

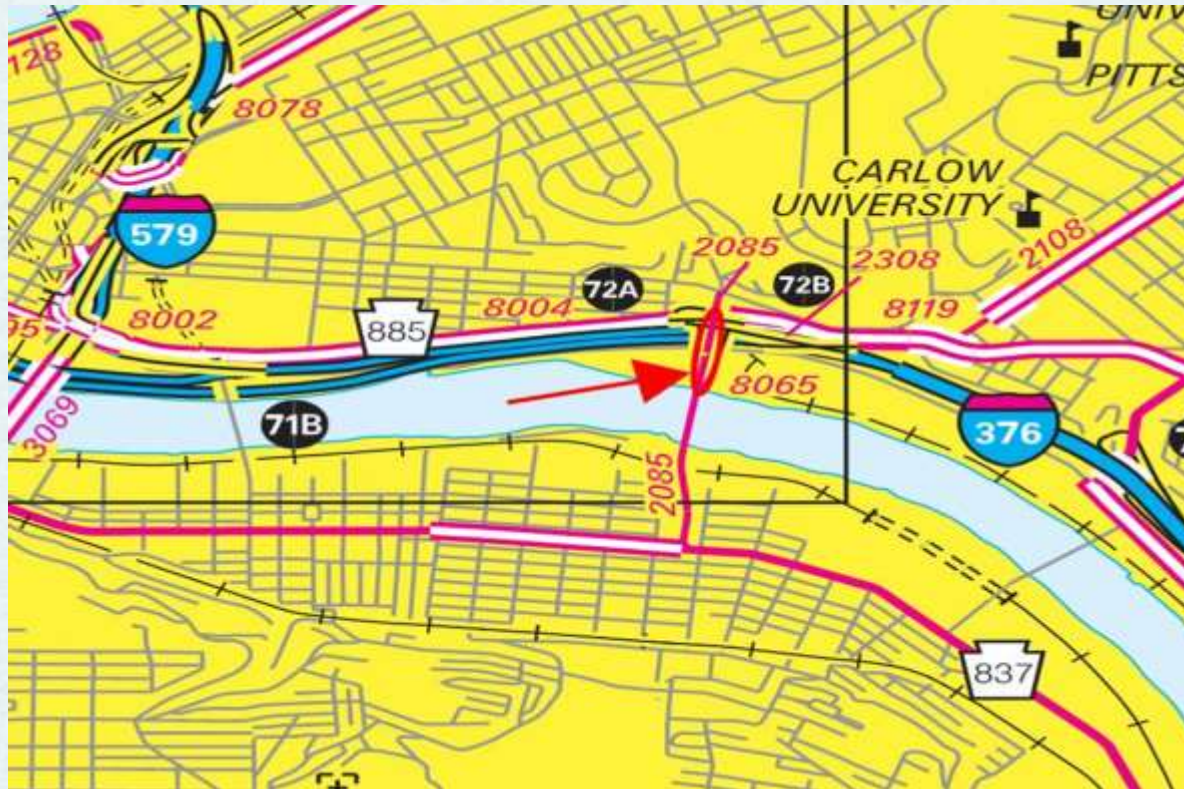
# Birmingham Bridge Preservation



Ahmad K. Ahmadi, PE, PhD, SAI Consulting Engineers, Pittsburgh, PA



# Birmingham Bridge – Location



# Brady Street Bridge (Birmingham Bridge)



# Birmingham Bridge – Features

- Opened in 1977
- 19 Spans (18 multi-girder approach spans)
- 620' Main Span (tied-arch)
- Total Structure Length 2740.5'
- Total Project Length 3,400'
- ADT = 21,360
- 6 Lanes of Traffic, 1 Sidewalk, and 2 Bicycle Lanes
- Structure Spans Monongahela River, Second Avenue, Forbes Avenue, SR 0376, Blvd. of the Allies, Southside Riverfront Park, Eliza Furnace Trail, and CSX Railroad
- Widest Bridge over the Monongahela River  
([www.bridgemapper.com](http://www.bridgemapper.com))



# Birmingham Bridge – Main Span



# Birmingham Bridge – Approach Spans



# Birmingham Bridge – Team



- **PennDOT District 11-0** – Owner
- **SAI Consulting Engineers, Inc.** – Preservation Design
- **Joseph B. Fay Company** – General Contractor
- **Avalotis Painting Company** – Paint
- **Amelie Construction & Supply** – Steel Work and Bearing Replacement
- **Tri-State Design and Development, Inc.** – Field Survey
- **KTA Tator, Inc.** – Paint System Evaluation
- **Cardno** - SUE

# Birmingham Bridge – Scope

- Structural Steel Repairs (corrosion and fatigue retrofits)
- Bearing System Replacement
- Substructure Spall Repairs
- Painting of the Entire Structure
- Deck Hydro Demolition
- Deck Latex Overlay
- New Street Lighting



# Birmingham Bridge – Traffic Control



- Traffic maintained via bi-directional flow. Detoured ramps to and from Forbes Avenue and intermittent Blvd. of the Allies and Parkway East closures.

