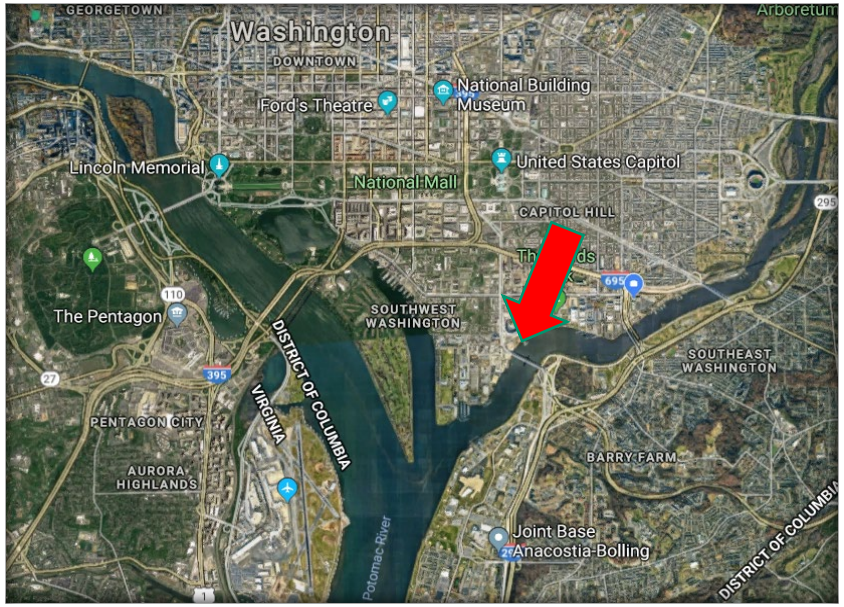
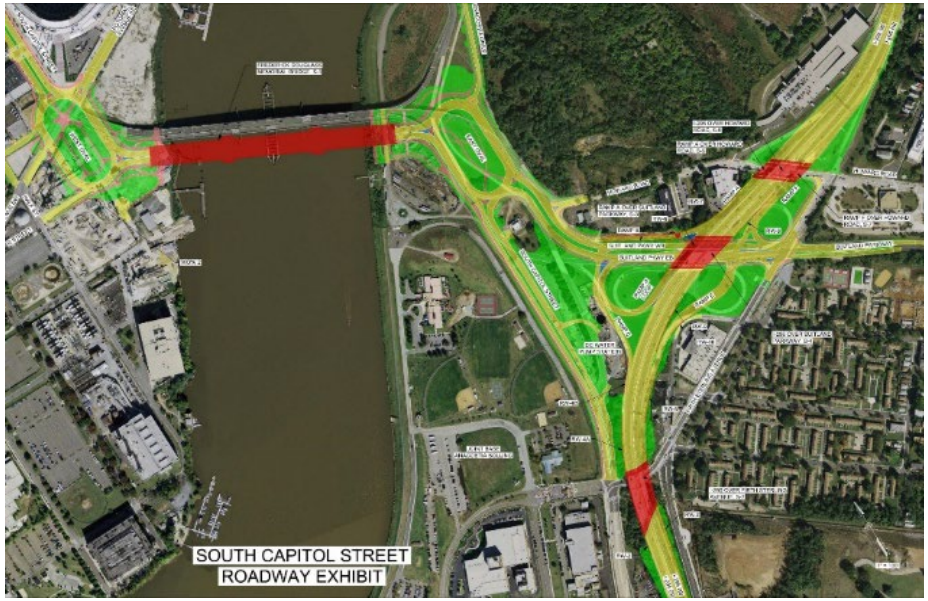
ILLINOIS TRANSPORTATION
AND HIGHWAY ENGINEERING
CONFERENCE

Design and Construction of the New Frederick Douglass Memorial Bridge Washington, D.C.

Nathan M. Porter, P.E., AECOM, USA

South Capitol Street Corridor Phase I





- 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: December 2021

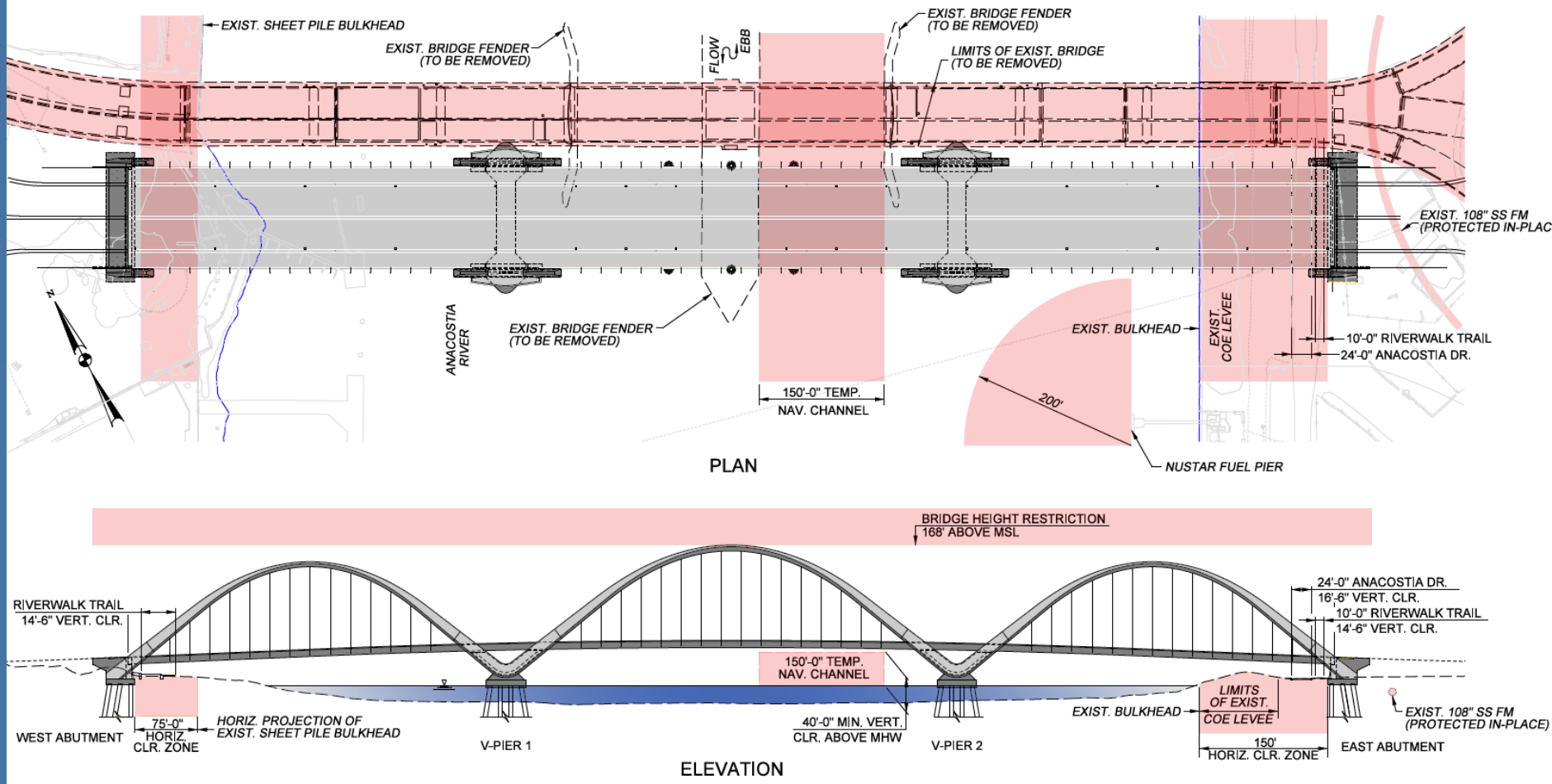
Project Design Appearance Goals

- Transform South Capitol Street
  - Grand Urban Boulevard
  - Gateway to the District's Monumental Core
- Create an elegant and iconic new bridge
- Reflects the classical sentiment of Washington's monumental bridges
- Harmonize the proposed scale and height with the long-term projected growth

Project Design Appearance Goals

- Pass/Fail 15 specific Project Design Appearance Goals (PDAGS)
- Visual Quality Concept Process
- Aesthetic Review Committee (ARC)
  - DDOT
  - FHWA
  - CFA
  - NCPC
  - SHPO
- Technical Proposal - Visual Quality Plan (VQP)
- Design-Build Selection Scoring
  - Total Score 1000 points
  - Price Proposal 600 points
  - Technical Proposal 400 points (160 points Visual Quality)
- Record of Recommendation (ROR)

