U.S. 20 Iowa River Bridge

2ND NATIONAL PREFABRICATED BRIDGE ELEMENTS AND SYSTEMS WORKSHOP

NEW BRUNSWICK, NEW JERSEY

September 8-10, 2004

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History of the Relocation Process

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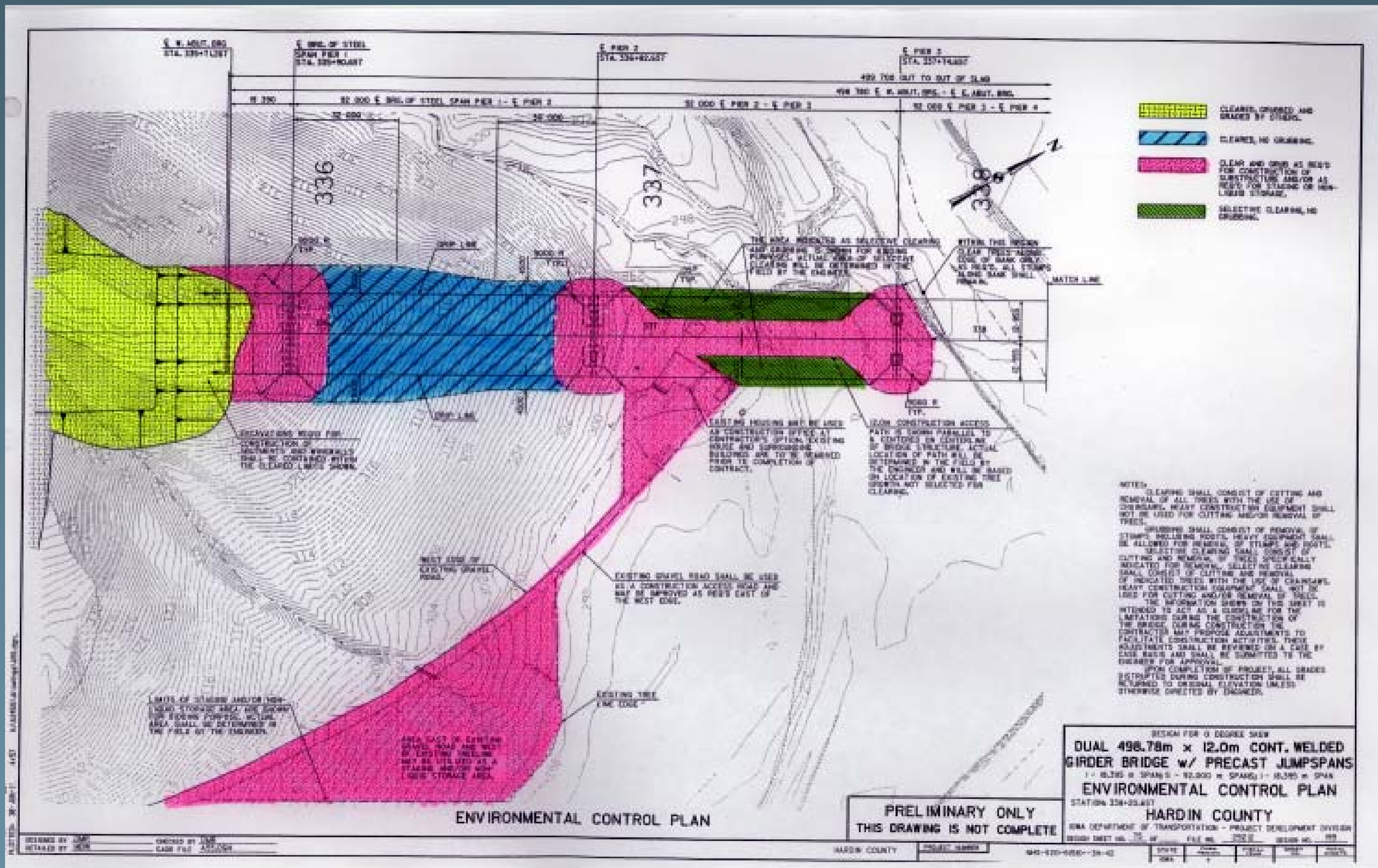
Environmental Concerns & Restrictions

- **Concerns**
  - **Eagles roosting area**
  - **Northern Monkshood plant**
  - **Mussels in river**
  - **Quality Wetlands**