# Birmingham Bridge – Traffic Control

- SAI and the District worked with local access and bicycling groups to create uniquely signed detours and other special accommodations to facilitate and ensure full access during construction for all modes of transportation (vehicle, bicycle, pedestrian, and ADA transport).
- The Oakland Transportation Management Association (OTMA) was utilized as an information source to facilitate and communicate to the general public on the constantly evolving traffic patterns and activities throughout construction.

# Birmingham Bridge – Costs

- **Estimated Project Cost:** \$33,364,020
- **Actual Project Cost:** \$29,908,289
- **Estimated Structure Cost:** \$31,695,819
- **Actual Structure Cost:** \$28,412,874



# Birmingham Bridge – Schedule

- **2009** – Final Design Begins
- **2010** – Project Placed On-Hold Due to Funding
- **2013** – Rehabilitation Inspection
- **2014** – Plans, Specifications, and Estimates submitted
- **July 2014** – Bid Opening
- **November 2016** – Opened to Unrestricted Traffic



# Stringers' End Repair





# Hanger Cables Protection



# Fatigue Retrofits

## Floor Beam to Tie-Girder Connection



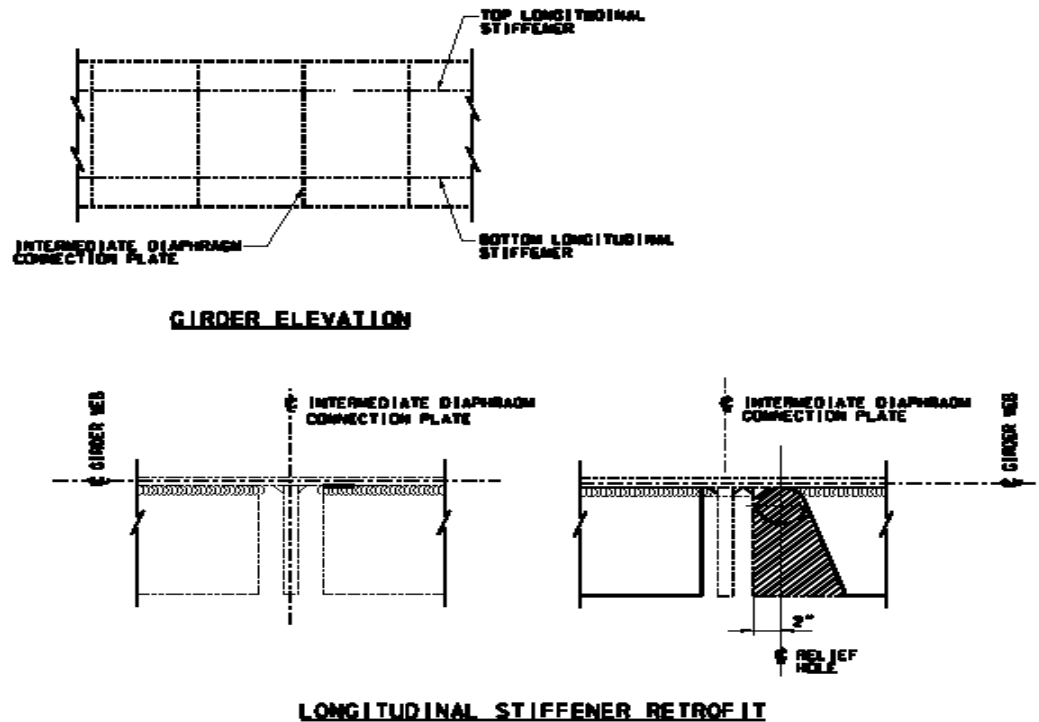
# Fatigue Retrofits

## Stringers to Floor Beam Connection



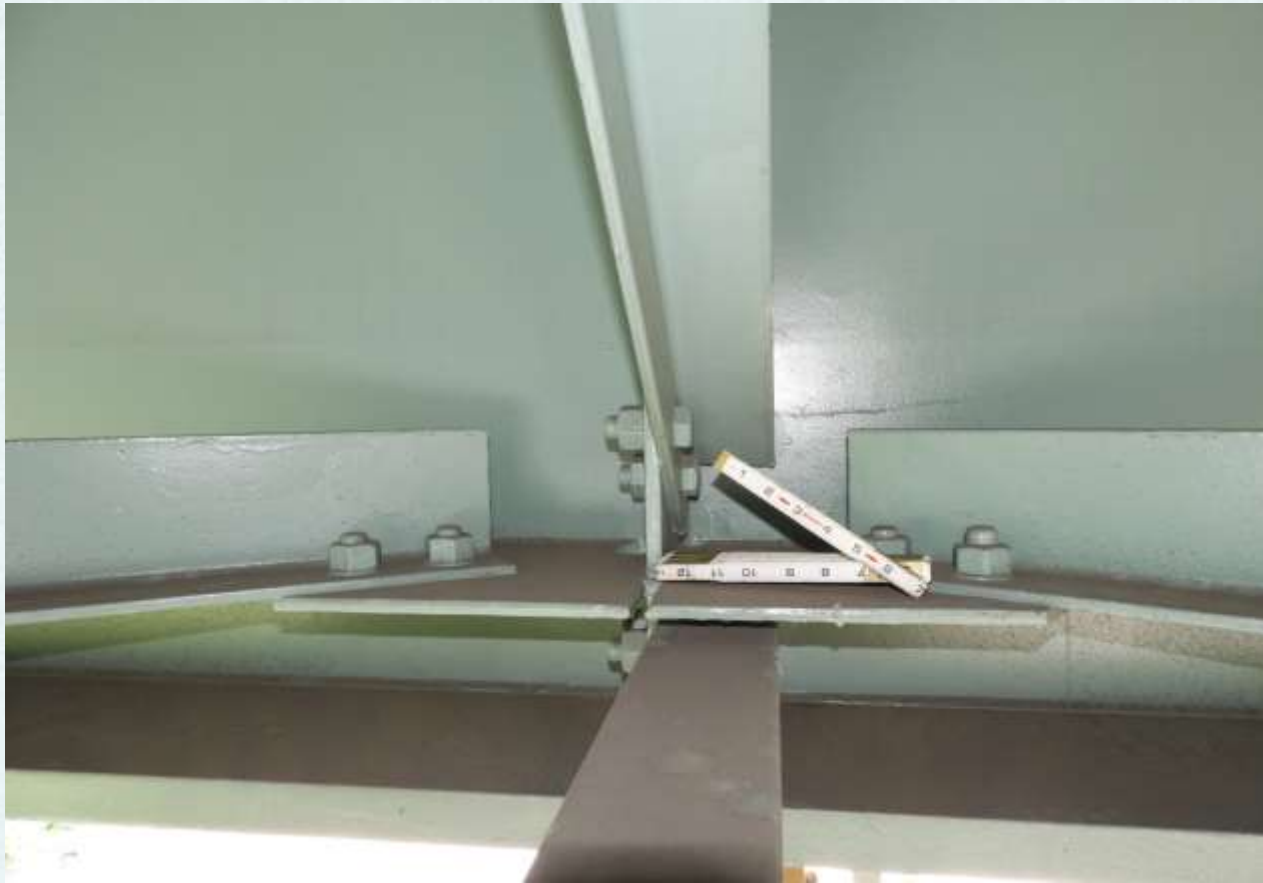
# Longitudinal Stiffener retrofit

Cracked Longitudinal Stiffener's weld  
Welds spacing  $\leq 1/4"$



# Lateral Bracing (Hoan detail) Retrofit

Welds spacing  $\leq 1/4$ "





# Tie-Girder Bottom Flange Splice



# Tie-Girder Bottom Flange Splice



# Bearing Replacement

Total of 222 bearings including:

155 neoprene bearings, 23 pot bearings, 22 metal sliding bearings, 20 disc, and 2 spherical bearings