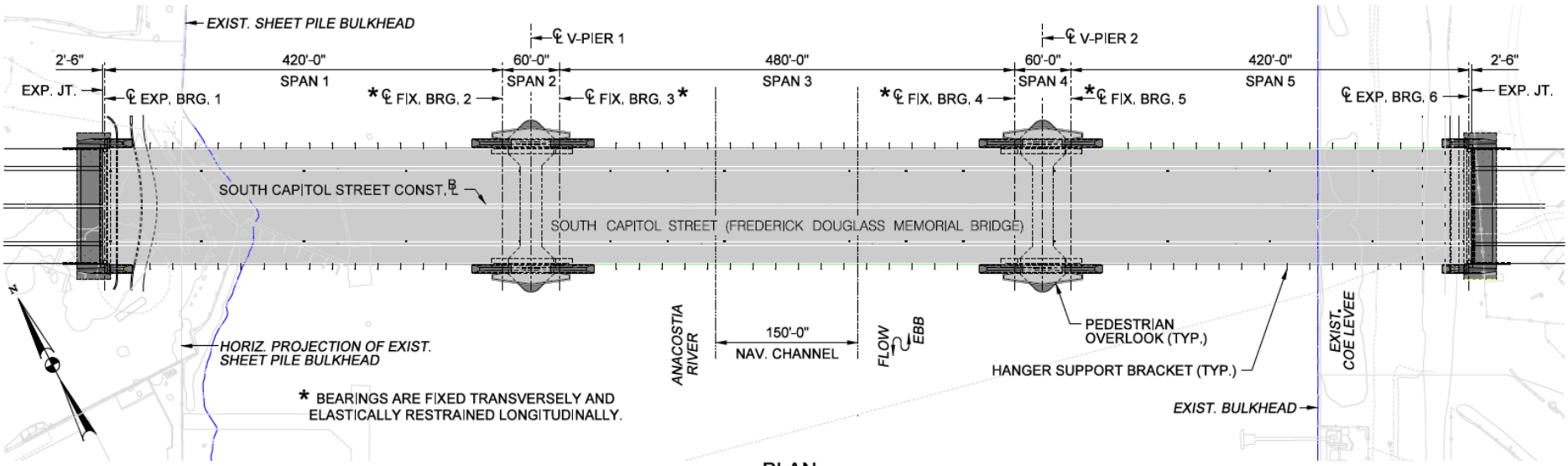
Clearance Requirements



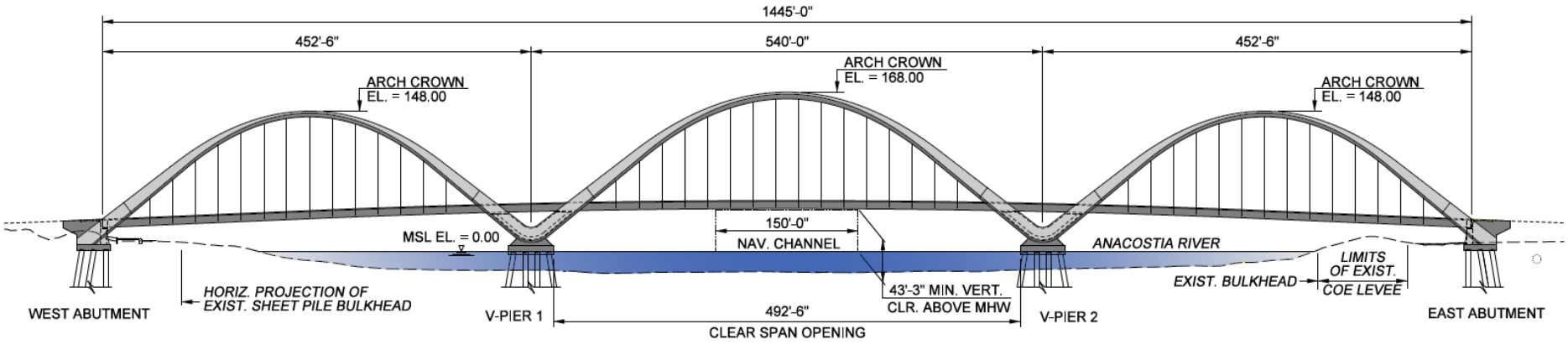
Controlling Design Parameters

- 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

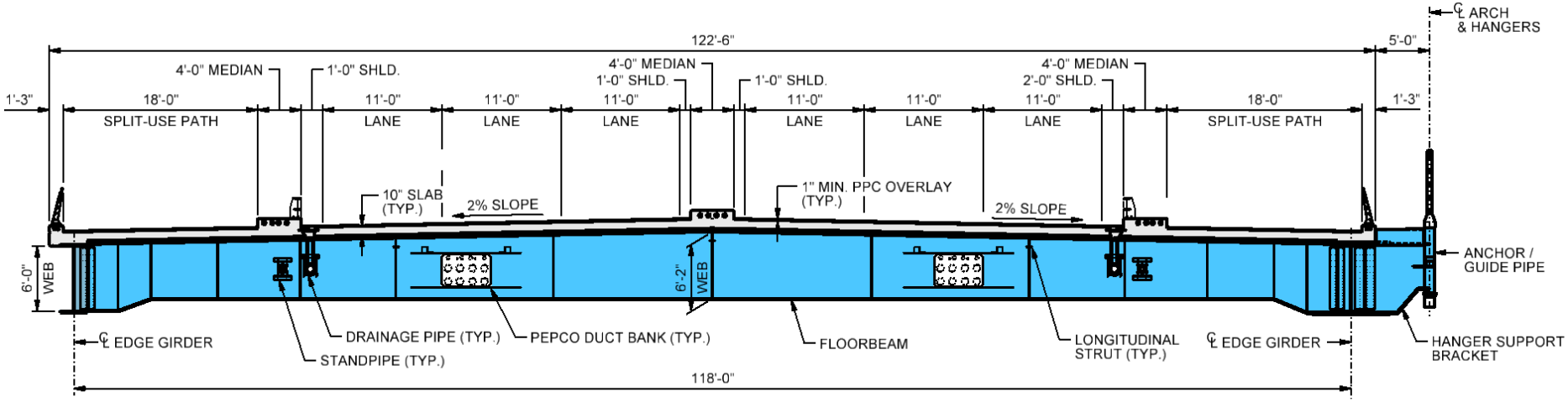


PLAN



ELEVATION

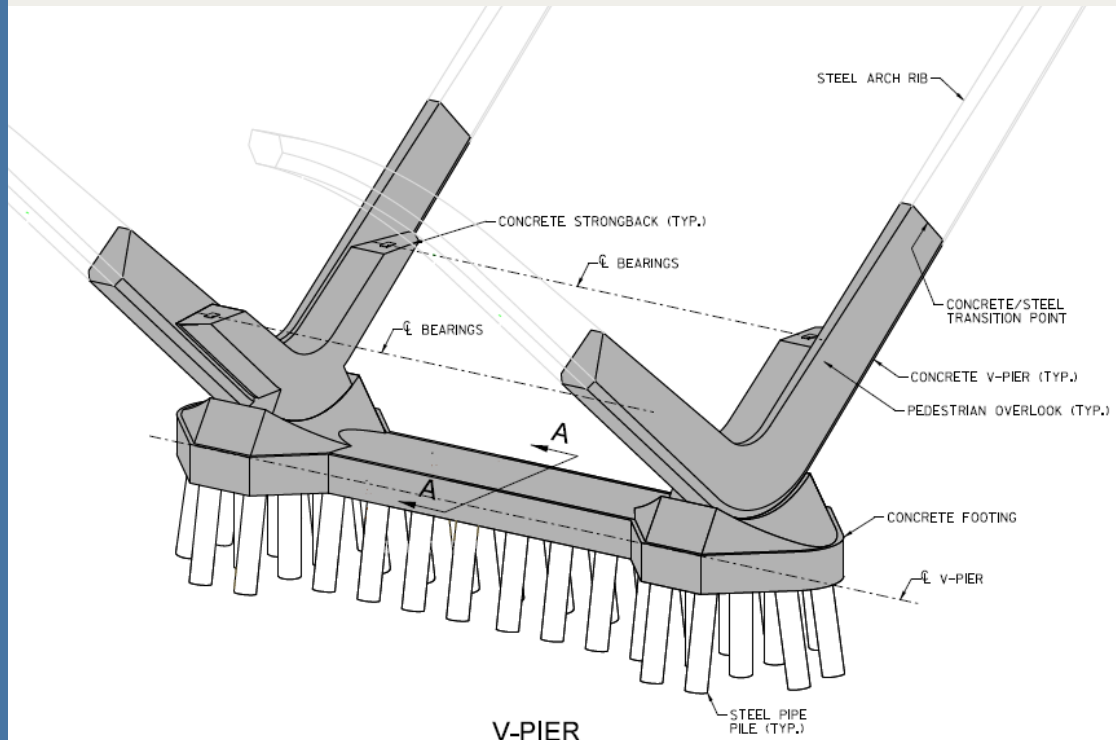
Superstructure Typical Section



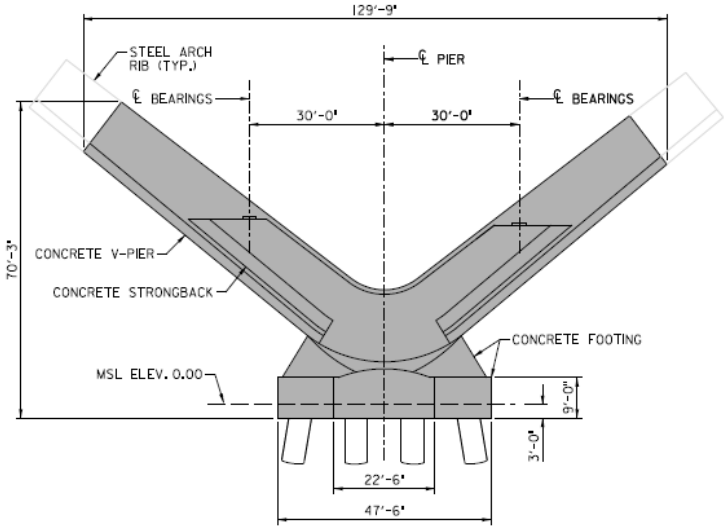
HALF TYPICAL SECTION

HALF SECTION AT HANGERS

V-Piers

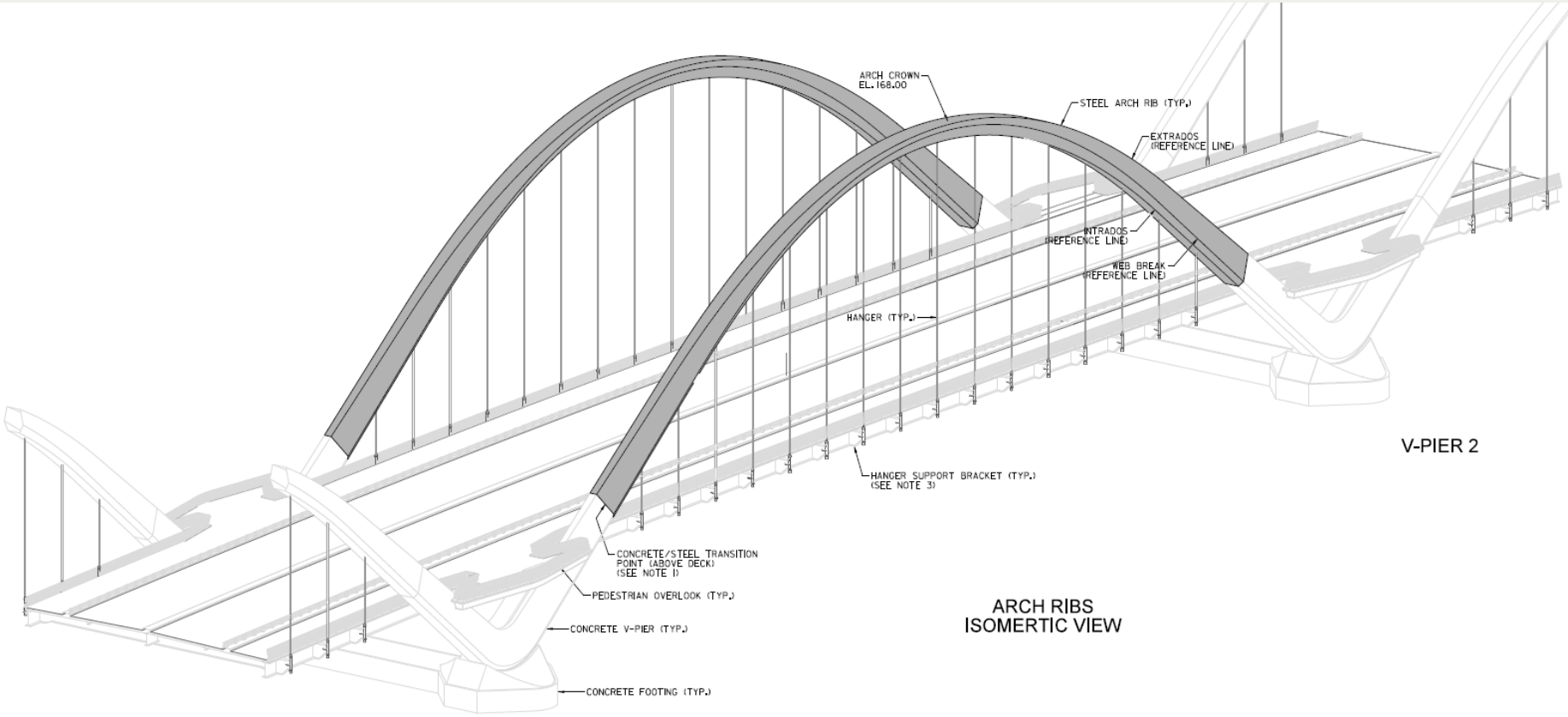


V-PIER
