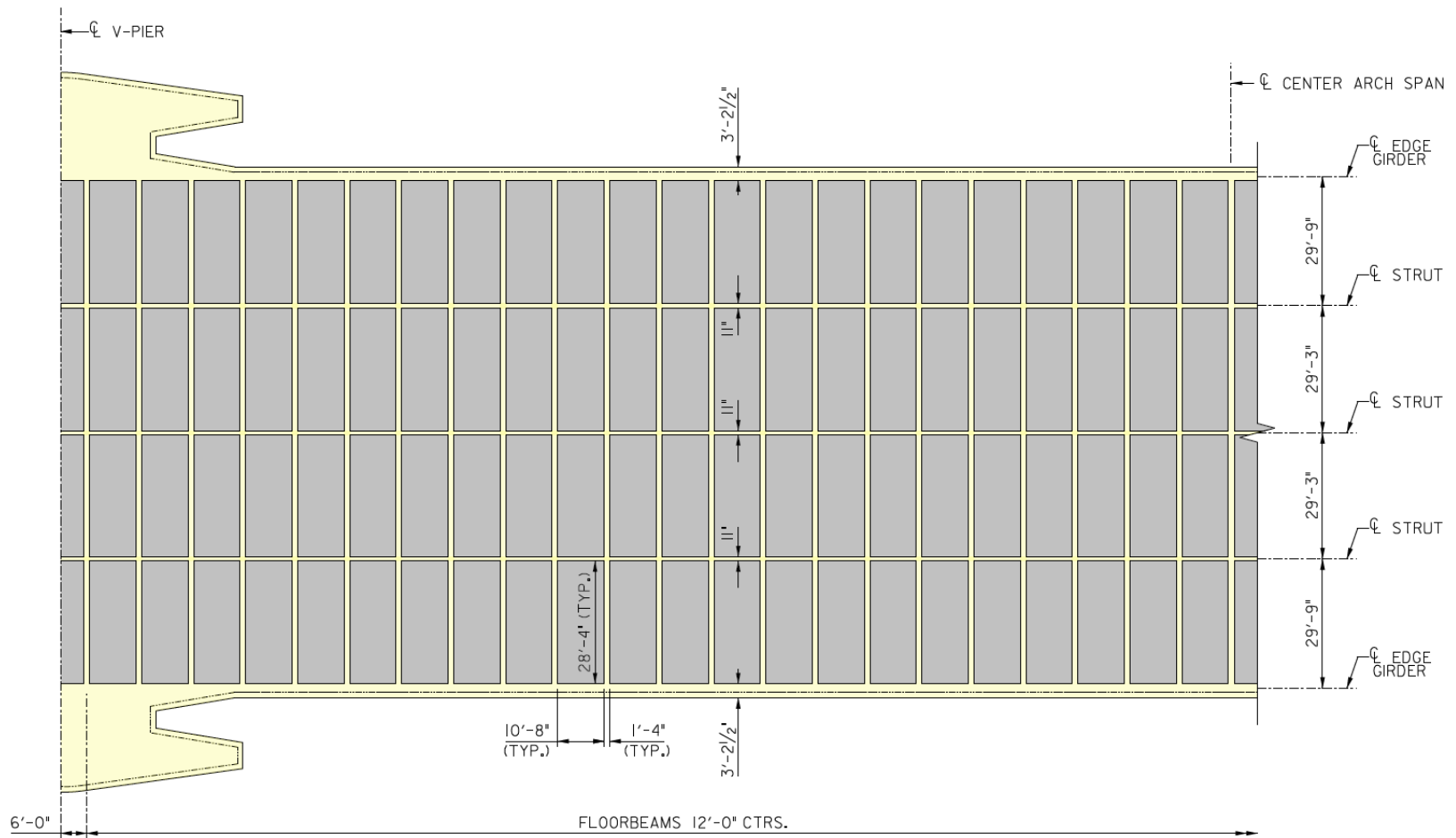
CONNECTION AT HANGER SUPPORT BRACKET

TYPICAL CONNECTION

CONNECTION AT OVERLOOK SUPPORT BRACKET

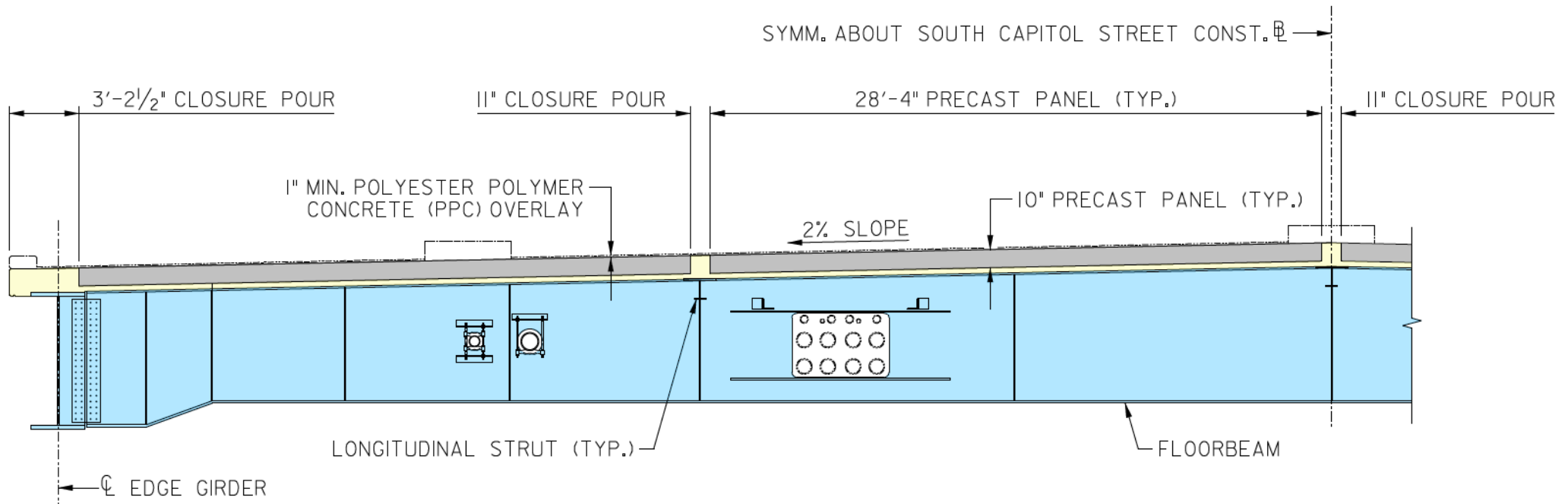


Superstructure – Precast Deck Panels



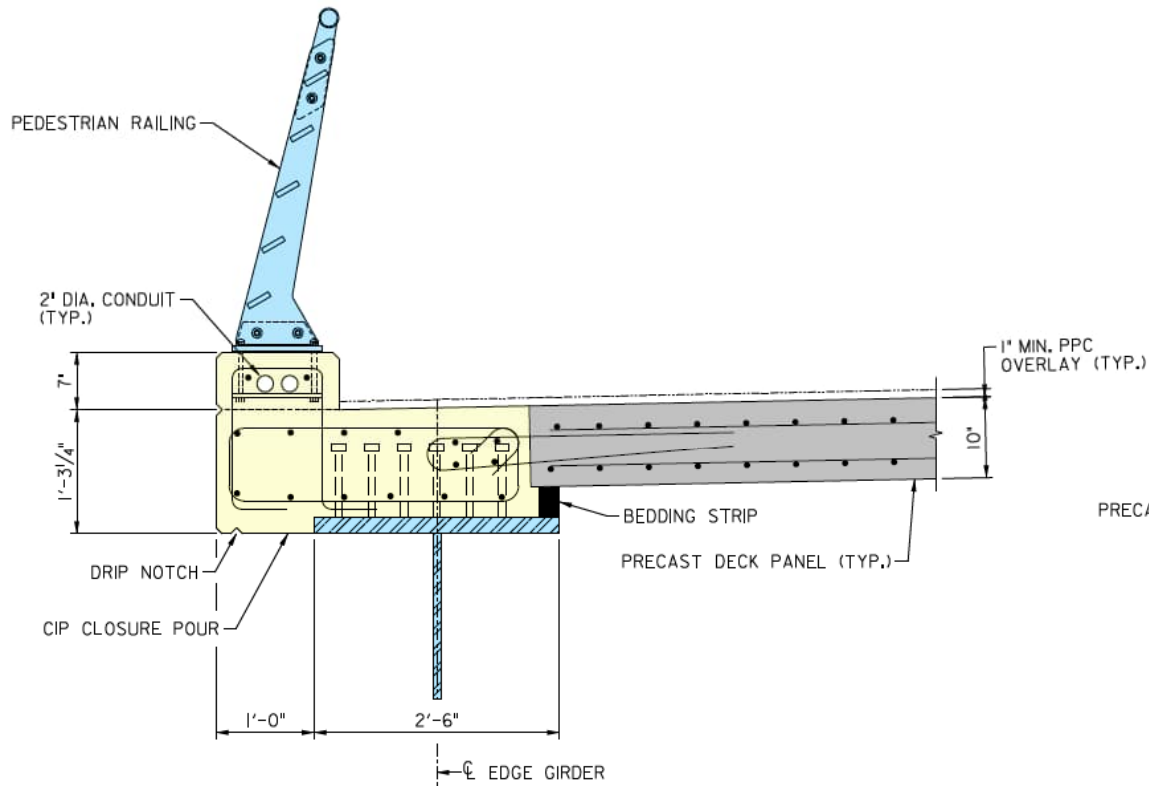
PARTIAL DECK PLAN - PRECAST DECK PANELS

Superstructure – Precast Deck Panels

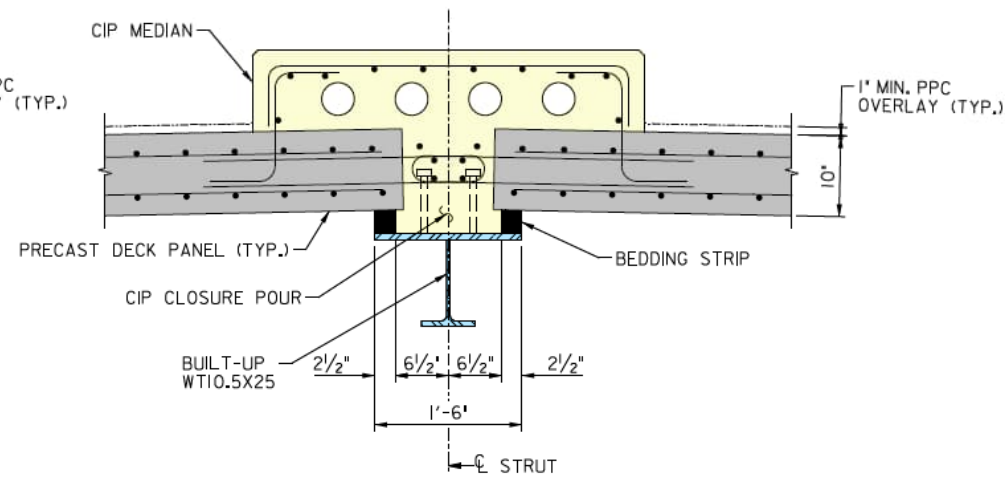


PRECAST DECK PANEL

Superstructure – Deck Closure Pour



**PRECAST DECK PANEL
EDGE GIRDER CLOSURE POUR**



**PRECAST DECK PANEL
LONGITUDINAL STRUT CLOSURE POUR**

Hangers – Stay Cables

- Hangers

- 14 hangers side arches; 16 hangers center arches;
88 total hangers