# Elastomeric Bearings



# Elastomeric Bearings



# Disc Bearings



# Metal Bearings



# Substructure Concrete Spall Repair



# Deck Spalls



# Hydro Demolition and LMC

1" milling

Hydro demolition to prepare deck surface

1 1/4" latex modified concrete



# Birmingham Bridge – Deck

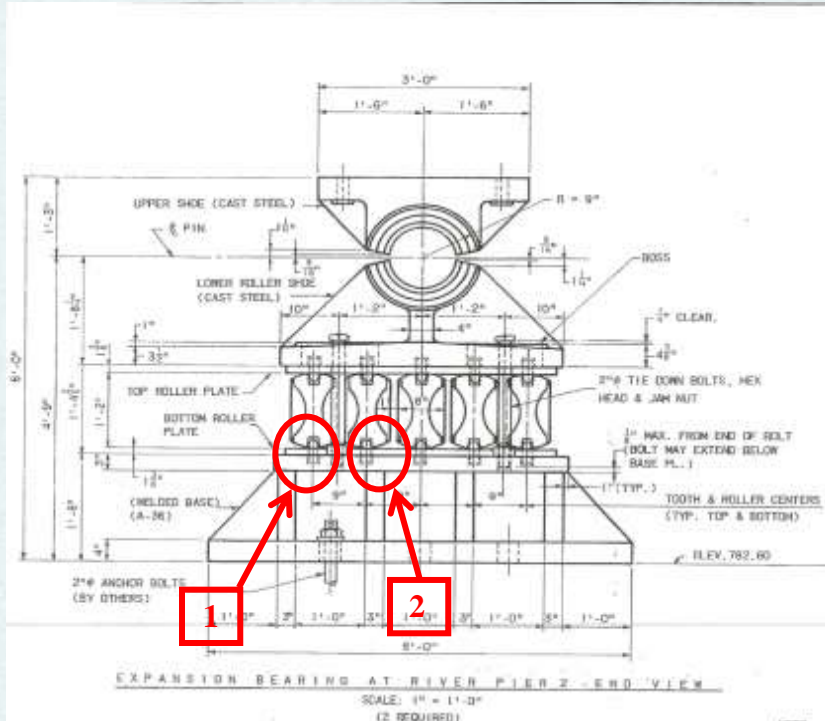


# Additional Work: Main Span Bearing Replacement

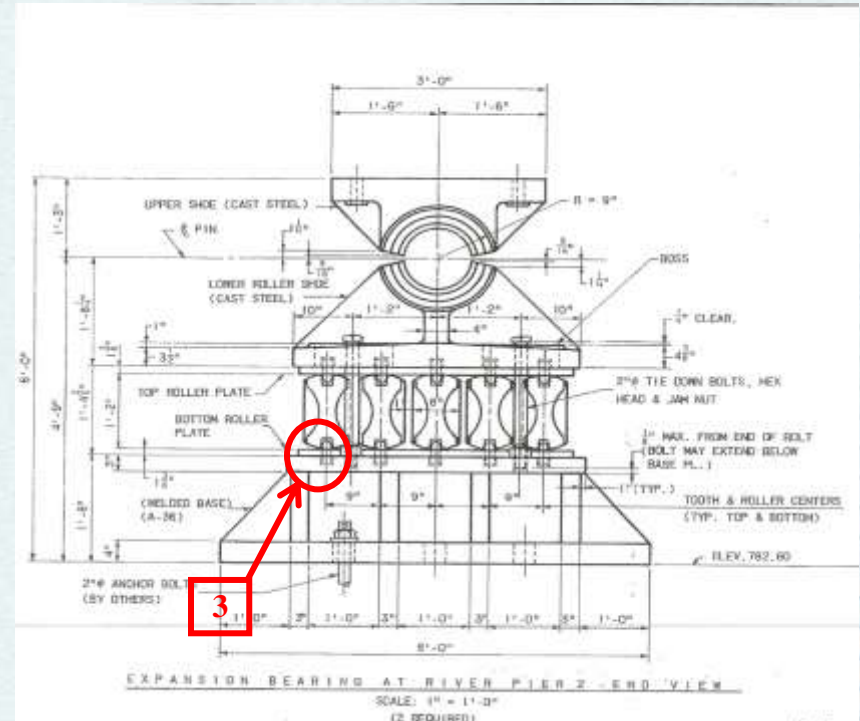




# Downstream Bearing



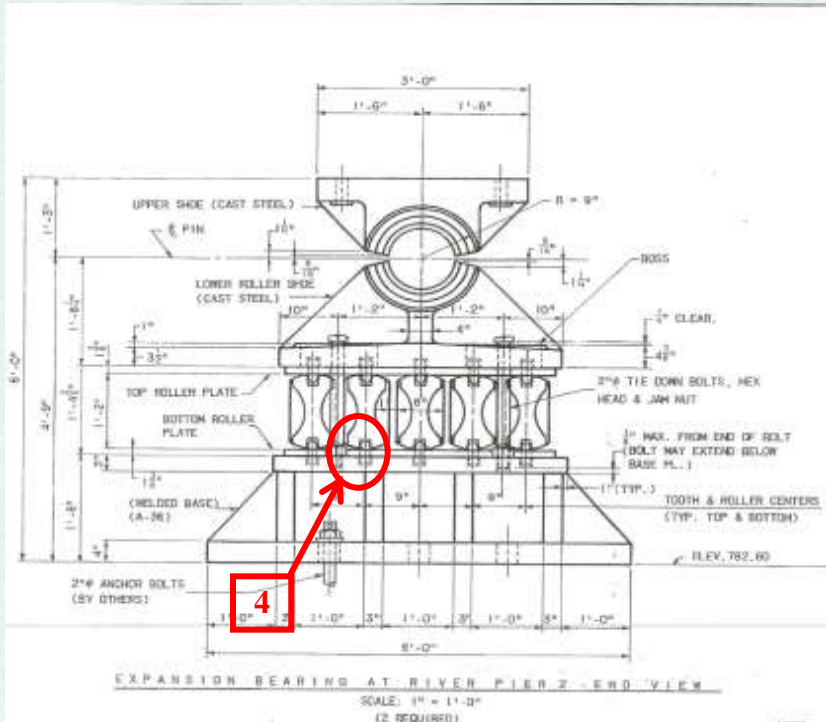
Upstream Face



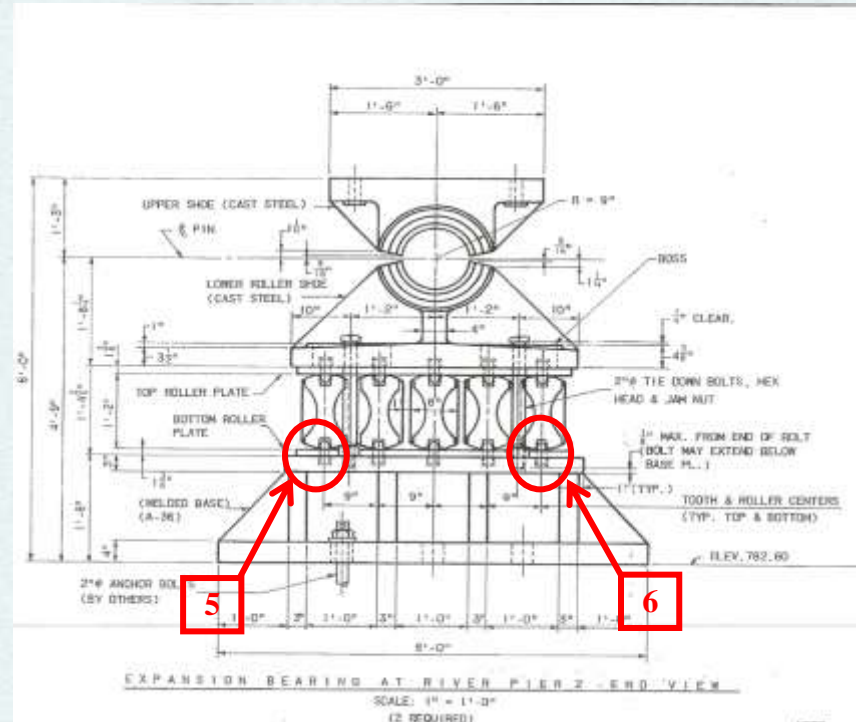
Downstream Face

1. Previous inspection reports indicated tooth lifted. Cracked during construction
2. Previous inspection reports indicated tooth lifted. Cracked during construction
3. Tooth lifted during construction