ISOMETRIC VIEW

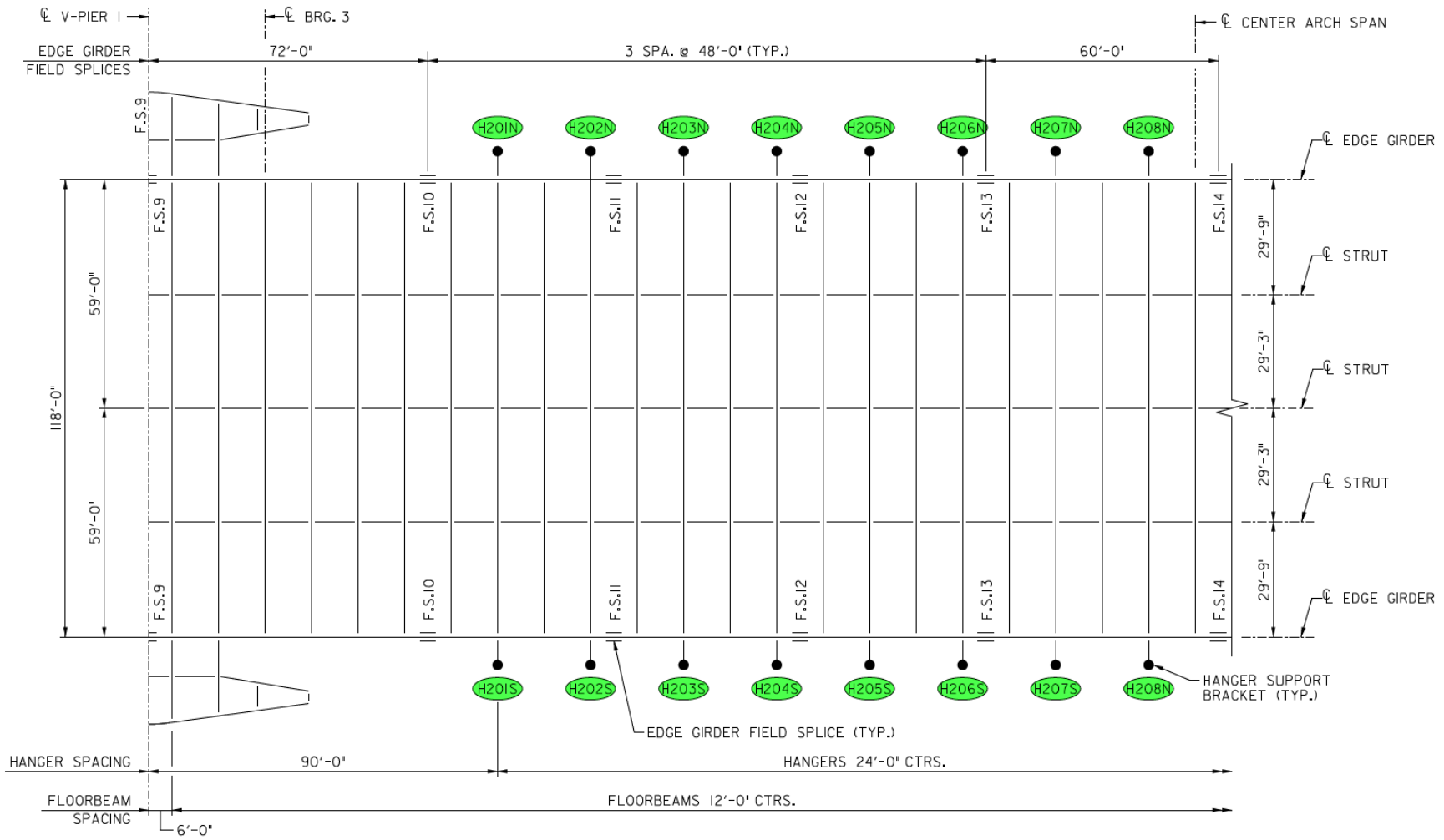


SECTION A-A

Arch Ribs

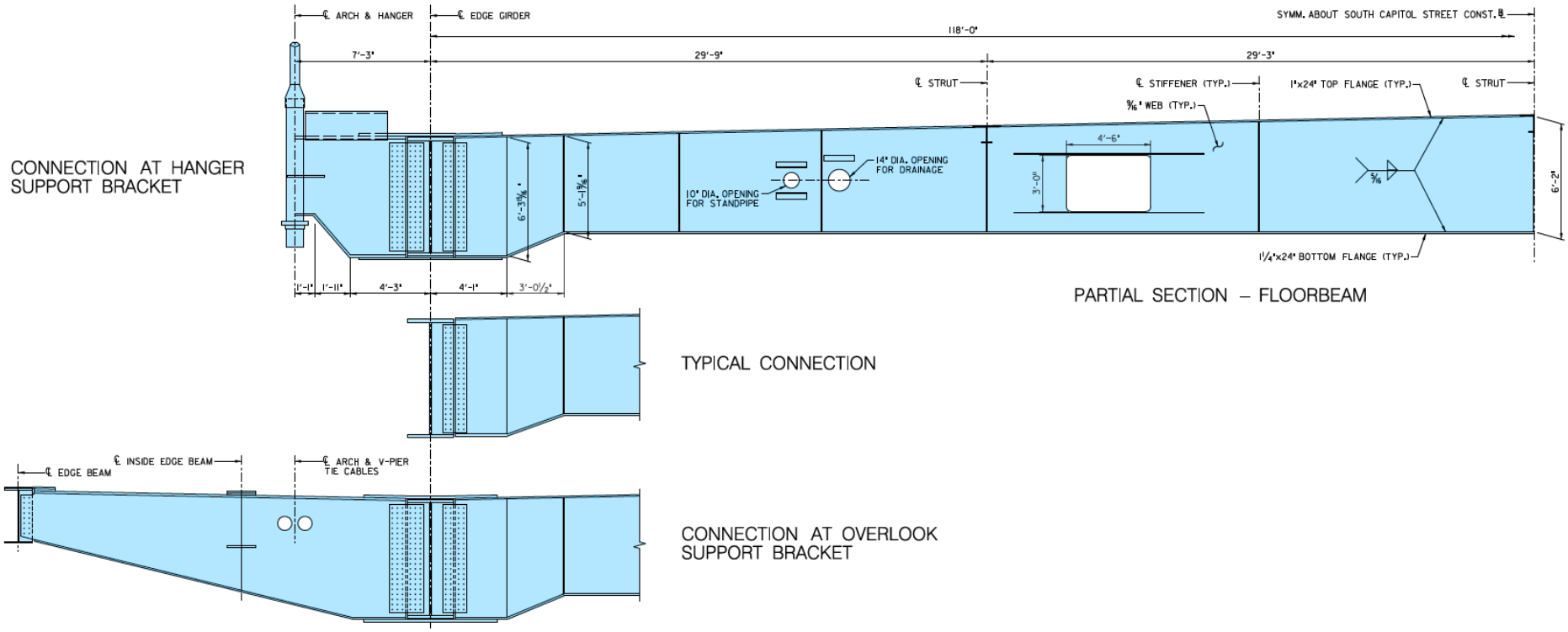

ARCH CROWN
EL. 168.00
STEEL ARCH RIB (TYP.)
EXTRADOS
(REFERENCE LINE)
INTRADOS
(REFERENCE LINE)
WEB BREAK
(REFERENCE LINE)
HANGER (TYP.)
HANGER SUPPORT BRACKET (TYP.)
(SEE NOTE 3)
CONCRETE/STEEL TRANSITION
POINT (ABOVE DECK)
(SEE NOTE 1)
PEDESTRIAN OVERLOOK (TYP.)
CONCRETE V-PIER (TYP.)
CONCRETE FOOTING (TYP.)
V-PIER 1
V-PIER 2
ARCH RIBS
ISOMERTIC VIEW