- Single stage stressing initial force/length; second stage stressing load/geometry control, as required

- Strands

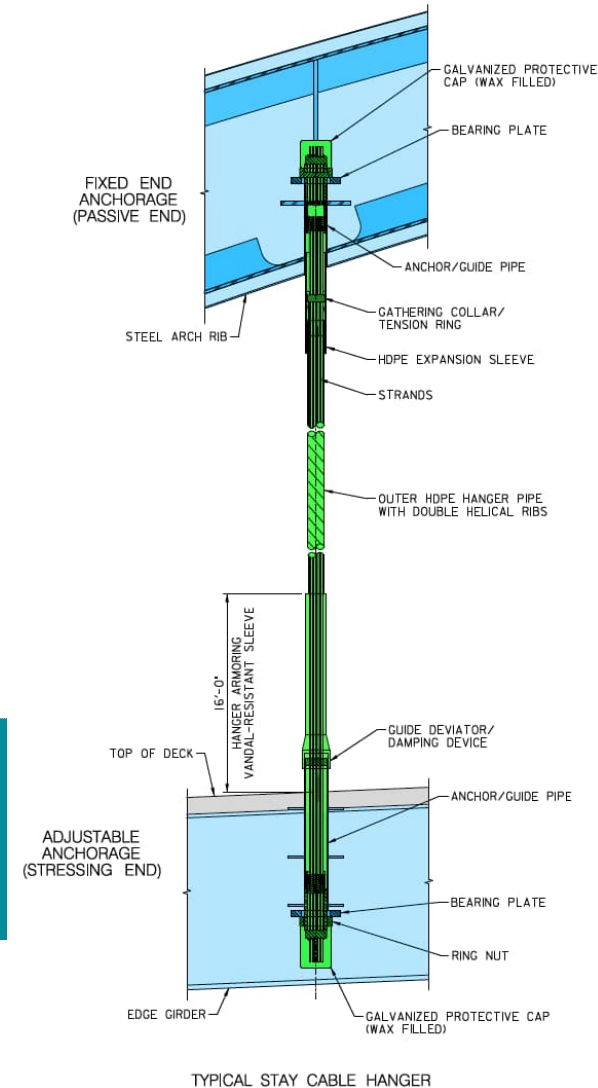
- 0.62” diameter; coextruded HDPE sheathing; wax filled;
non-bonded and parallel
- 18 to 29 strands per hanger

- External HDPE Stay Pipe

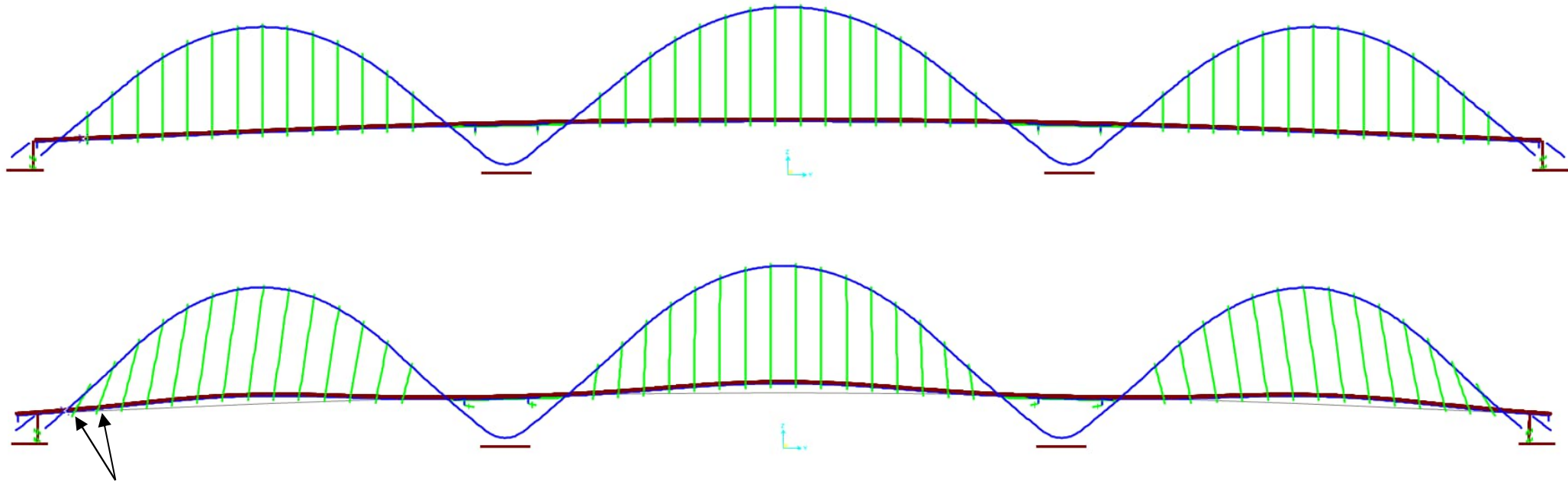
- Double helical rib

- Benefits

- Fatigue resistance; corrosion protection; easy to replace



Hangers – Stay Cables

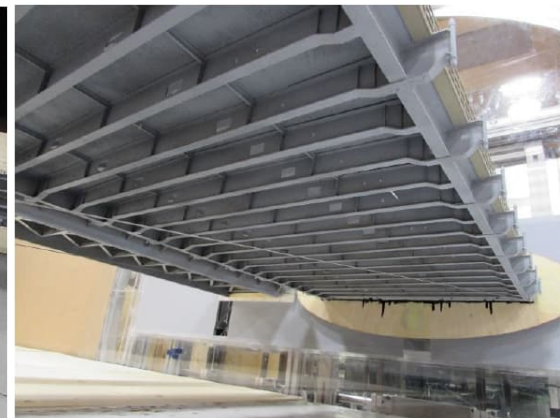


- Shortest hangers (approx. 31 feet long; 29 strand cable)
- Large lateral displacement / cable curvature
- High bending stresses at anchorages