# Upstream Bearing



Upstream Face



Downstream Face

- 4. Tooth lifted during construction
- 5. Previous reports indicated tooth cracked
- 6. Tooth rotated during construction

# Cracked Teeth



# Cracked Tooth



# Options Evaluated for Main Span Expansion Bearings

- Install keeper angles on the side of the rollers.
- Repair existing bearings: **Jacking the bearings, removing the rollers, replacing cracked teeth, and pushing the lifted teeth in place.**
- Replace existing bearing with new bearings.

Decision was to replace the existing bearings with new bearings.

# New Bearing Options

- Replace existing bearing with new bearings: Disc Bearing, Pot Bearing, Spherical Bearing

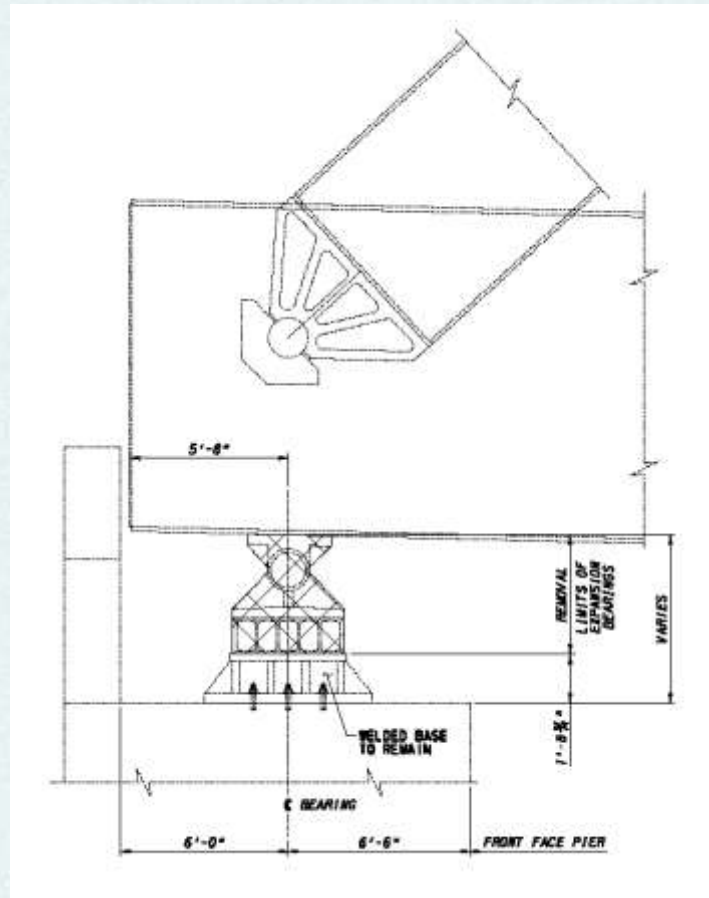
Spherical Bearing was chosen.

Design and drafting approximately 5 weeks.