Superstructure – Framing Plan

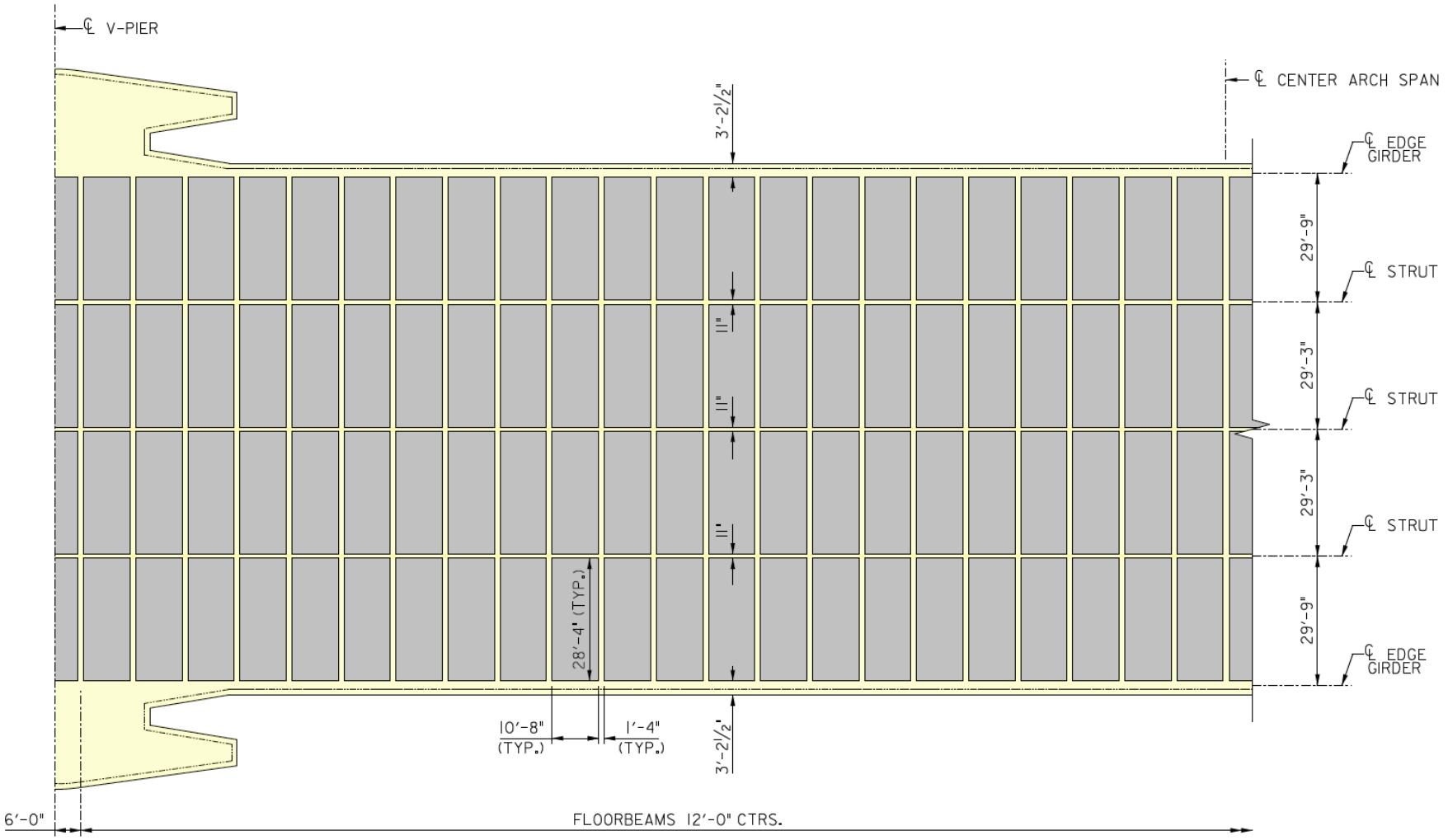


PARTIAL DECK PLAN - STRUCTURAL STEEL FRAMING

Superstructure – Floorbeams

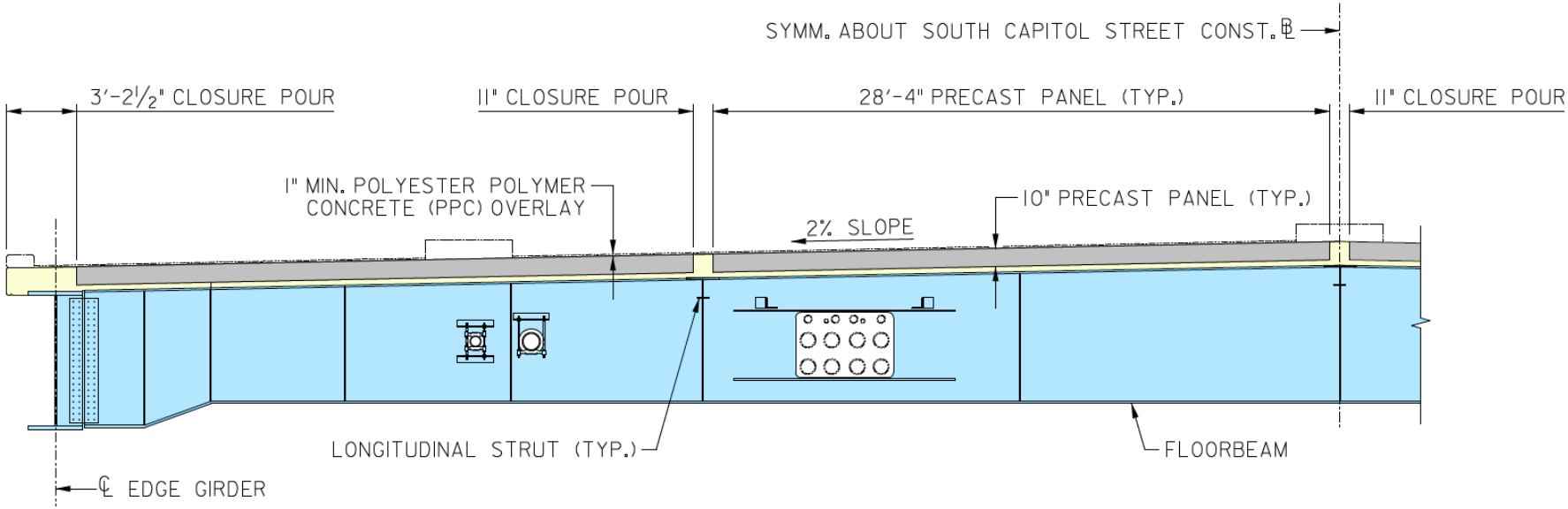


Superstructure – Precast Deck Panels



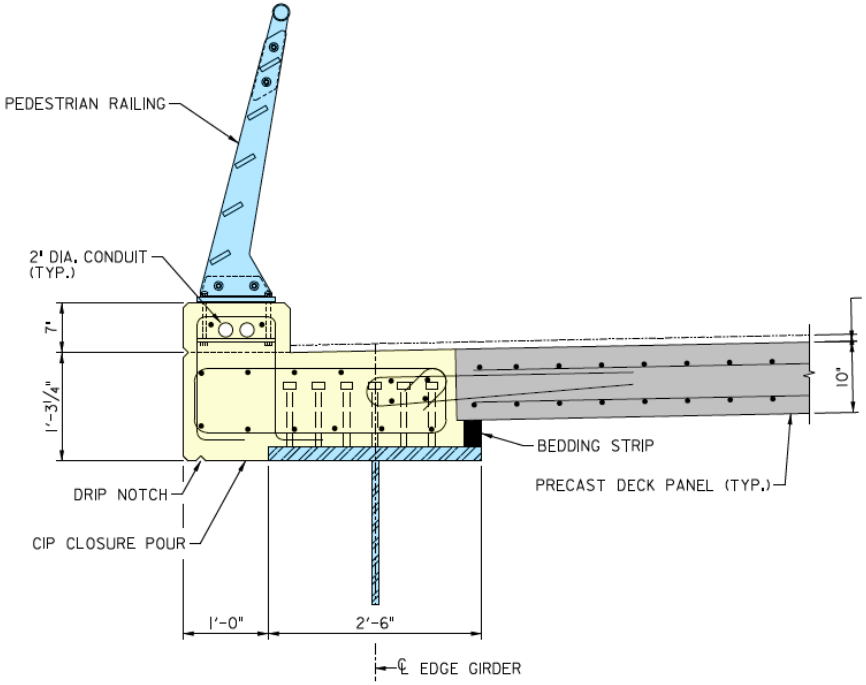
PARTIAL DECK PLAN - PRECAST DECK PANELS

Superstructure – Precast Deck Panels

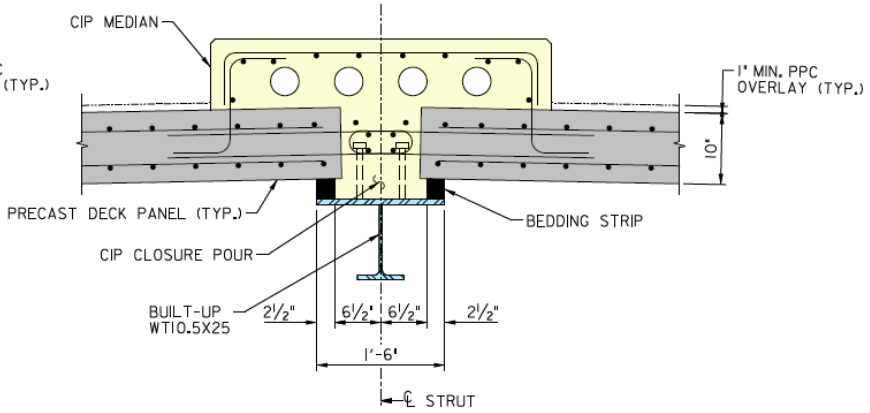


PRECST DECK PANEL

Superstructure – Deck Closure Pour



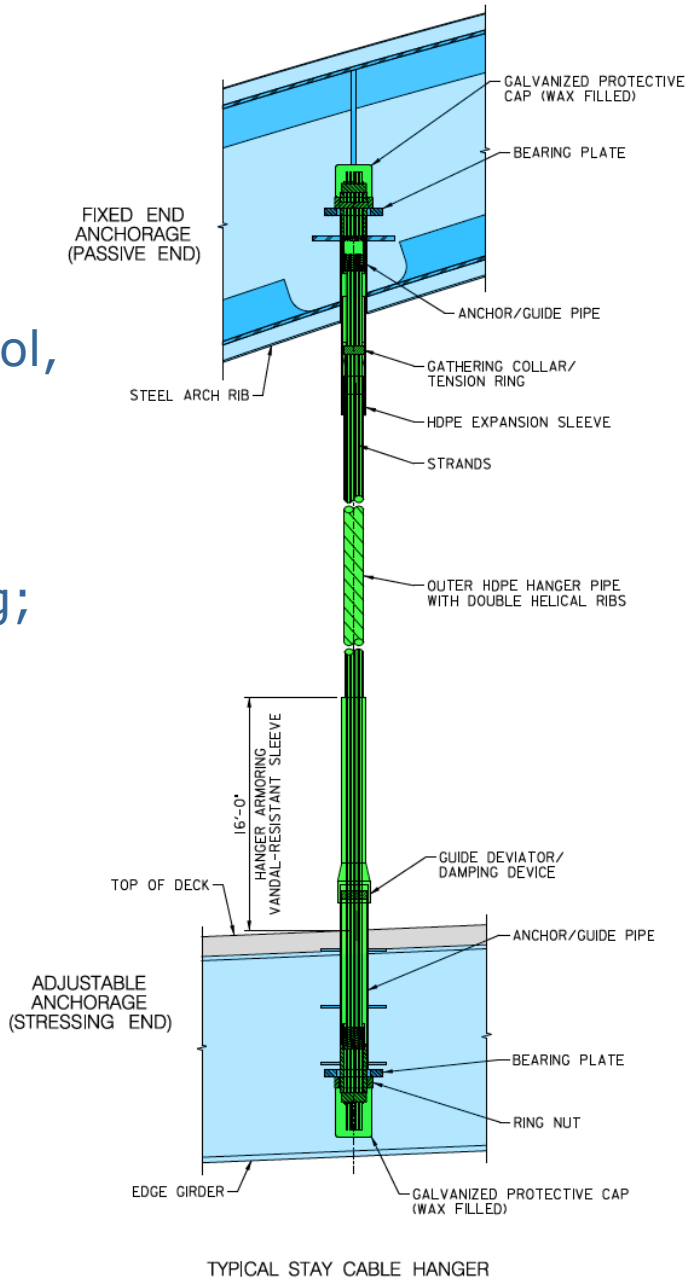
PRECAST DECK PANEL
EDGE GIRDER CLOSURE POUR



PRECAST DECK PANEL
LONGITUDINAL STRUT CLOSURE POUR

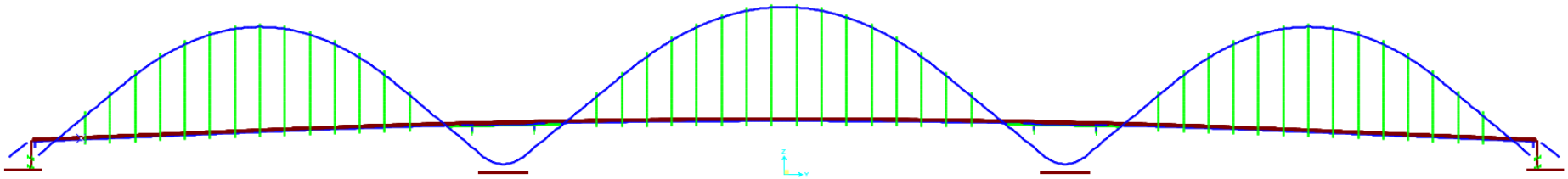
Hangers – Stay Cables

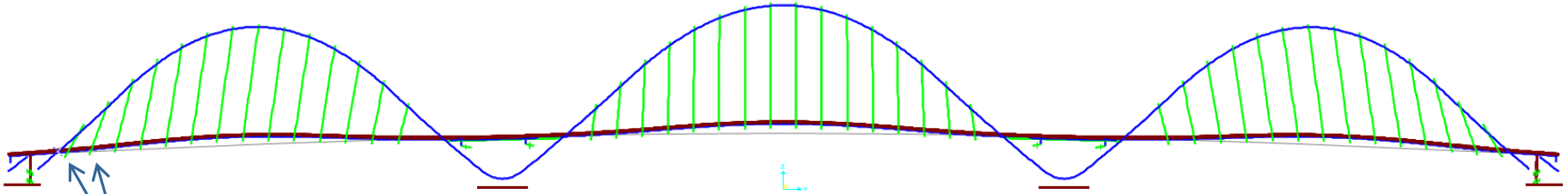
- Hangers
  - 14 hangers side arches; 16 hangers center arches; 88 total hangers
  - Single stage stressing initial force/length; second stage stressing load/geometry control, as required
- Strands
  - 0.62” diameter; coextruded HDPE sheathing; wax filled; non-bonded and parallel
  - 18 to 29 strands per hanger
- External HDPE Stay Pipe
  - Double helical rib
- Benefits
  - Fatigue resistance; corrosion protection; easy to replace



TYPICAL STAY CABLE HANGER

Hangers – Stay Cables



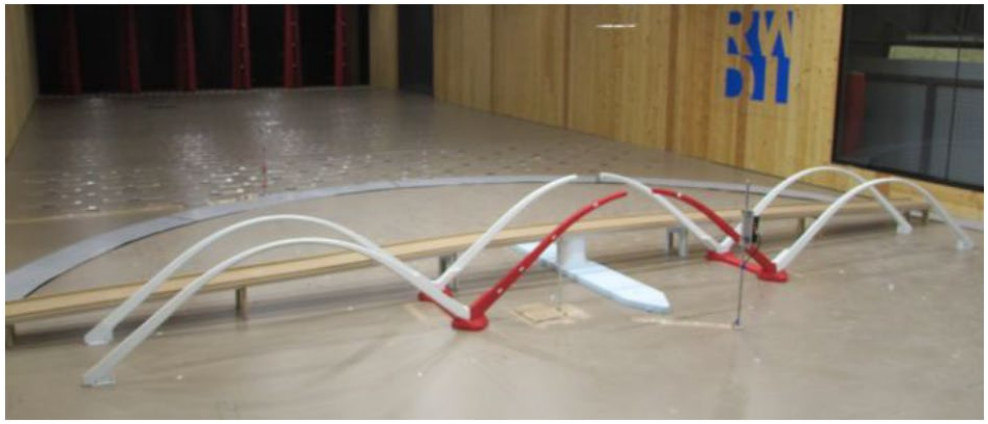


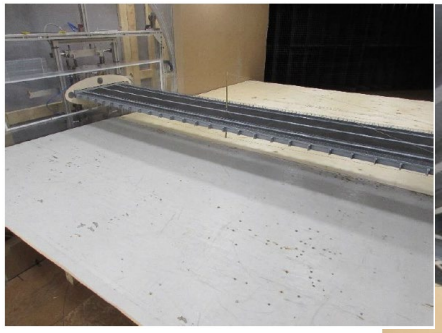
- Shortest hangers (approx. 31 feet long; 29 strand cable)
- Large lateral displacement / cable curvature
- High bending stresses at anchorages

Longitudinal Movement – Thermal Rise

Wind Tunnel Testing

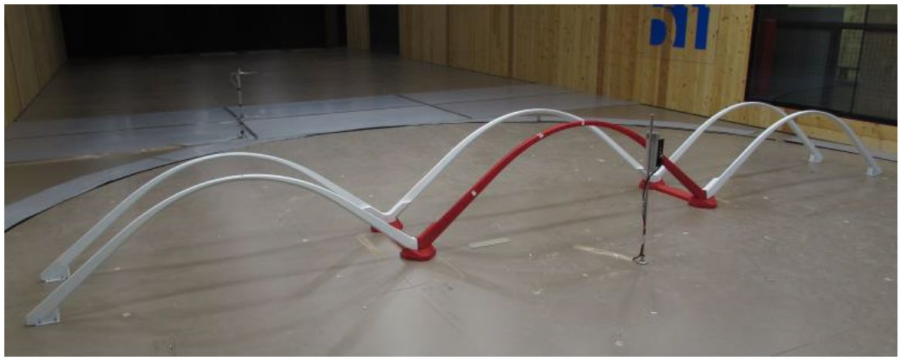
- Site Specific Wind Study
- Arch Pressure Integration Study
  - Vortex Shedding
  - Static Force Coefficients
- Section Model Tests
  - w/ Existing Bridge
  - w/o Existing Bridge
- Cable Vibration Assessment
  - Min. Req'd Damping 21 to 27%
- Pedestrian Comfort Study

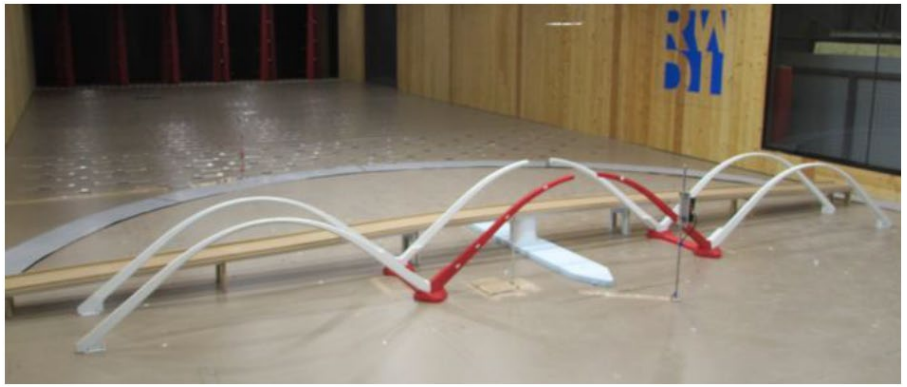




Wind Tunnel Testing

- Aeroelastic Model Testing
  - Completed Arch
  - Partial Arch (Construction Stages)
  - Vortex-induced oscillations (VIO) observed during arch erection
  - VIO mitigation measures will include wind restrictions during erection as well as deployment of in-line VDD as-required.