Longitudinal Movement – Thermal Rise

Wind Tunnel Testing

- Site Specific Wind Study
- Arch Pressure Integration Study
 - Vortex Shedding
 - Static Force Coefficients
- Section Model Tests
 - w/ Existing Bridge
 - w/o Existing Bridge
- Cable Vibration Assessment
 - Min. Req'd Damping 21 to 27%
- Pedestrian Comfort Study



Wind Tunnel Testing

- Aeroelastic Model Testing
 - Completed arch
 - Partial arch (construction stages)
 - Vortex-induced oscillations (VIO) were observed during arch erection
 - VIO mitigation measures included wind restrictions during erection as well as deployment of in-line VDD as-required

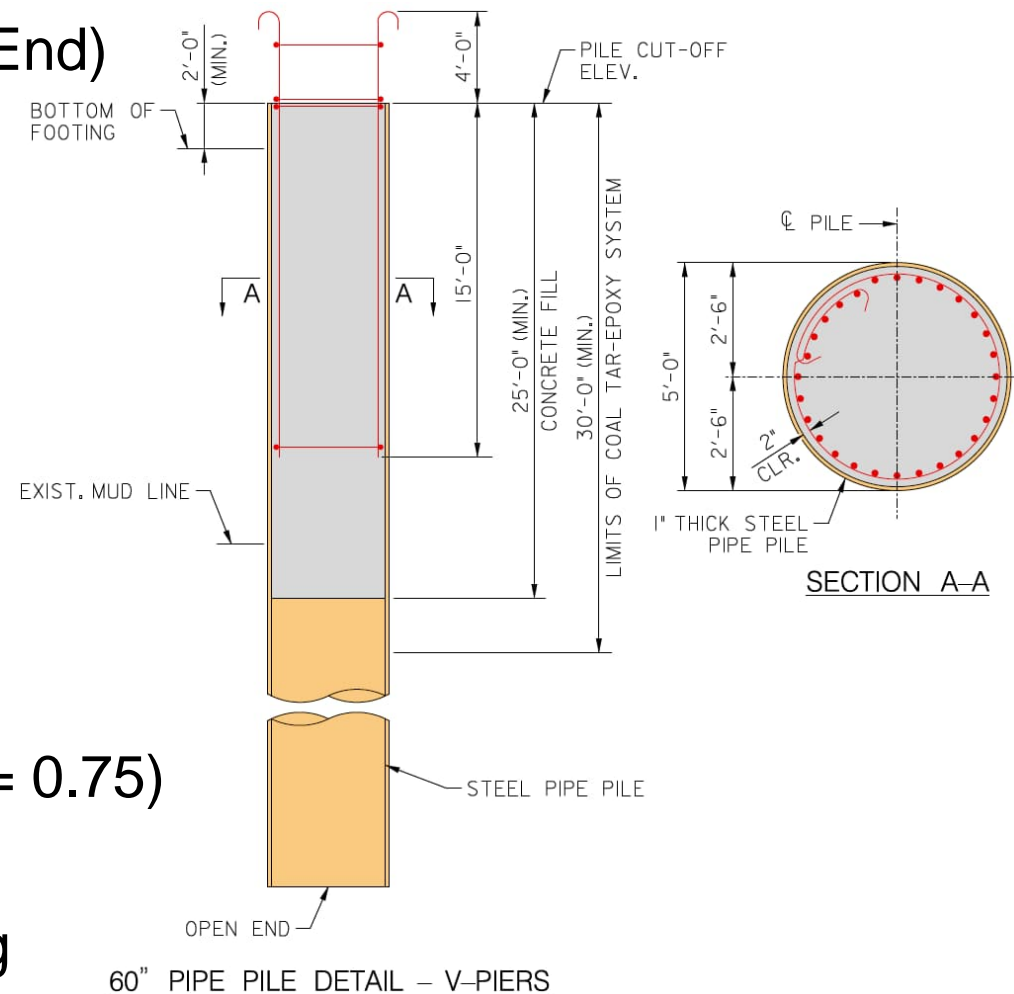


Wind Tunnel Testing

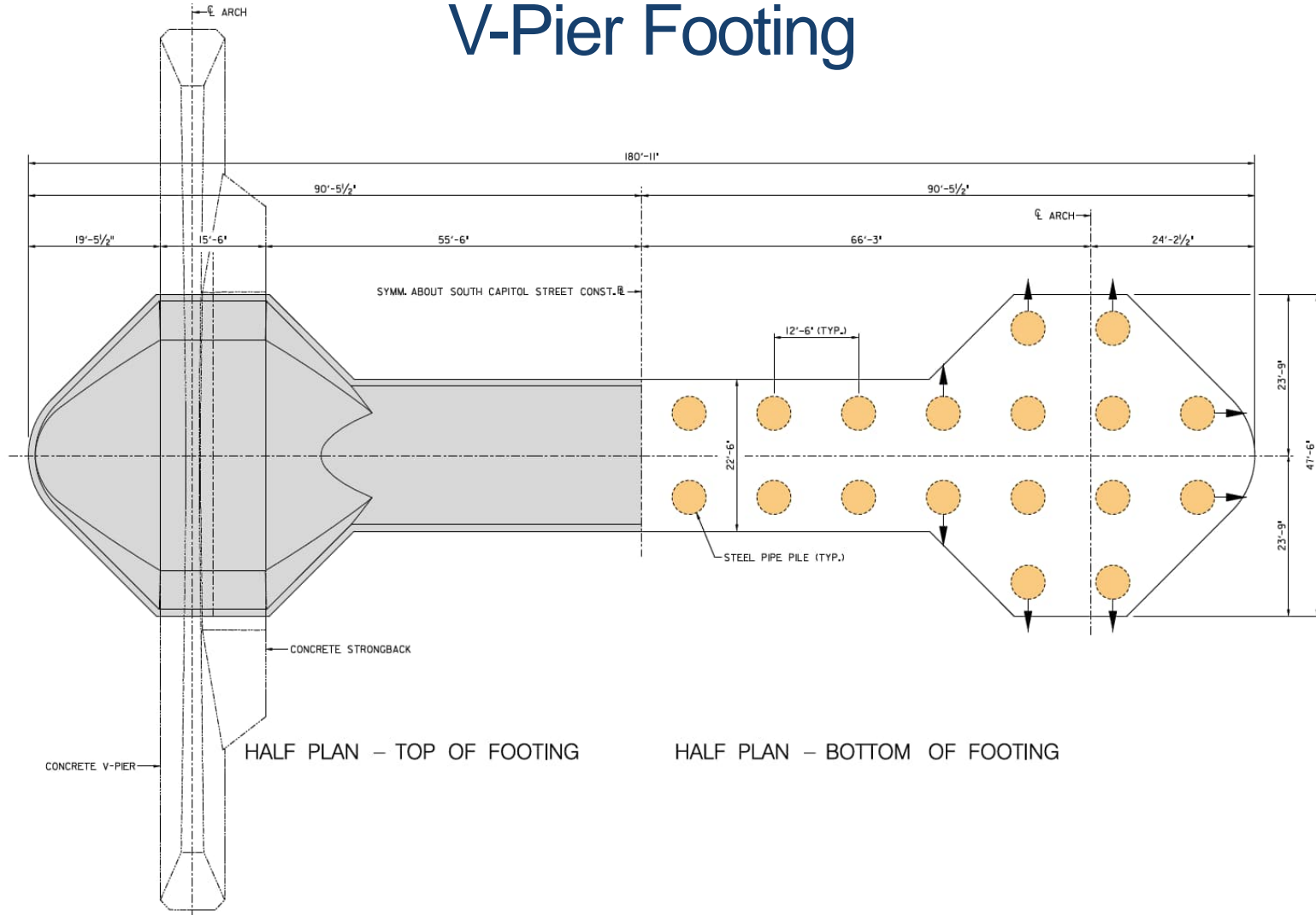


Pile Foundations

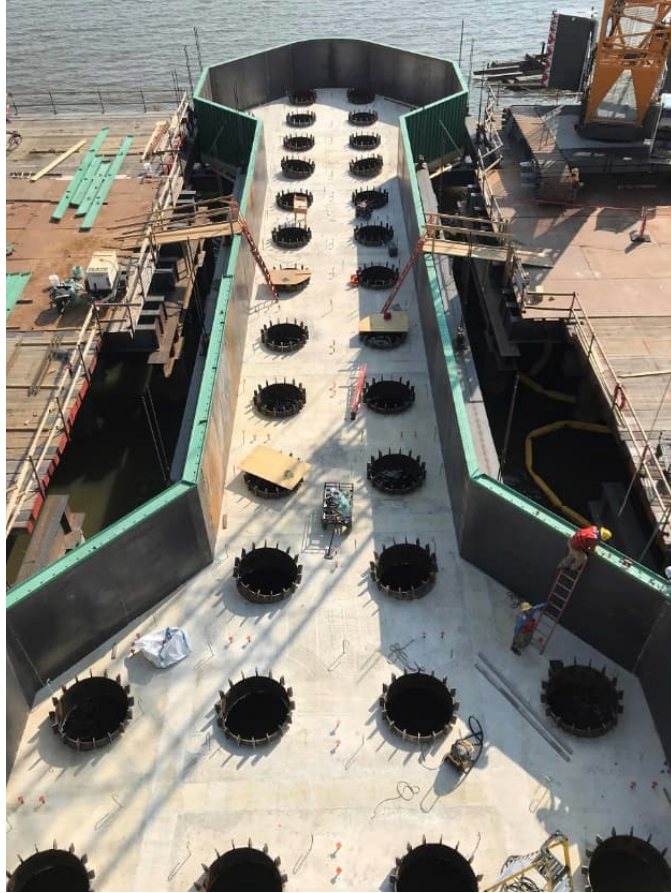
- 60" Dia. x 1" Steel Pipe Piles (Open End)
- ASTM 252, Grade 3 ($f_y = 45$ ksi)
- Spiral Welded
- Nominal Driving Resistance
 - 1720 tons (Abutments)
 - 2010 tons (V-Piers)
- Pile Lengths
 - 85 feet (Abutments)
 - 105 feet (V-Piers)
- Statnamic and PDA Load Testing ($\phi = 0.75$)
- Reinforced Concrete Filled
- Corrosion Protection - Epoxy Coating



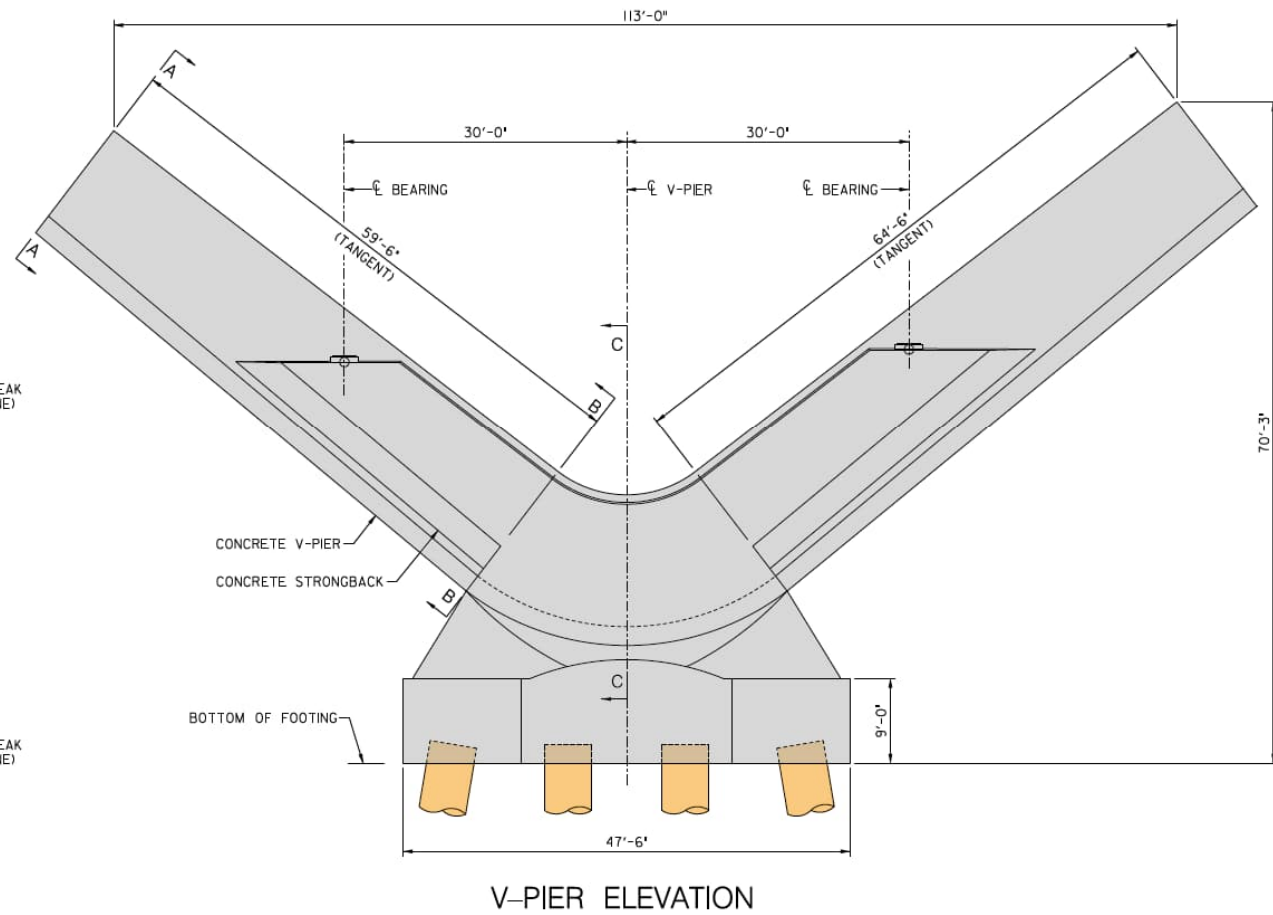
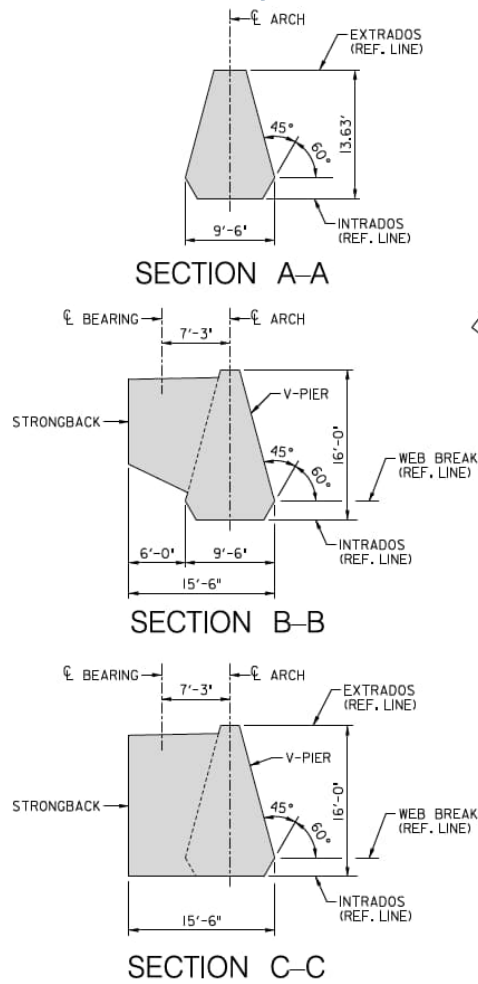
V-Pier Footing