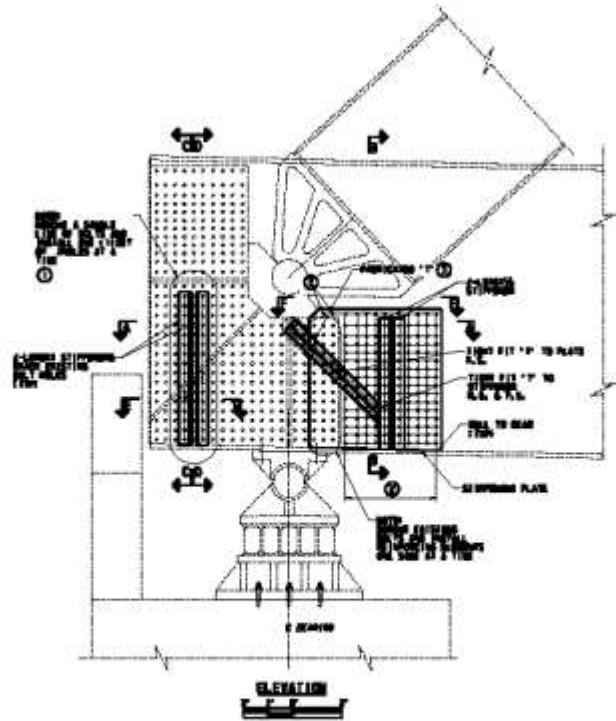
# Spherical Bearing – Cost

- Engineering Estimate      \$1,271,000
- Actual Cost (bearing, strengthening, jacking, and installation)    **\$1,200,000**