Environmental Concerns & Restrictions

- **Restrictions**
  - Limited clearing & grubbing under bridge.
  - Minimized areas of construction zone.
  - No bridging or crossing of the river.
  - No work on site Nov. 1st - Apr. 15th. This restriction was lifted

Environmental Concerns & Restrictions



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Archeological Restrictions

- Indian burial mounds
- Ancient native american campsites
- Headstones

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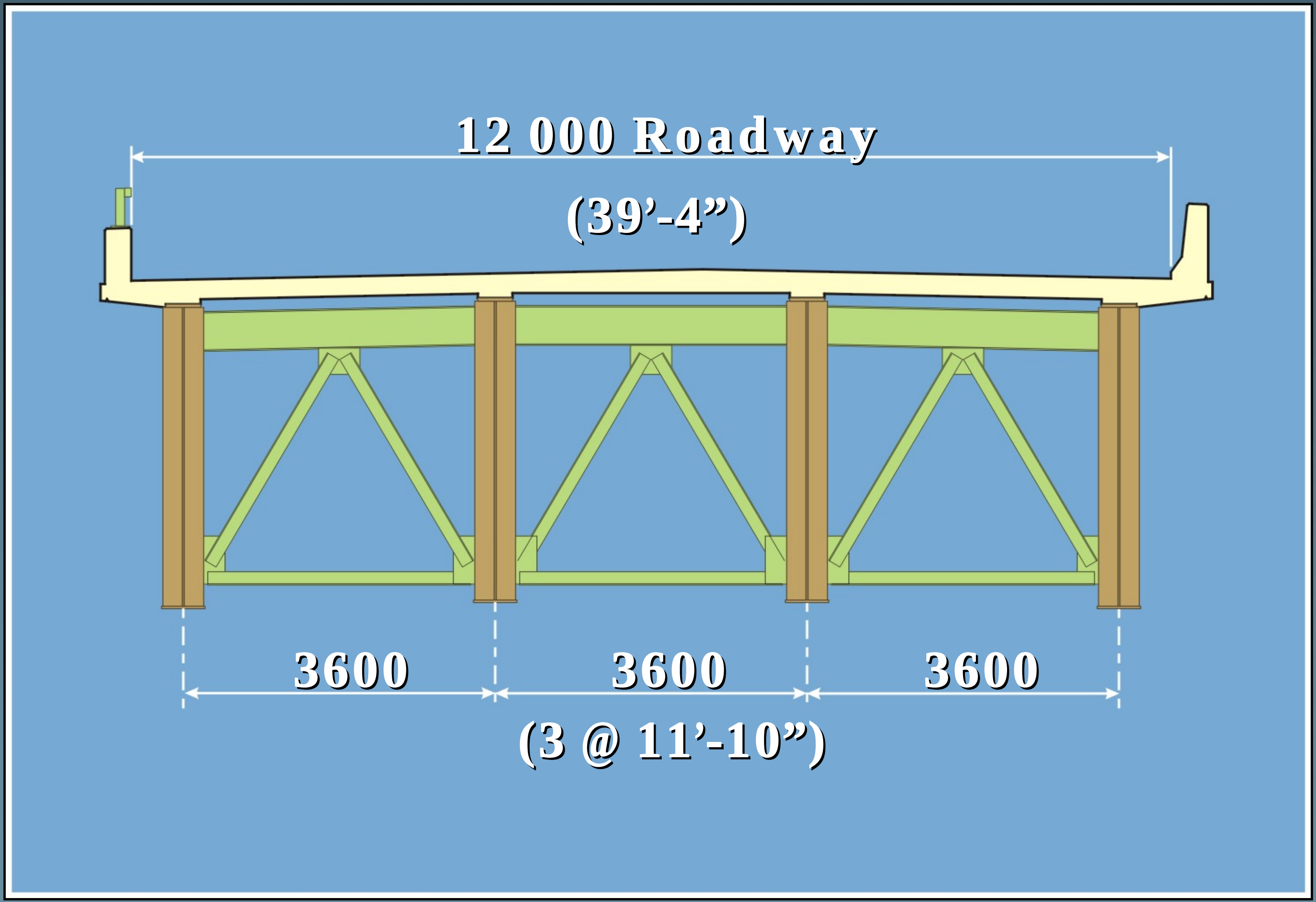
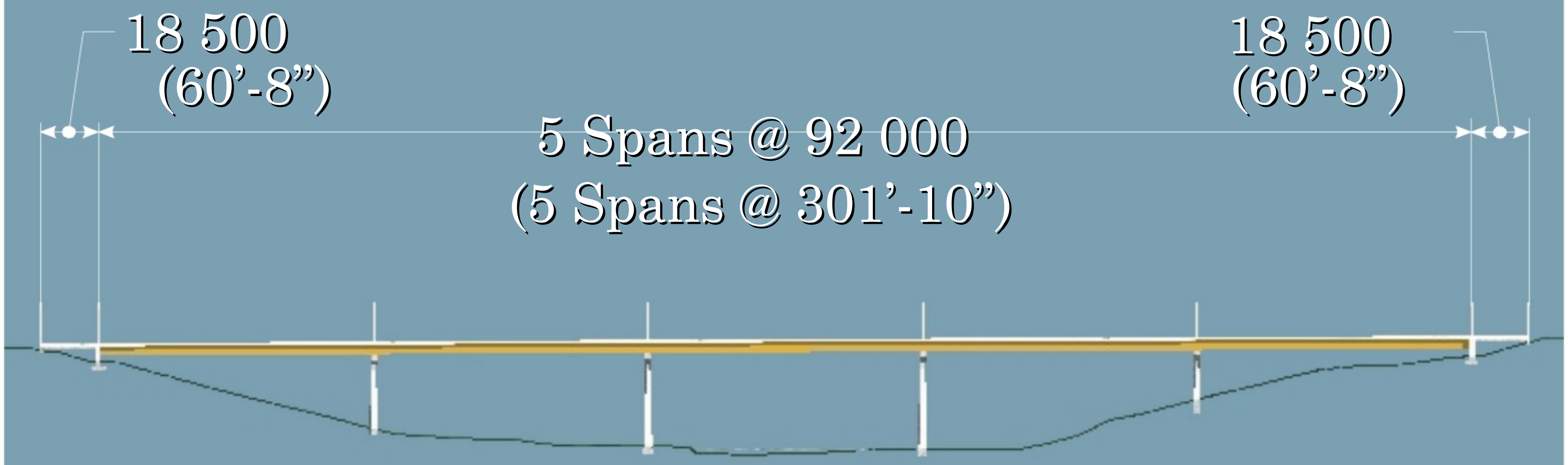
Bridge Details (One Superstructure)