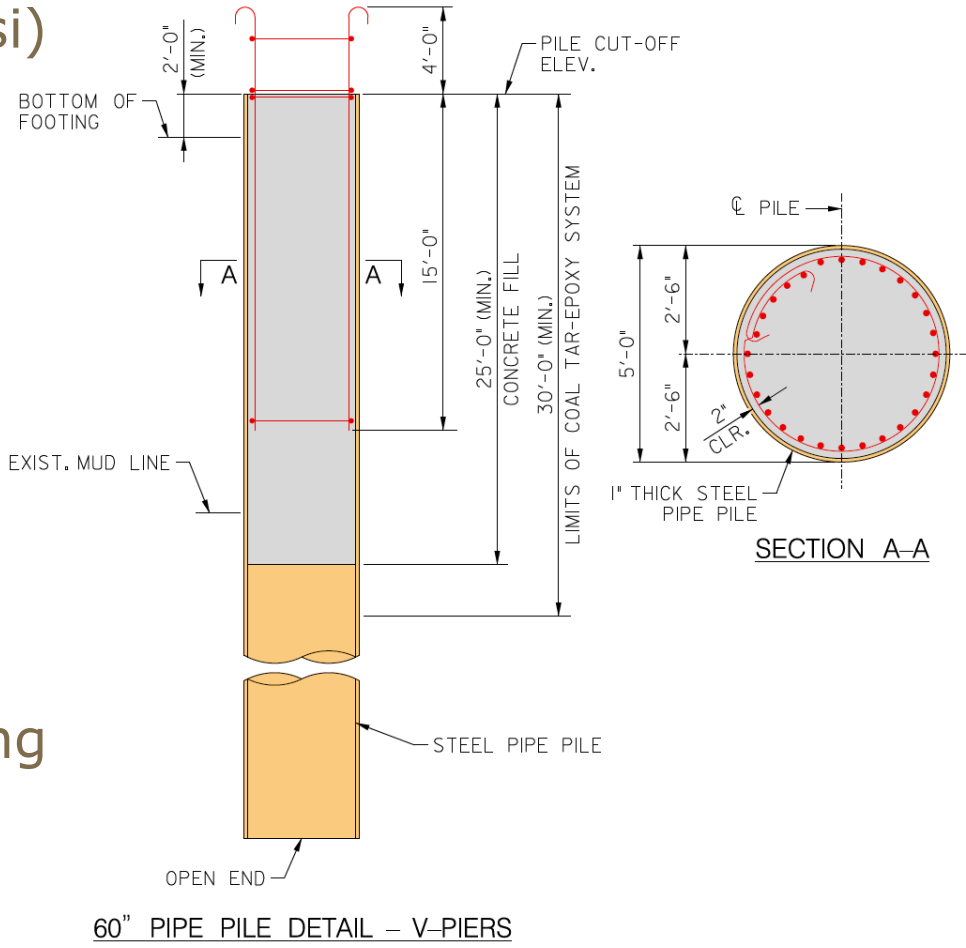




Wind Tunnel Testing

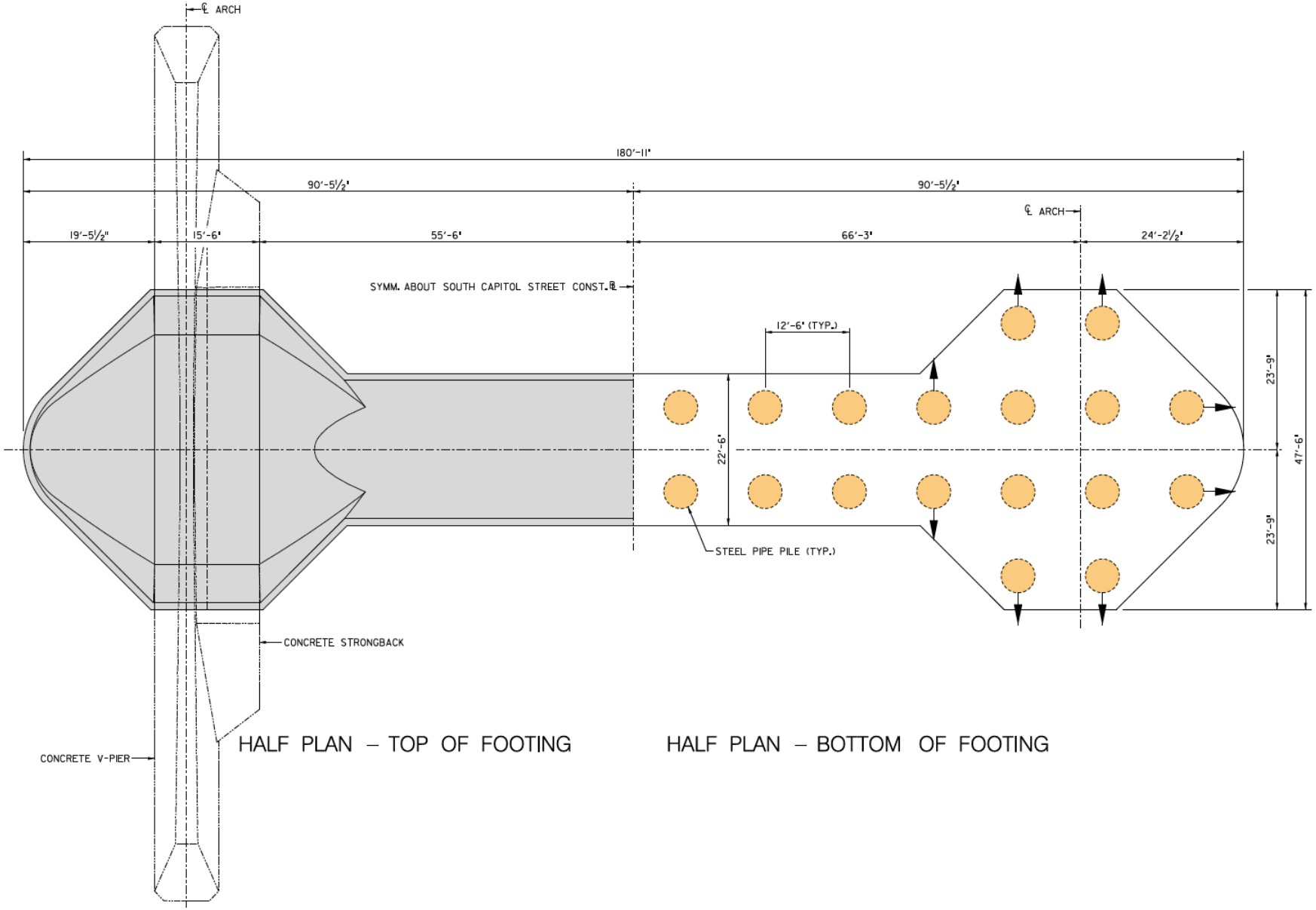
Pile Foundations

- 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 (ϕ = 0.75)
- Reinforced Concrete Filled
- Corrosion Protection - Epoxy Coating