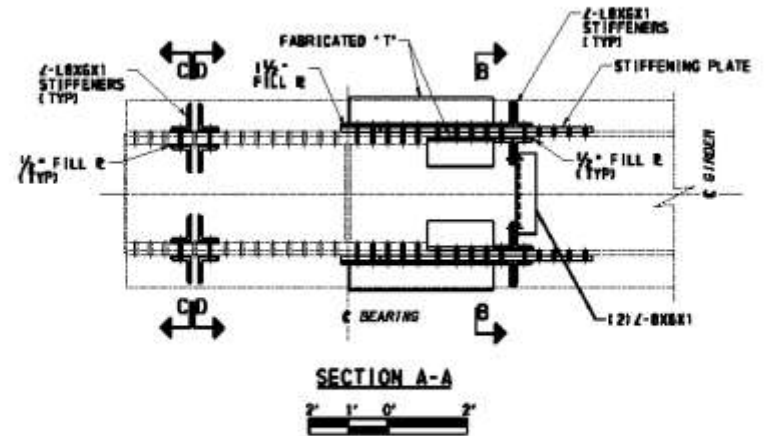
# Bearing and Tie Girder End Details



# Strengthening Plan

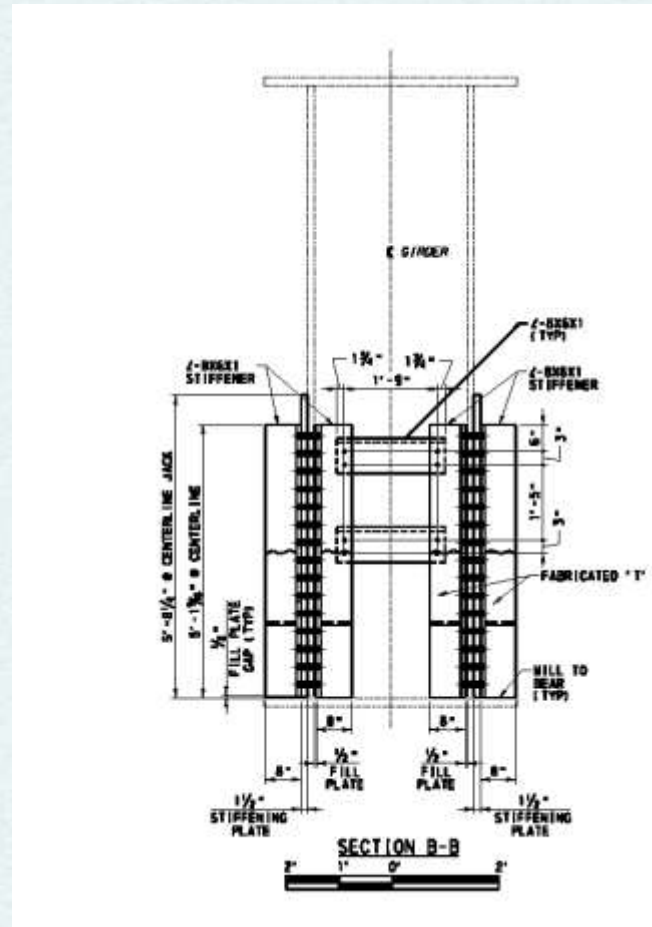


Elevation

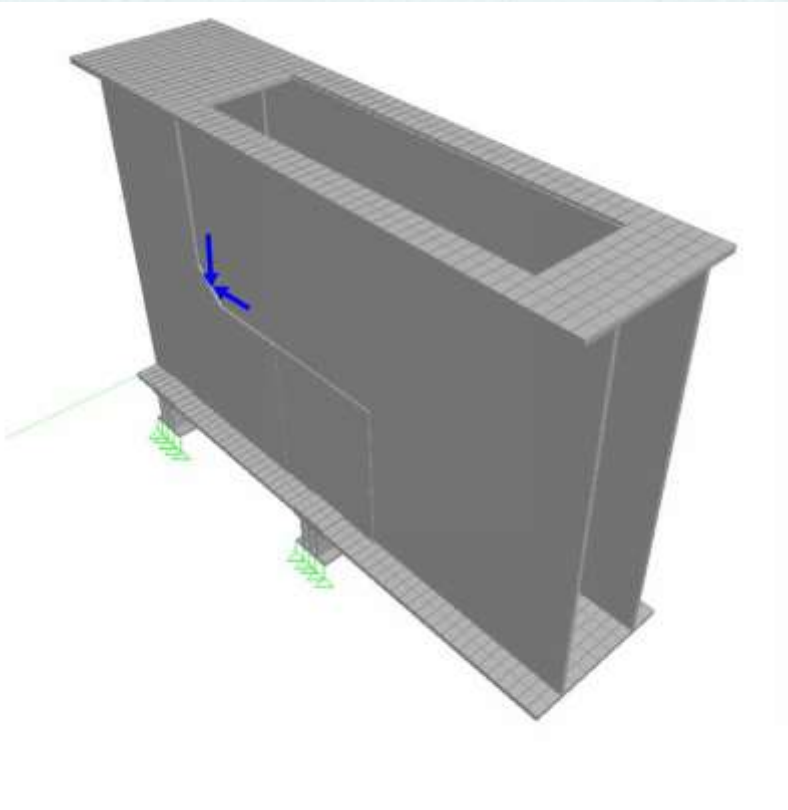


Plan

# Tie Girder Cross-Section and Strengthening

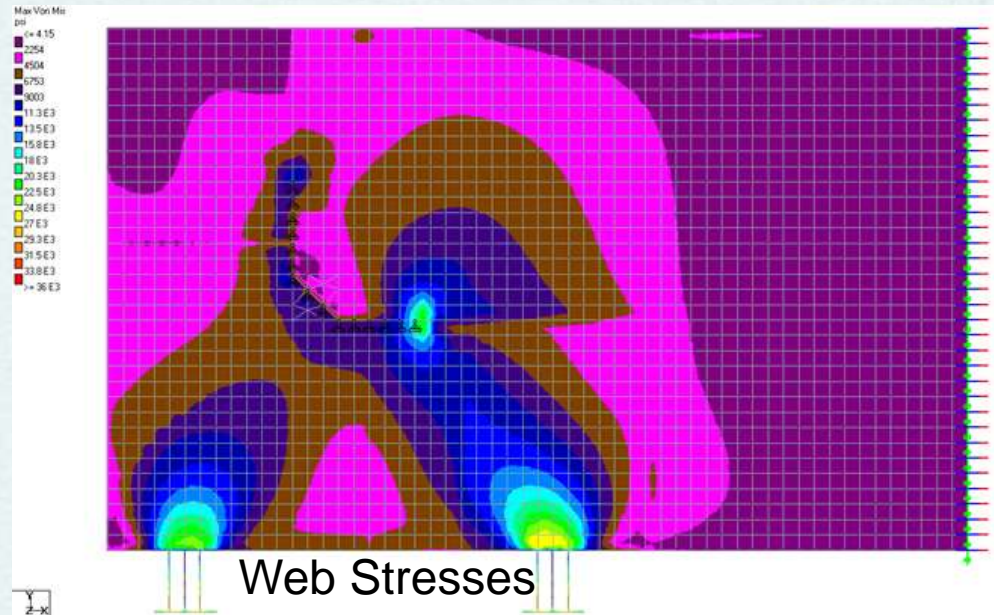


# Analysis: Finite Element Model, Web and Flange Stresses

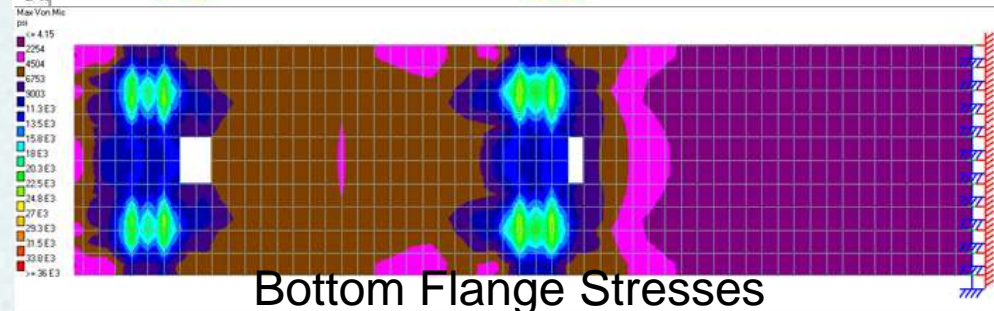


Tie-Girder End

- Bearing Reaction : 5500 Kips

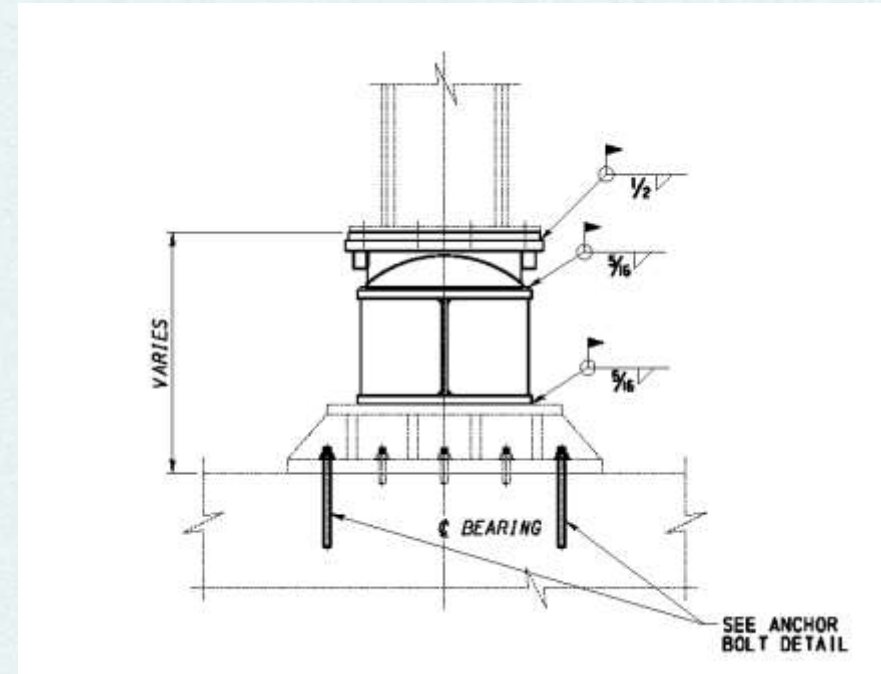
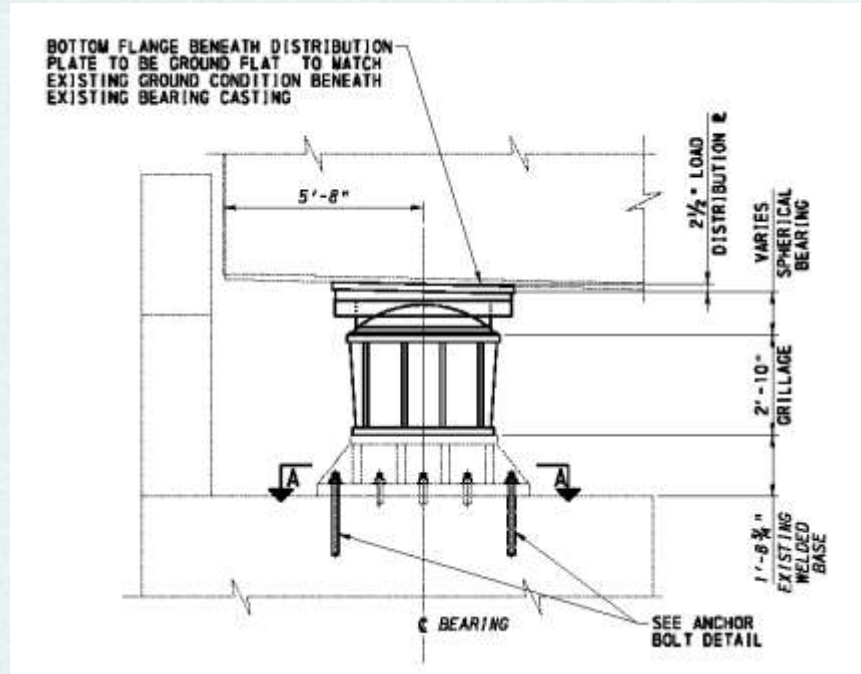


Web Stresses



Bottom Flange Stresses

# Spherical Bearing



# Construction

- Shop drawing preparation and bearing fabrication (D.S. Brown)
- Preparatory field work and installation (Amelie Construction)