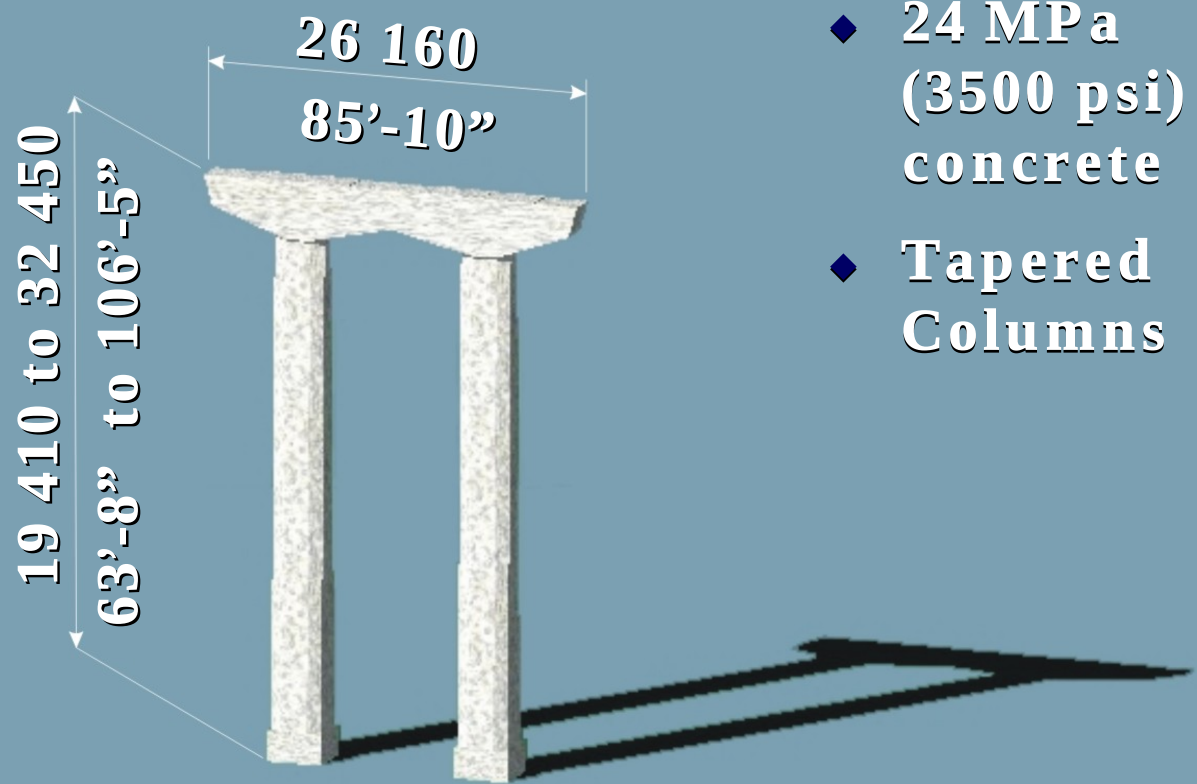


Bridge Details



Longitudinal Section