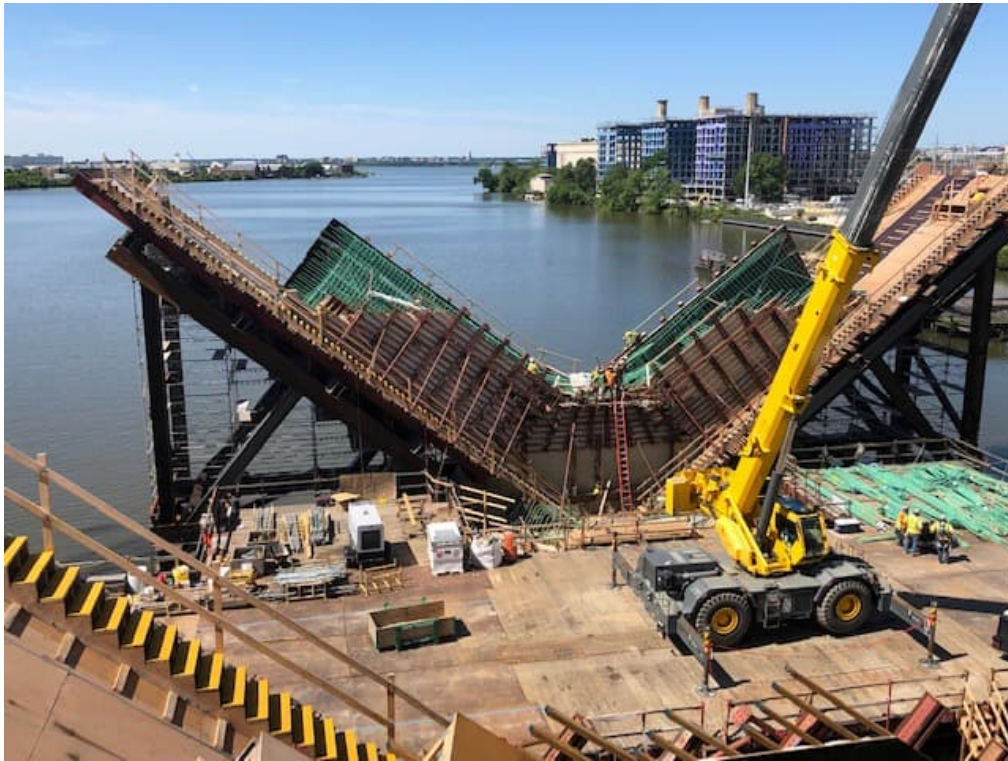
V-Pier Footing



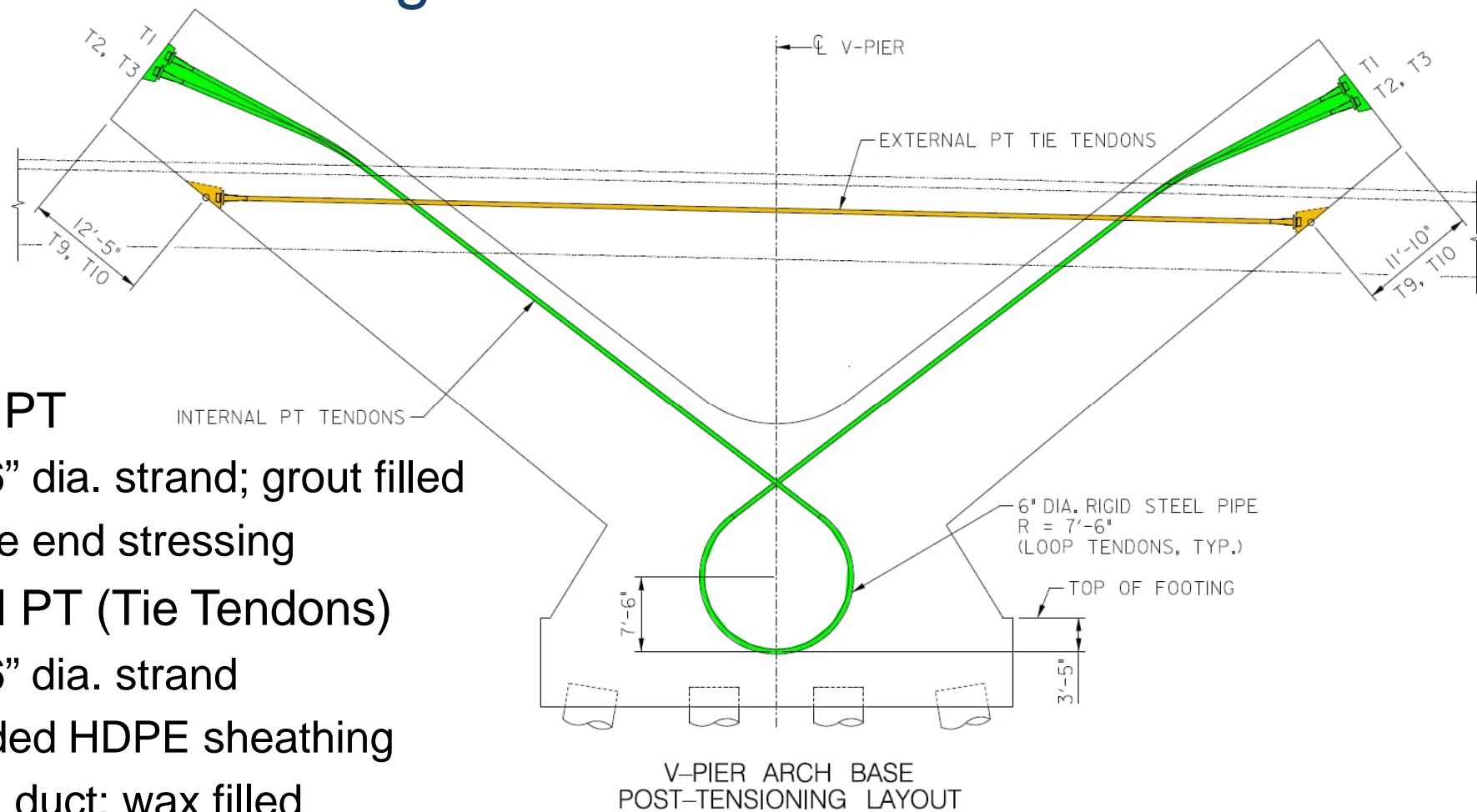
V-Pier Layout



V-Pier Layout

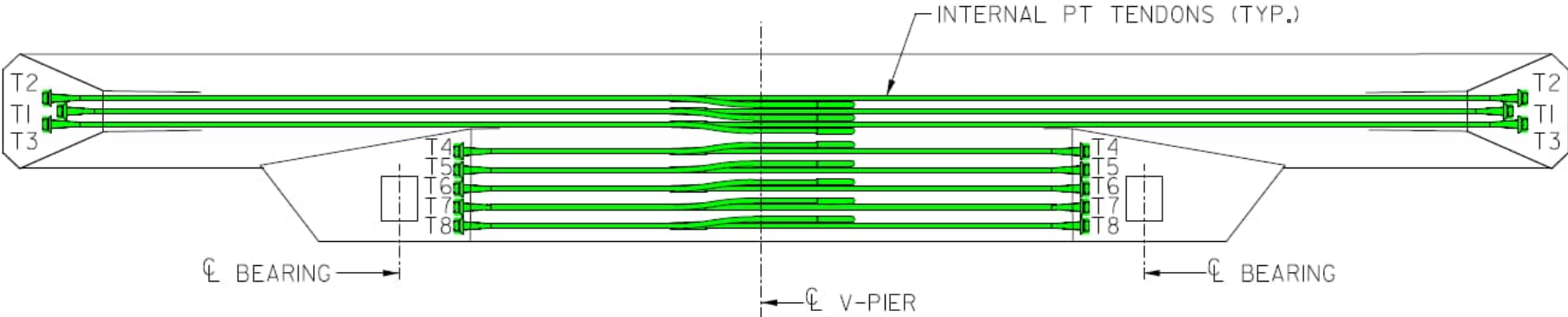


V-Pier Post-Tensioning



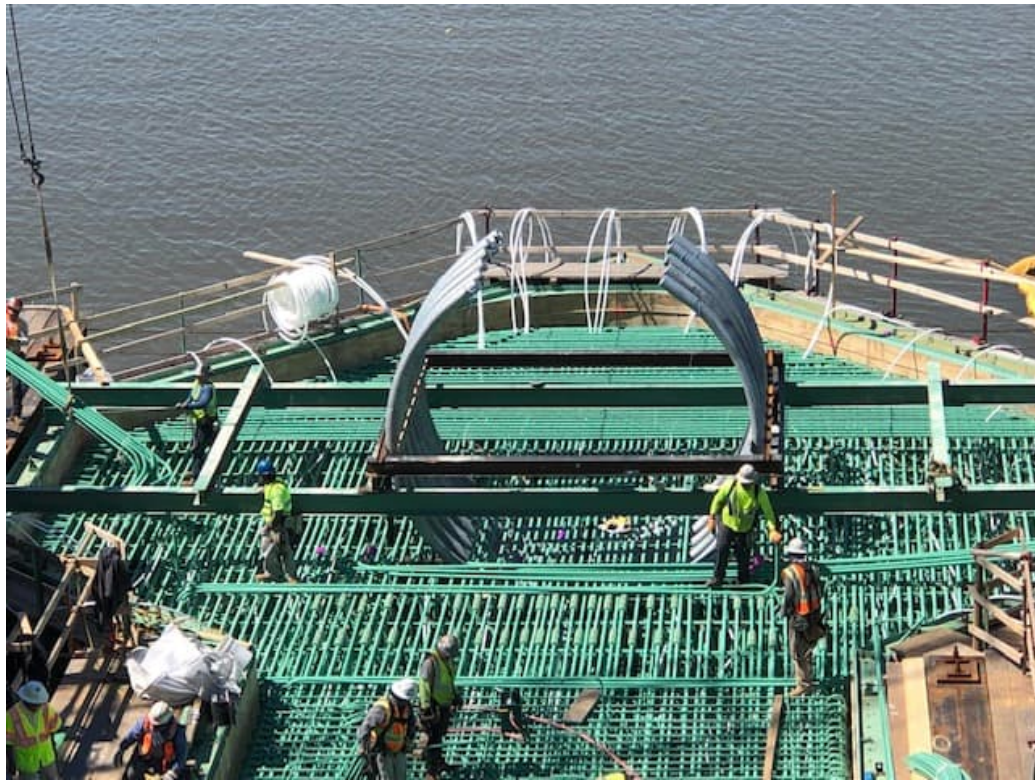
- Internal PT
 - 27-0.6" dia. strand; grout filled
 - Double end stressing
- External PT (Tie Tendons)
 - 27-0.6" dia. strand
 - Extruded HDPE sheathing
 - HDPE duct; wax filled