- Preparatory field work took approximately 10 weeks and included:
  - End of tie girders strengthening
  - Fabrication and installation of the supporting temporary jacking system
  - Bottom flange surface preparation
  - Installation of railed system for bearing delivery

# Strengthening: Outside and Inside of Tie Girders



# Fabrication and Installation of Supporting Jacking System (16-250-Ton Jacks)



# Bottom Flange Surface Preparation

Bottom of flange was not “flat” (had approximately max.  $\frac{1}{4}$ ” belly):

- New sole plate is longer; bottom flange machined in the field.
- At the temporary jacking locations, “lead plates” were used.



# Disassembly and Removal of Bearings



Pin Removal



Existing Bearing Removal

# Spherical Bearing



- Bearing Designed for 5500 Kips

# Spherical Bearing Installed



# Conclusion

- The team selected by PennDOT and Contractor had excellent relationship in the past and fostered an excellent relationship throughout project duration.
- “Aggressive” plan by the contractor and subs.
- Construction was scheduled for 2.5 years; contractor planned to finish it in 2 years.
- Good planning and communication, including status of the schedule between owner, contractor, and designer.
- Bi-weekly Control Meetings were held.
- Monthly CPM schedule updates and discussion and review at the Bi-weekly Control Meetings.
- Timely response and cooperation by all the parties involved.



**Thank You!**