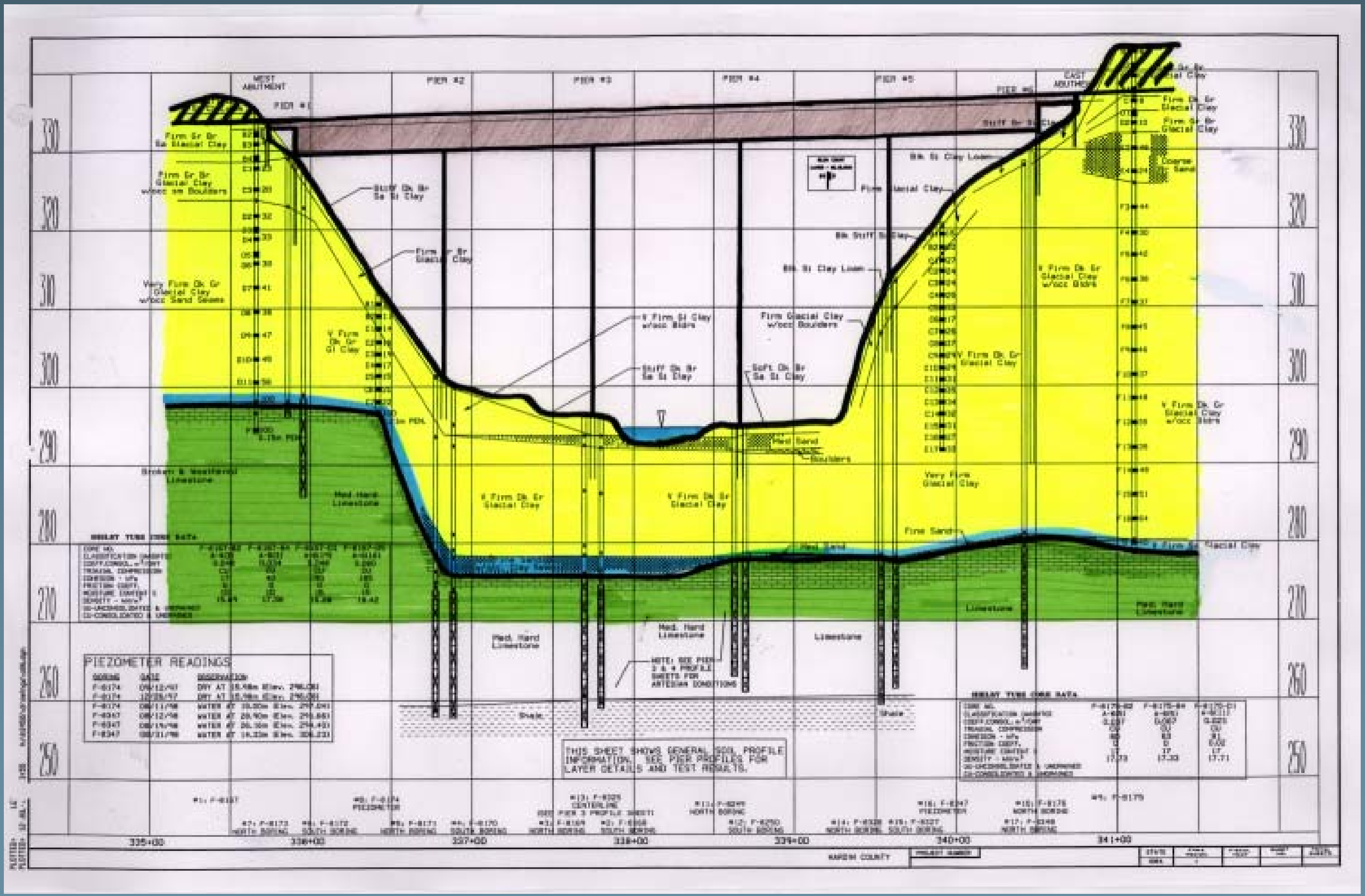
Bridge Details (Piers)