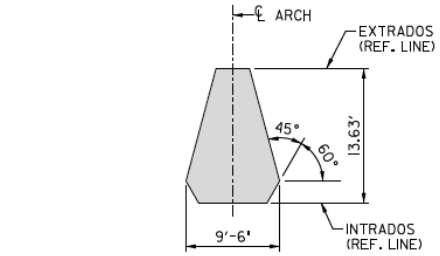
60” PIPE PILE DETAIL – V–PIERS

V-Pier Footing

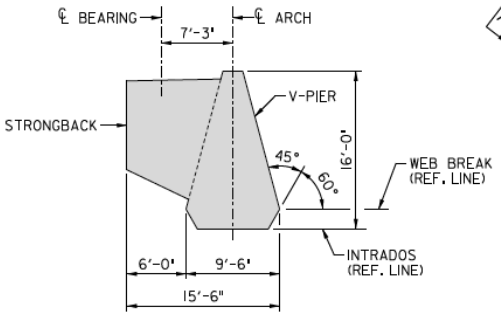


V-Pier Footing

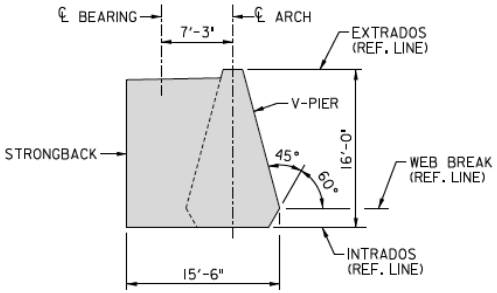
V-Pier Layout



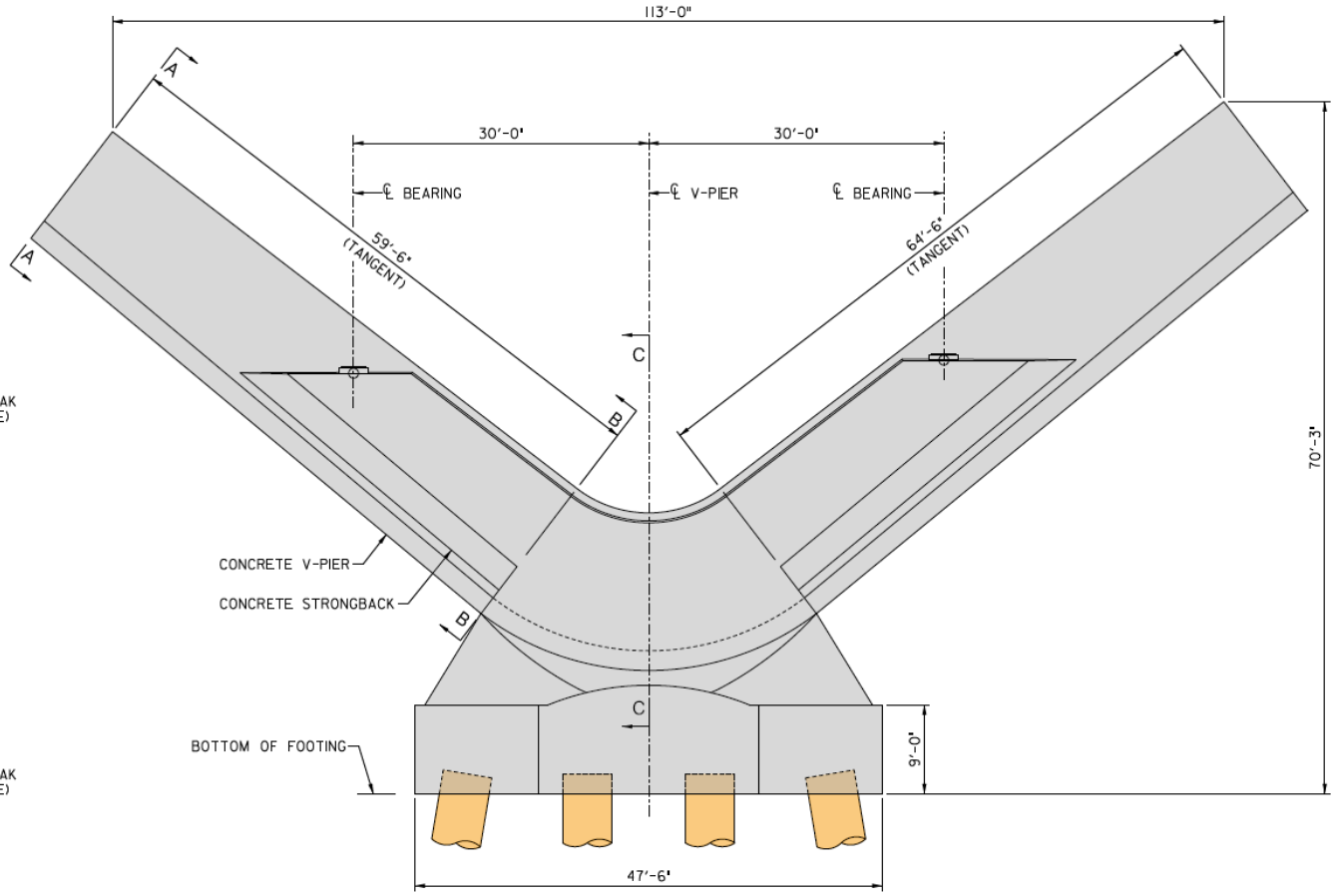
SECTION A–A



SECTION B–B



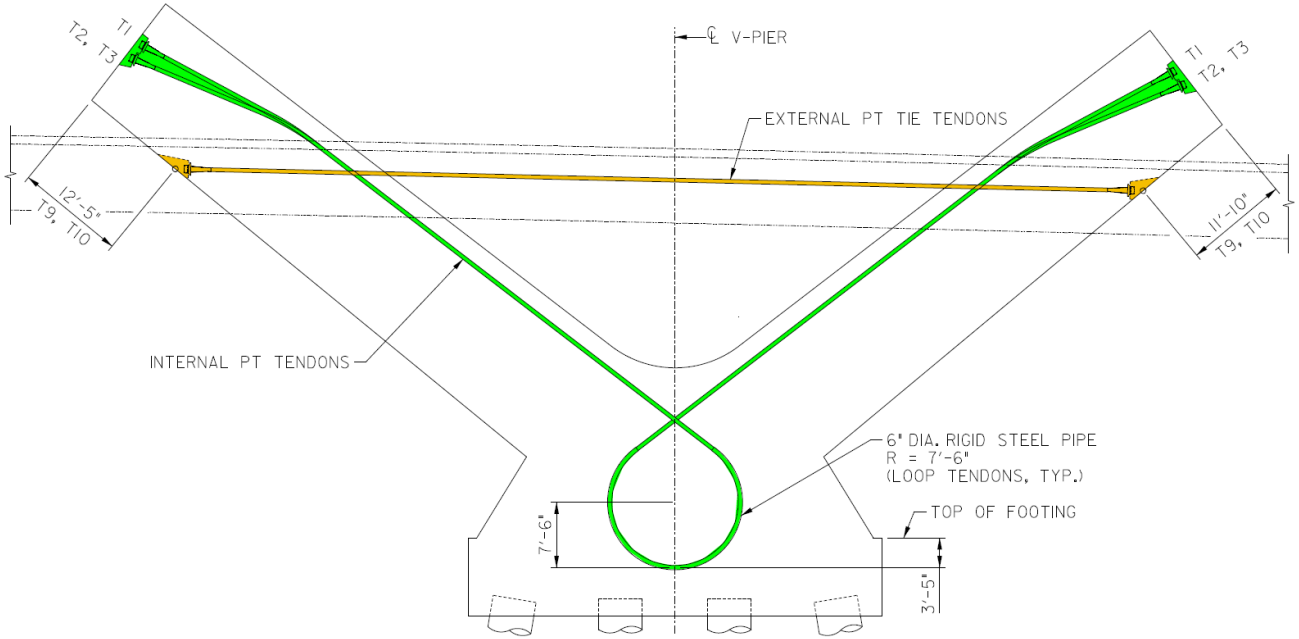
SECTION C–C



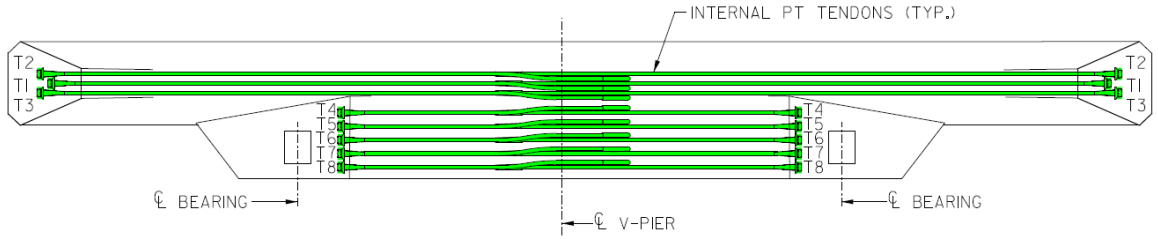
V–PIER ELEVATION

V-Pier Layout

V-Pier Post-Tensioning



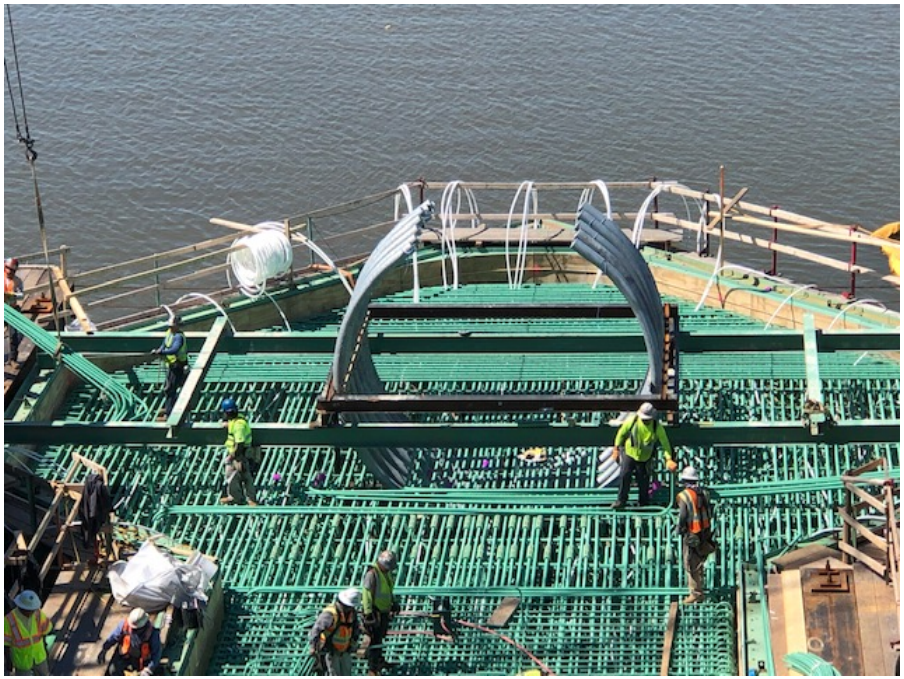
V–PIER ARCH BASE
POST–TENSIONING LAYOUT



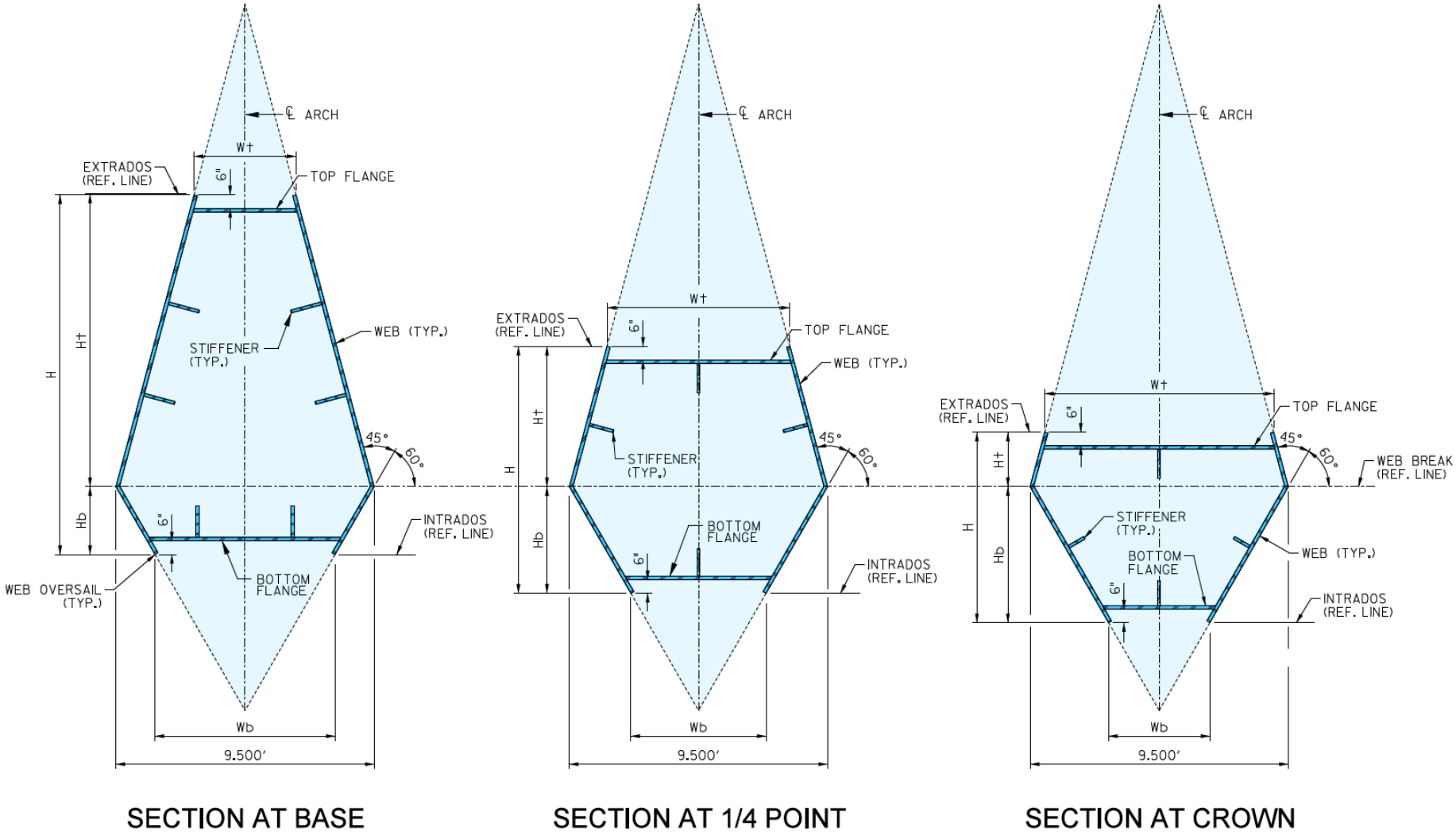
V–PIER ARCH BASE AND STRONGBACK
POST–TENSIONING LAYOUT

- 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

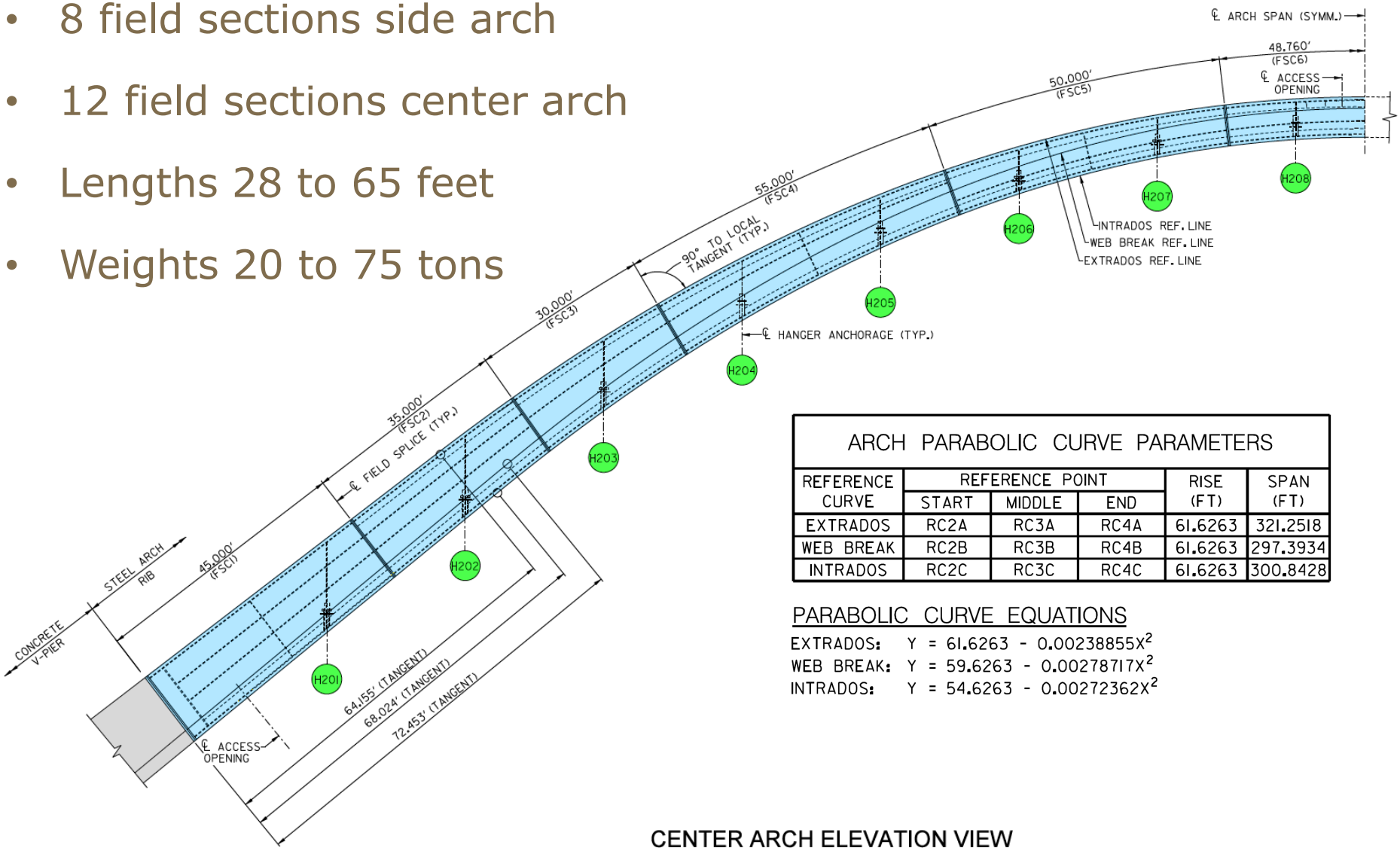


Steel Arches - Geometry



Steel Arches – Field Sections

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



CENTER ARCH ELEVATION VIEW