V-Pier Post-Tensioning

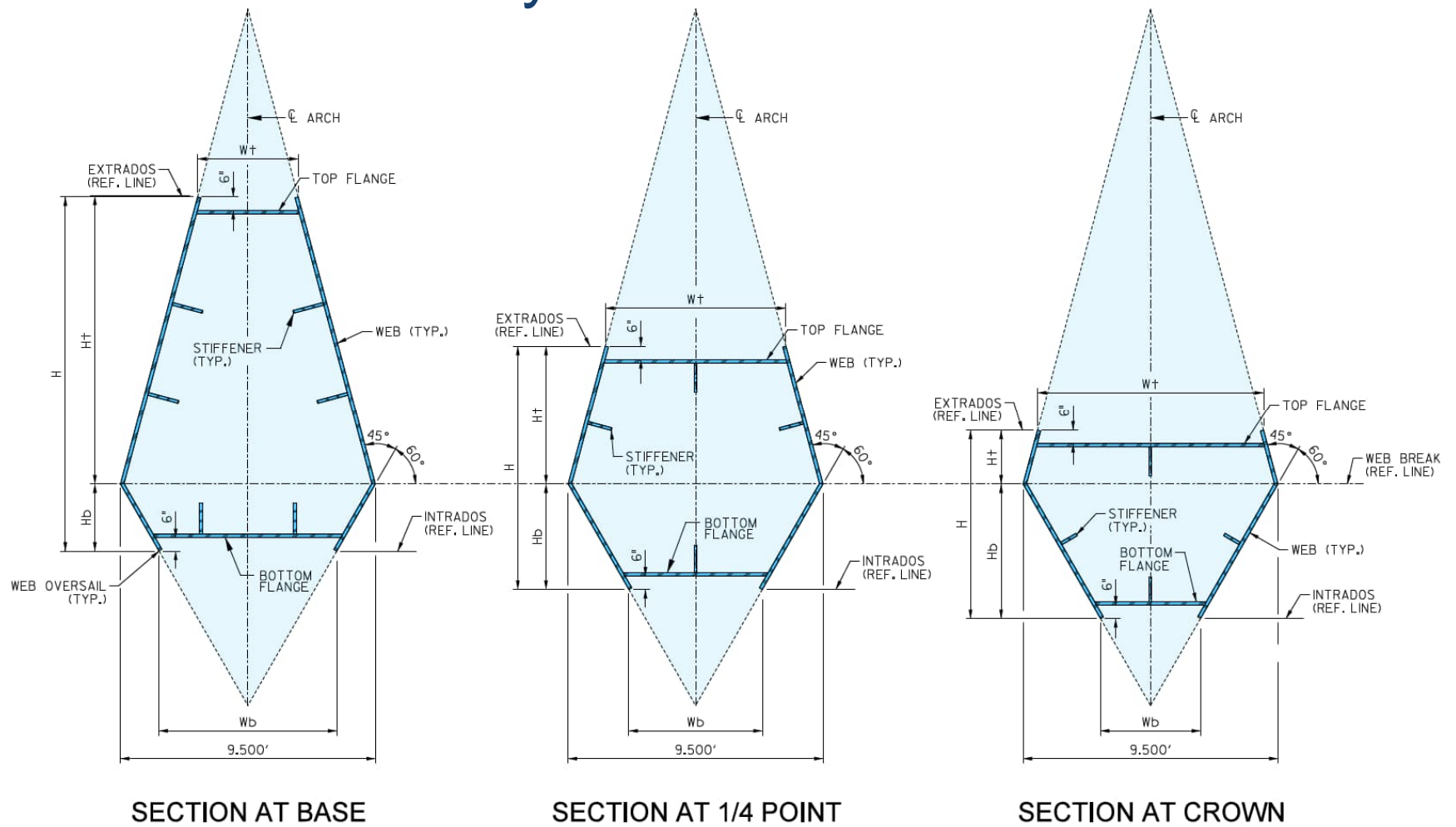


V-PIER ARCH BASE AND STRONGBACK
POST-TENSIONING LAYOUT

V-Pier Post-Tensioning

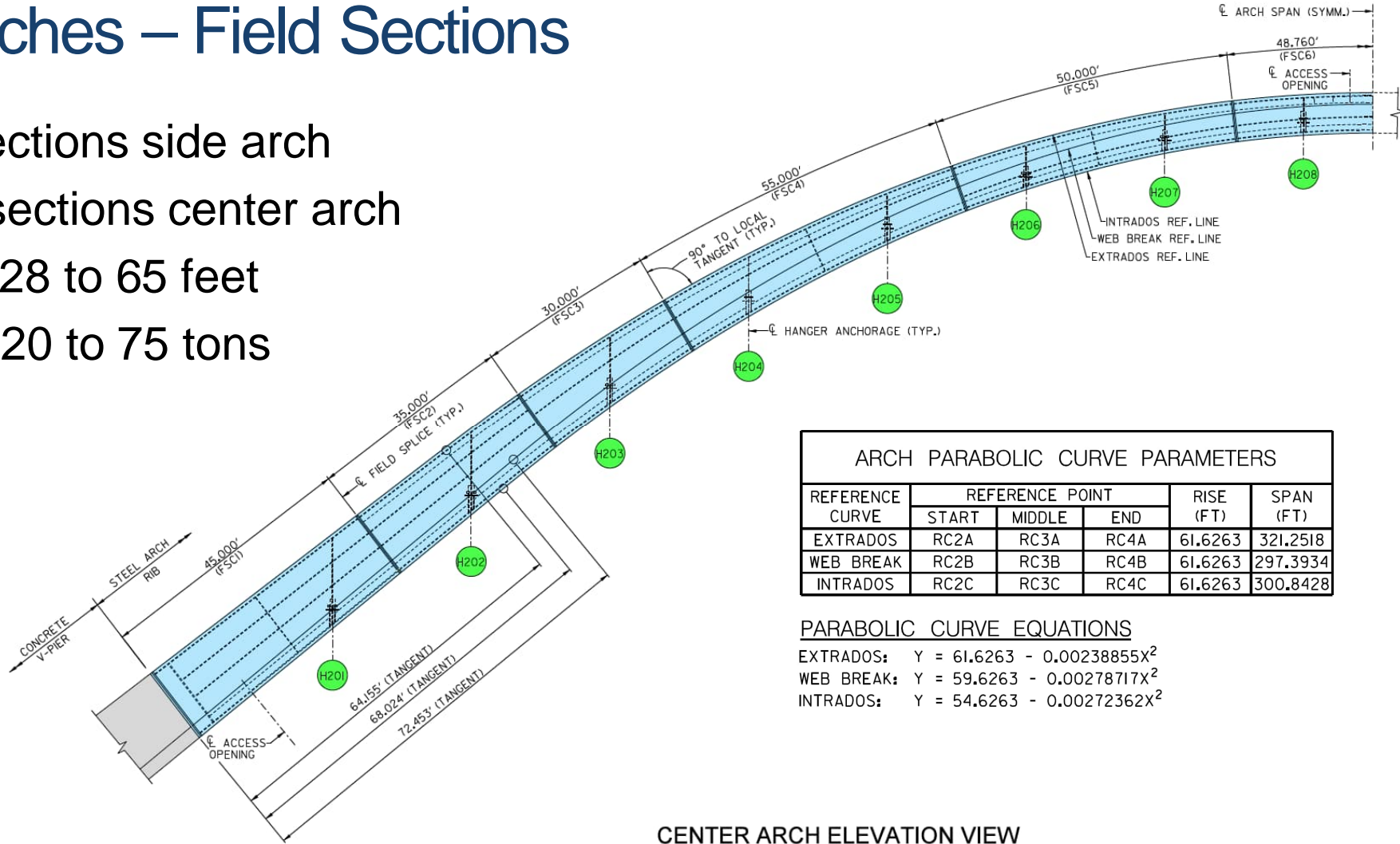


Steel Arches - Geometry



Steel Arches – Field Sections

- 8 field sections side arch
- 12 field sections center arch
- Lengths 28 to 65 feet
- Weights 20 to 75 tons