- 24 MPa (3500 psi) concrete
- Tapered Columns

Typical Pier

Geotechnical Analysis & Recommendations



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Launching Pit Excavated at East Abutment

Girders Assembled in Launching Pit

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Girders Supported Rollers

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Ramp Plates Aid Transition at Field Splices

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Girders Supported by Rollers

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Girders Guided by Horizontal Rollers

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Monitor Girder Position During Launching

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Jacking System Used for Launching

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Jacking System Used for Launching

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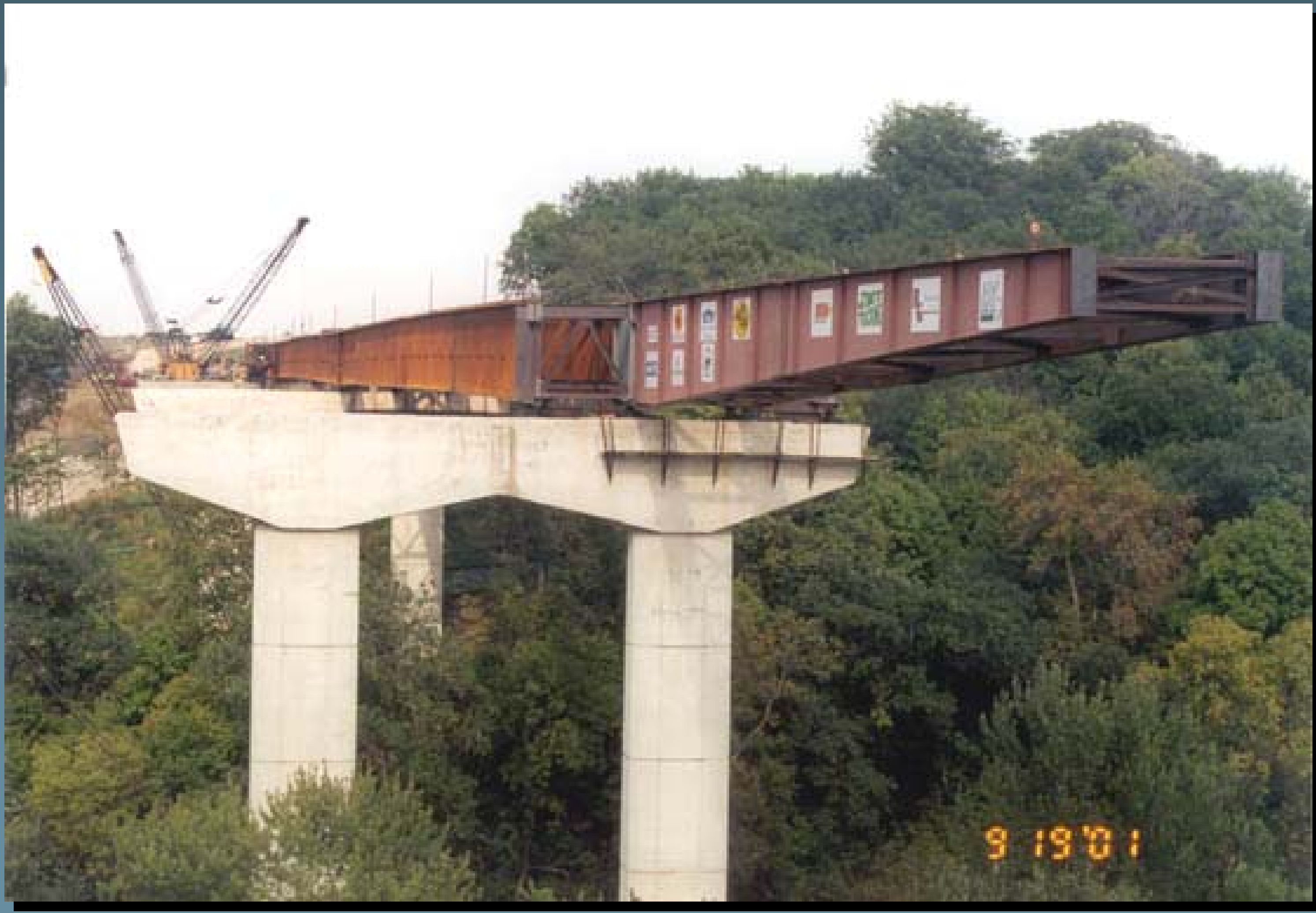
Launching Nose Accommodates Deflection