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

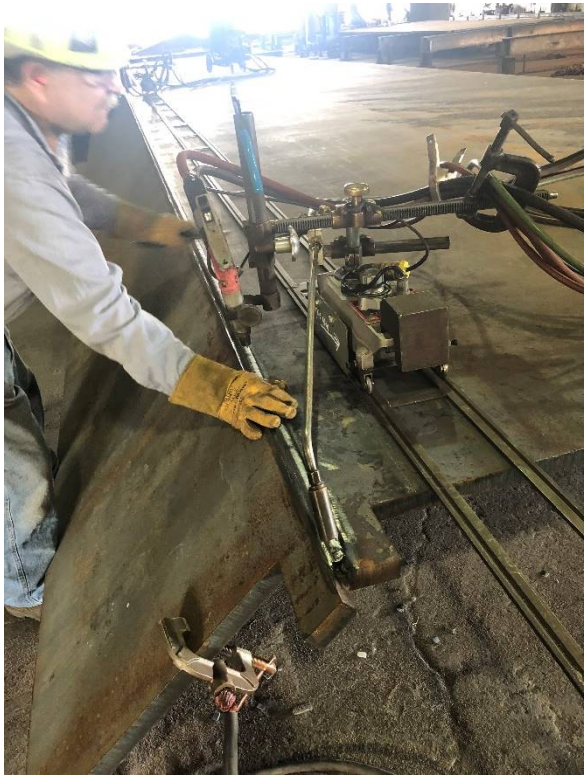
EXTRADOS: $Y = 61.6263 - 0.00238855X^2$

WEB BREAK: $Y = 59.6263 - 0.0027817X^2$

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

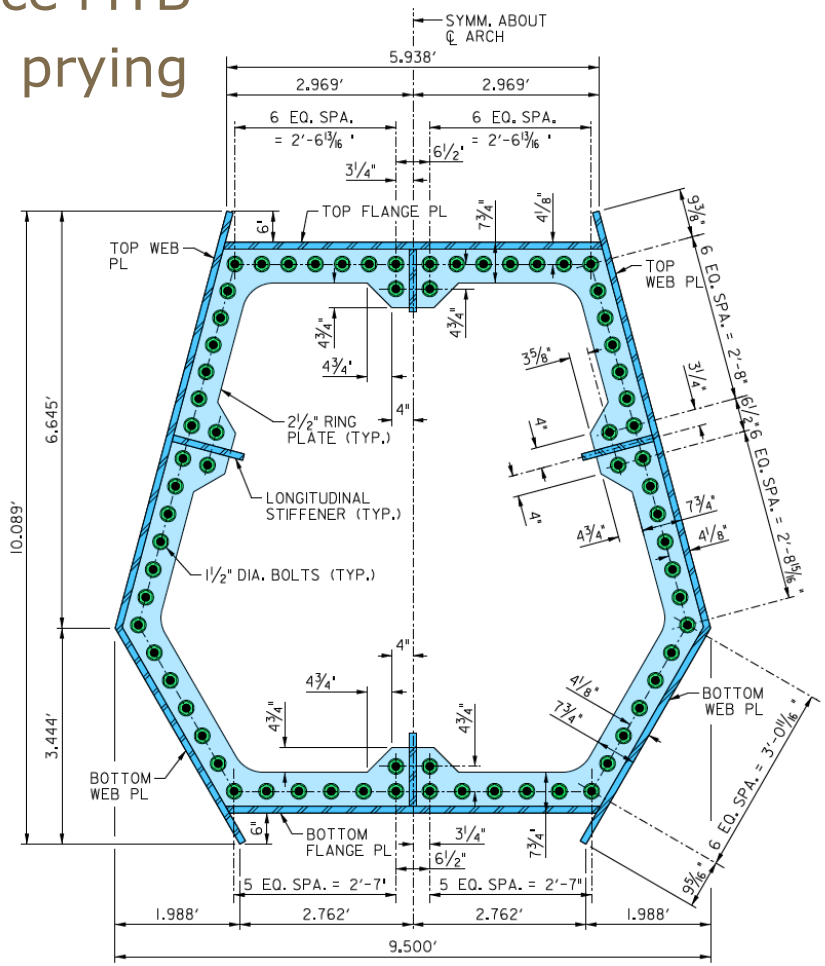
Steel Arches – Field Sections

Steel Arches – Field Sections

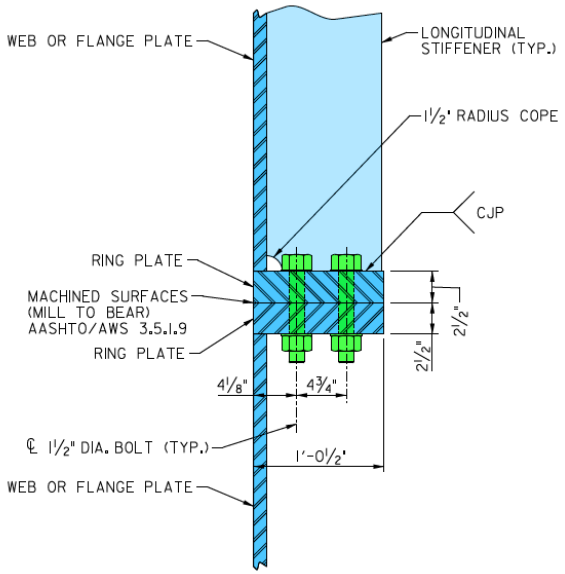


Steel Arches – Butt Splice

- 1½” dia. HS Bolts
- Machined surface MTB
- Bolt clamping / prying forces



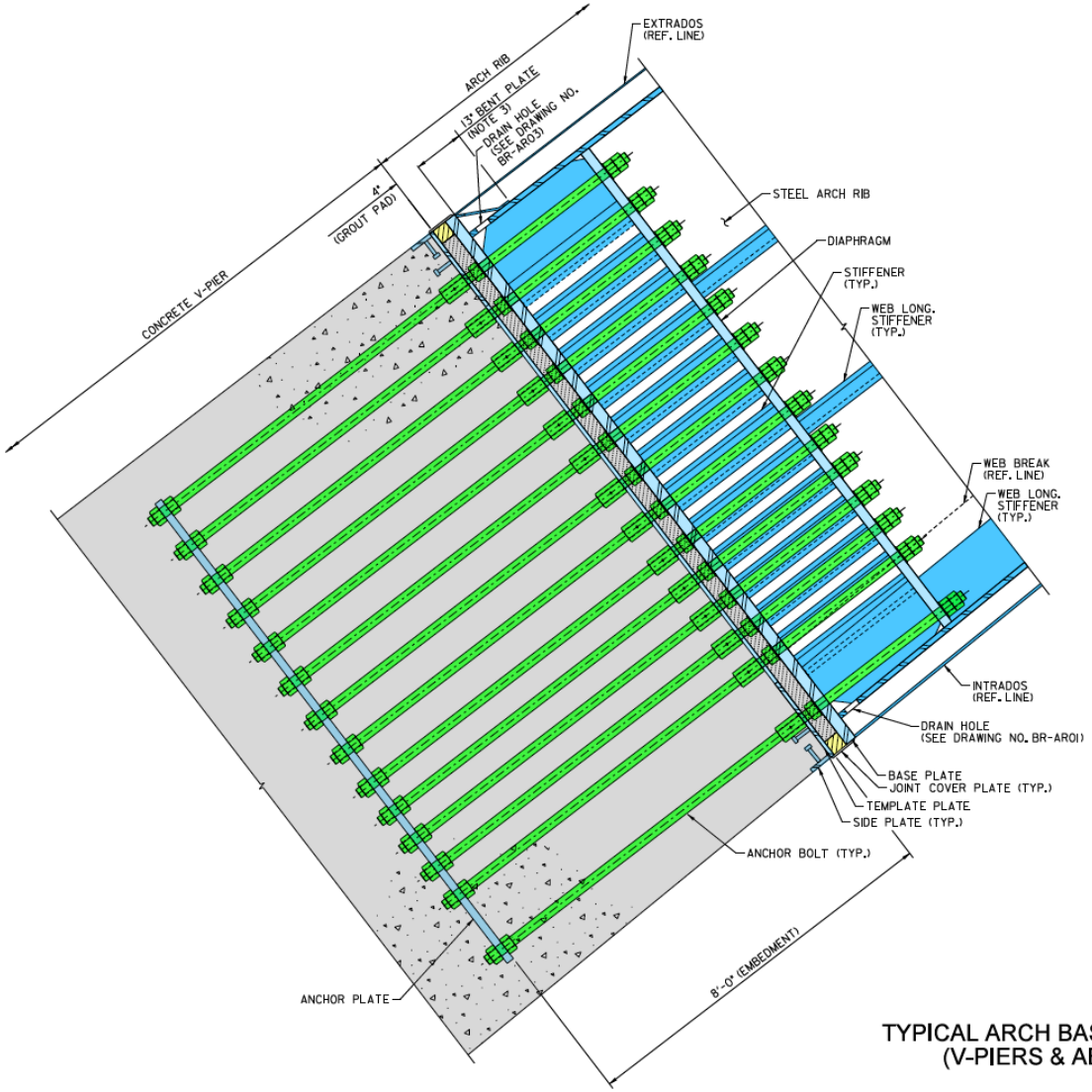
TYPE 7
FIELD SPLICE FS-C3

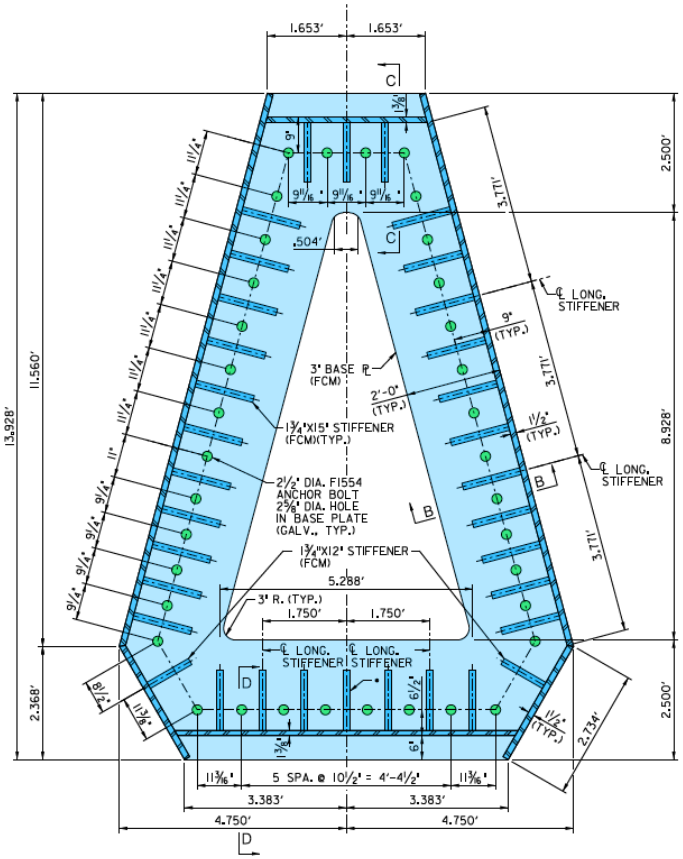


SECTION AT SPLICE

Steel Arches – Butt Splice

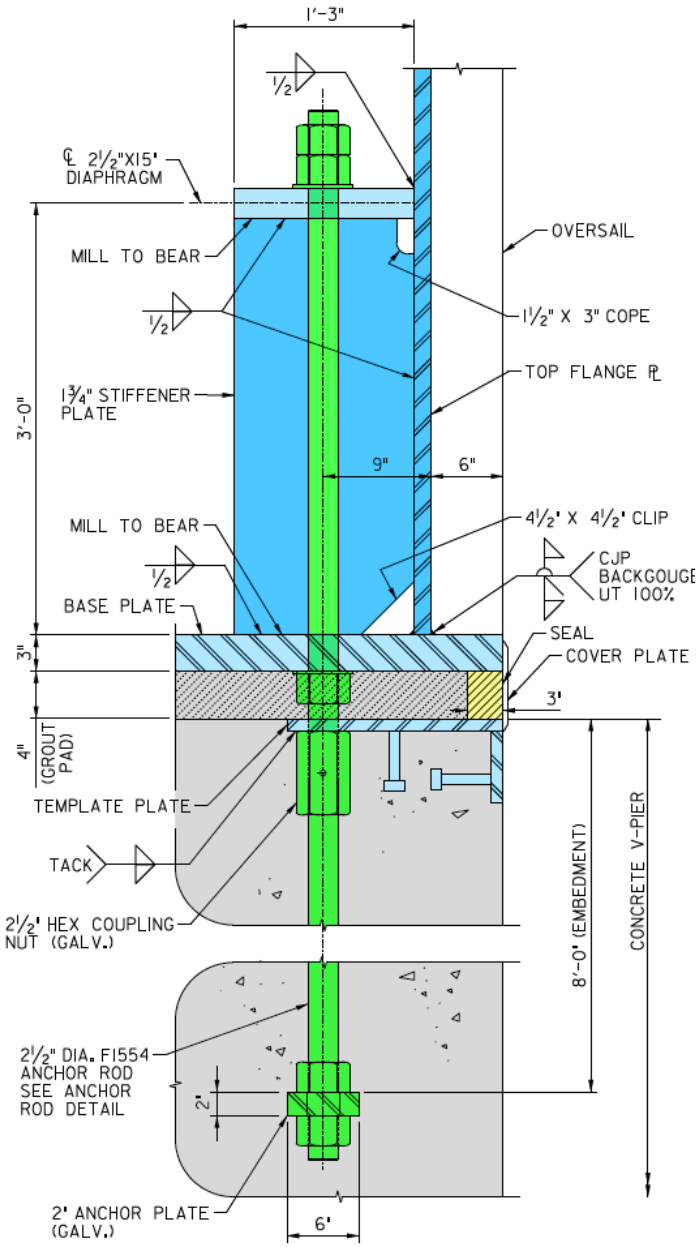
Steel Arches - Base Connection





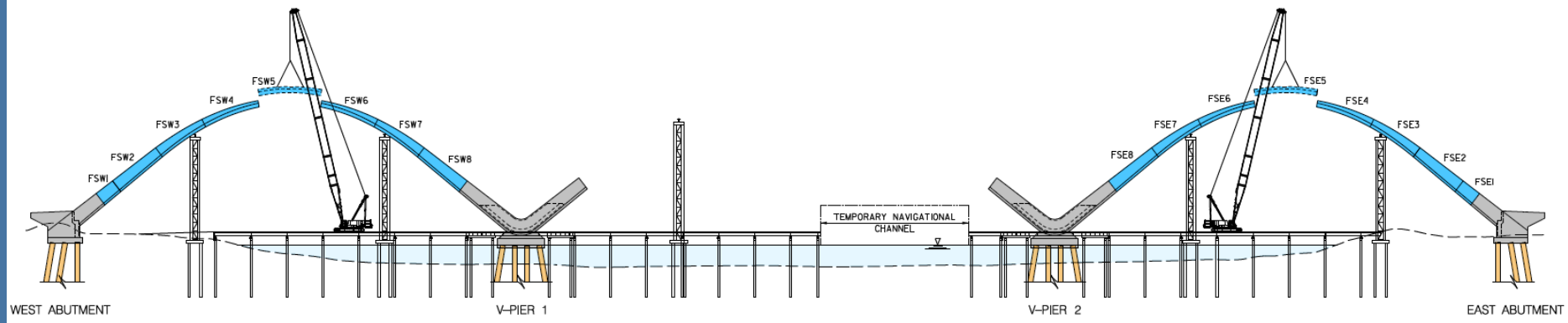
TYPICAL ARCH BASE CONNECTION
(V-PIERS & ABUTMENTS)

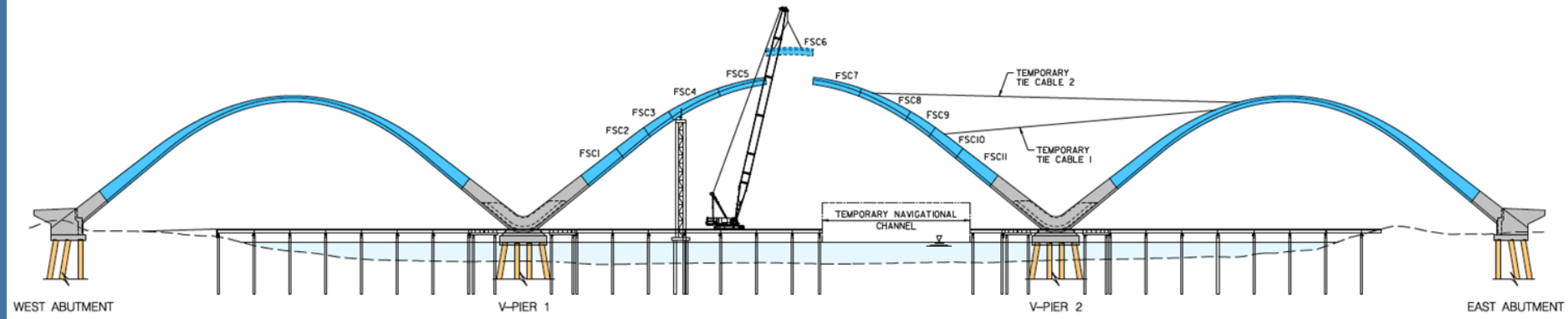