ARCH PARABOLIC CURVE PARAMETERS					
REFERENCE CURVE	REFERENCE POINT			RISE (FT)	SPAN (FT)
	START	MIDDLE	END		
EXTRADOS	RC2A	RC3A	RC4A	61.6263	321.2518
WEB BREAK	RC2B	RC3B	RC4B	61.6263	297.3934
INTRADOS	RC2C	RC3C	RC4C	61.6263	300.8428

PARABOLIC CURVE EQUATIONS

EXTRADOS: $Y = 61.6263 - 0.00238855X^2$

WEB BREAK: $Y = 59.6263 - 0.00278717X^2$

INTRADOS: $Y = 54.6263 - 0.00272362X^2$

CENTER ARCH ELEVATION VIEW

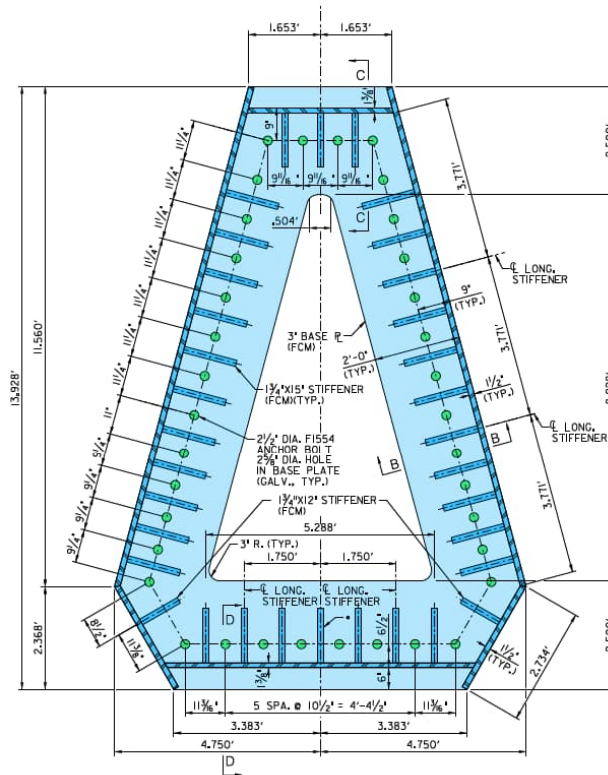
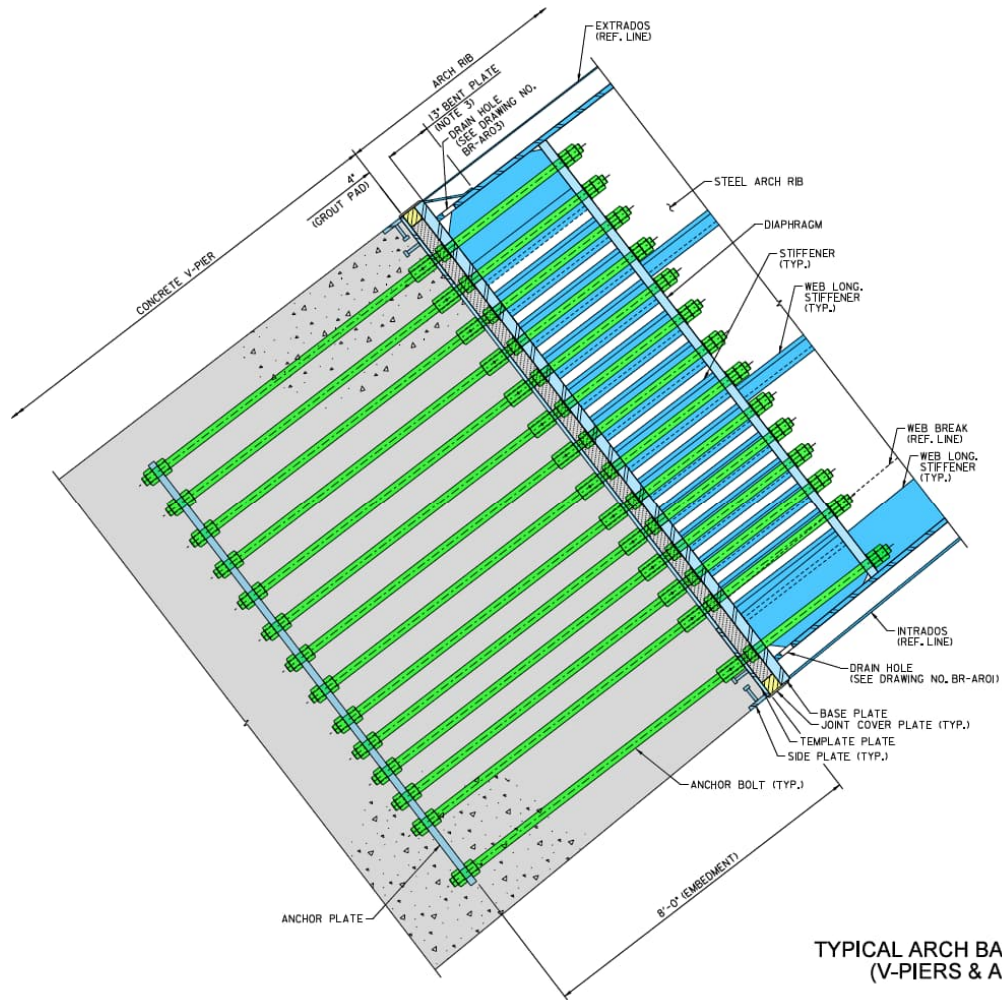
Steel Arches – Field Sections



Steel Arches – Butt Splice

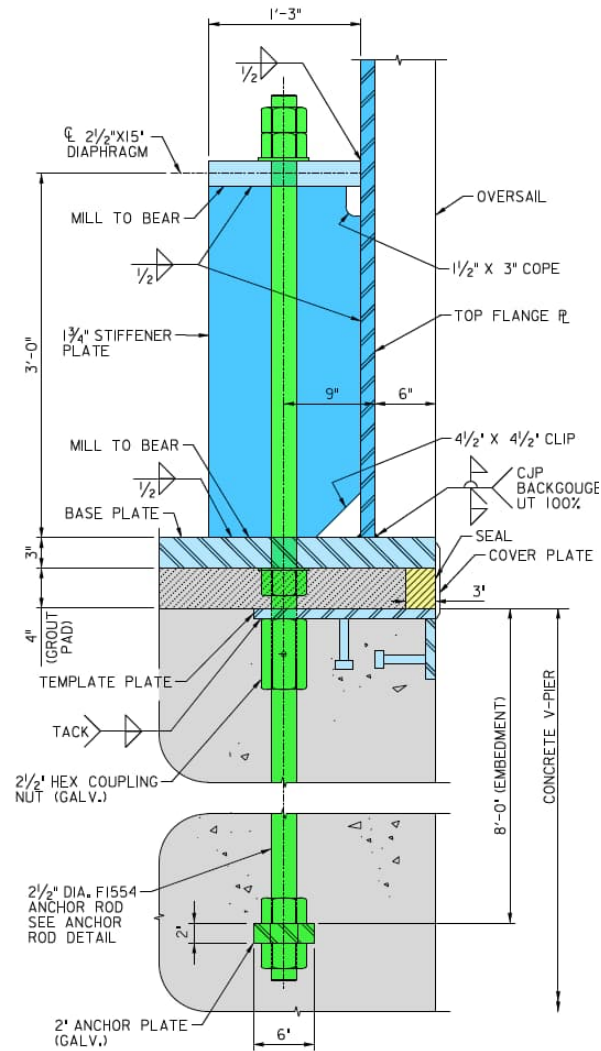


Steel Arches - Base Connection



TYPICAL ARCH BASE CONNECTION
(V-PIERS & ABUTMENTS)