Steel Arches - Base Connection



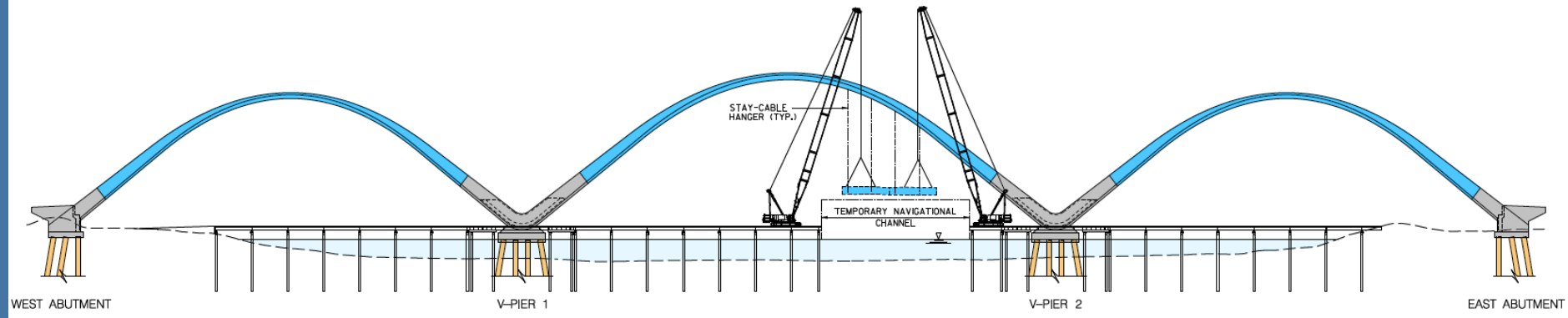
Steel Arches - Base Connection

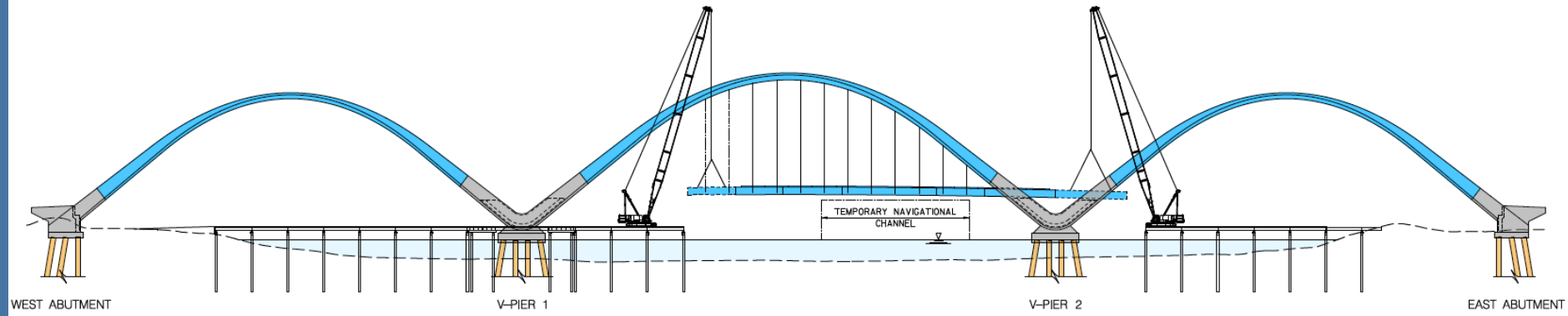
Erection Sequence - Arches

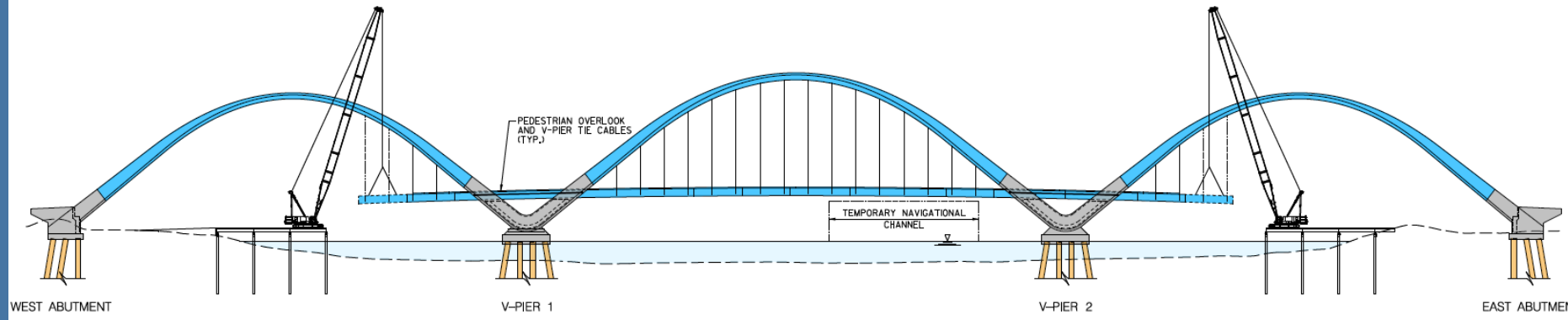




Erection Sequence - Deck







Erection Progress

Erection Progress

Credits

- **District Department of Transportation** (Owner)
- **HNTB** (PM/CM)
- South Capitol Bridgebuilders (JV: **Archer Western Construction, LLC** / **Granite Construction Co.**)
- **AECOM** (Lead Bridge Design)
- **ECS** (Geotechnical Engineering)
- **RWDI** (Wind)
- **BeAM** (Bridge Architect)
- **RBLD** (Aesthetic Lighting)
- **Systra/IBT** (Independent Design Check)
- **McNary Bergeron** (Erection Engineering)
- **SDI** (Cables Stays & Post-tensioning)
- **Veritas Steel** (Structural Steel Fabrication)

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