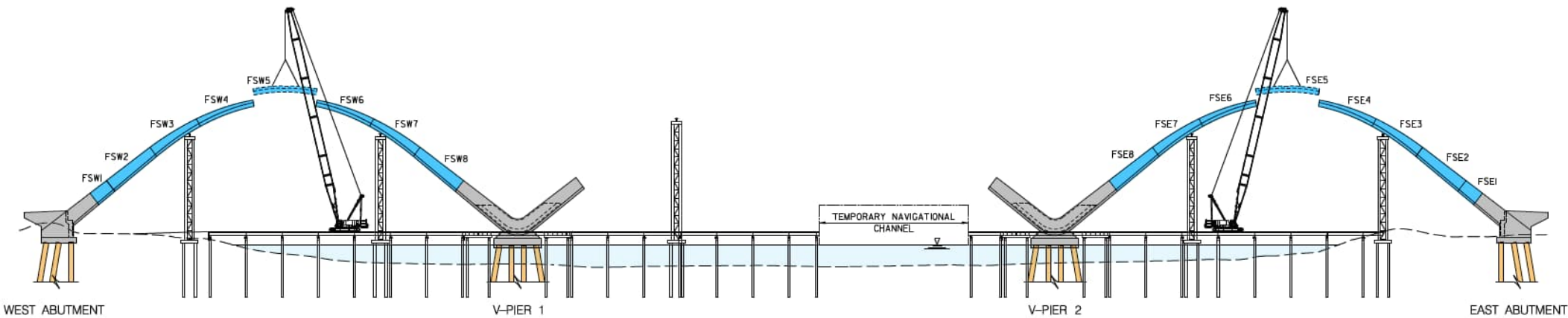
Steel Arches - Base Connection



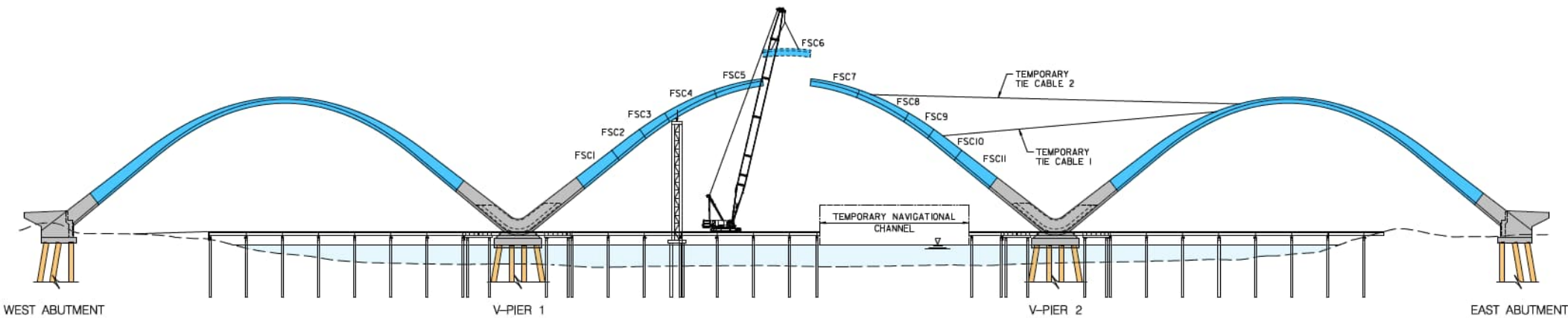
Steel Arches – Base Connection



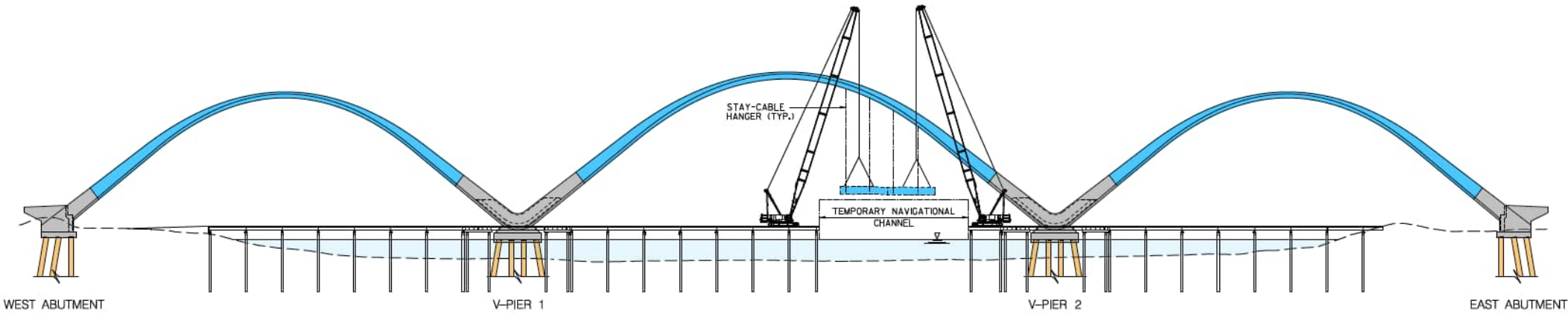
Erection Sequence - Arches



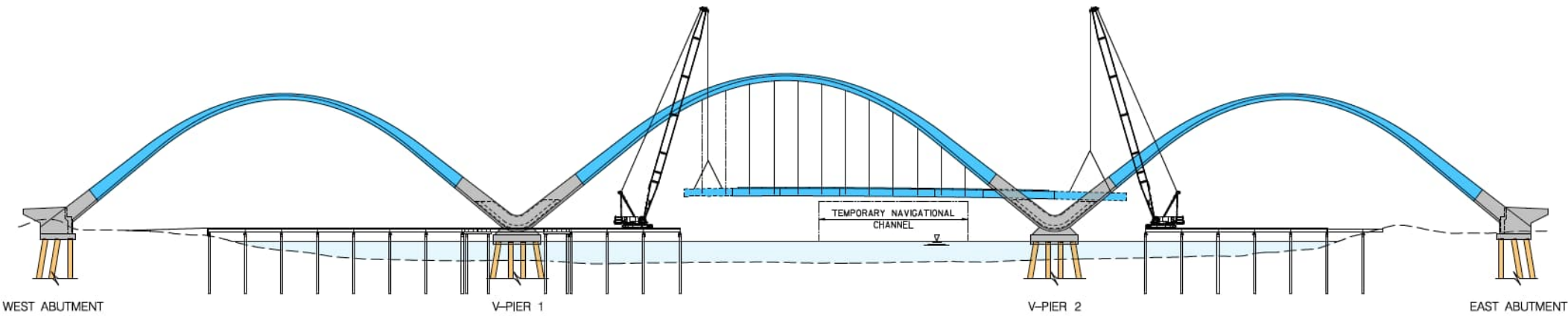
Erection Sequence - Arches



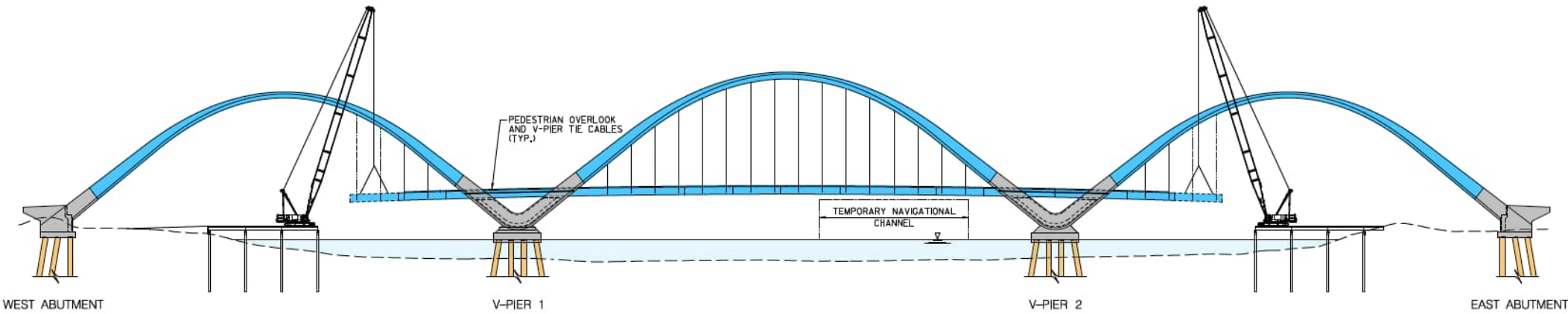
Erection Sequence - Deck



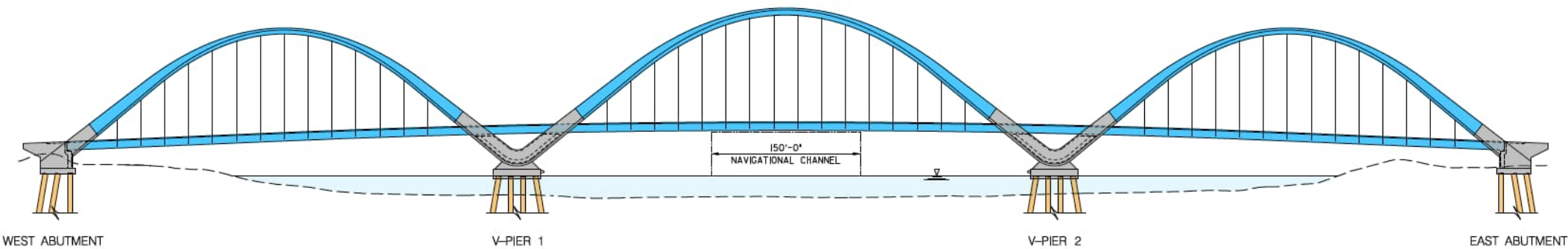
Erection Sequence - Deck



Erection Sequence - Deck



Erection Sequence - Complete





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