Deflection of WB Span 1 During Launch

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Launching Nose Landing at Final Pier

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Looking East From Beneath Girders at Pier 1

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Rollers Removed After Launching Completed

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Bearings Inserted and Girders Jacked Down

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Goals of Monitoring Program

Gain a more complete understanding of the behavior of launched plate girder bridges

Quantify structural performance and verify assumptions made during design

Identify locations of overstress or other damage

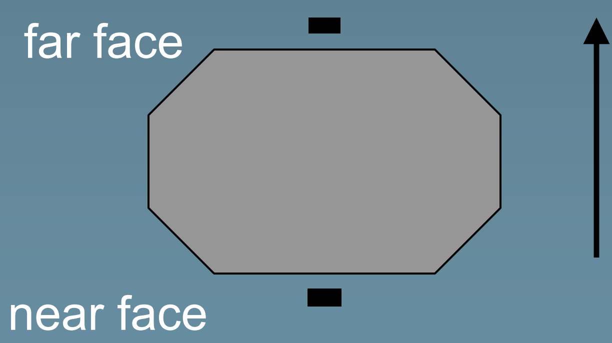
- Immediate repair
- Long-term maintenance concerns

Substructure Monitoring

General pier behavior (drilled shaft and driven pile)

- Column base strain
- Column base translation and tilt
- Cap beam tilt

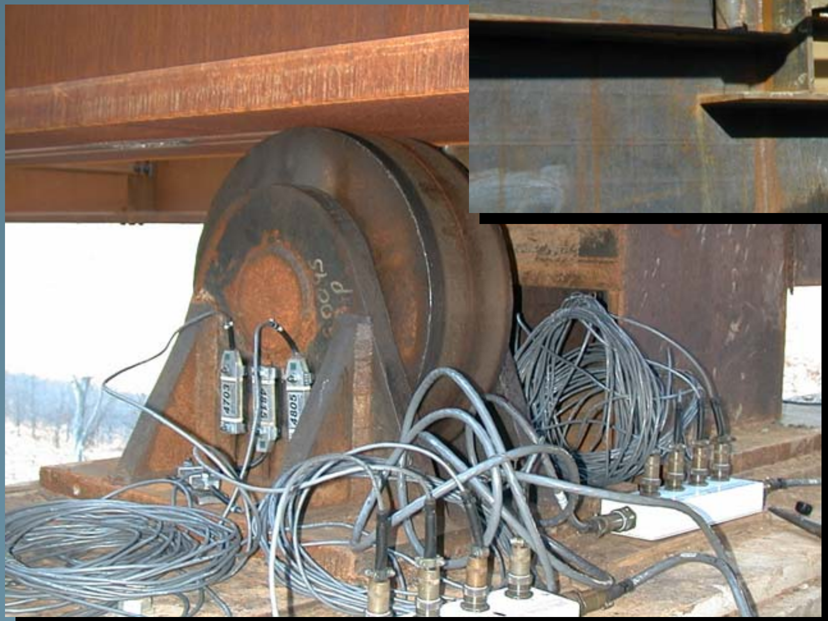
At near and far column faces



Substructure Monitoring

Magnitude of launch induced forces

- At hydraulic jacks
- At pier cap



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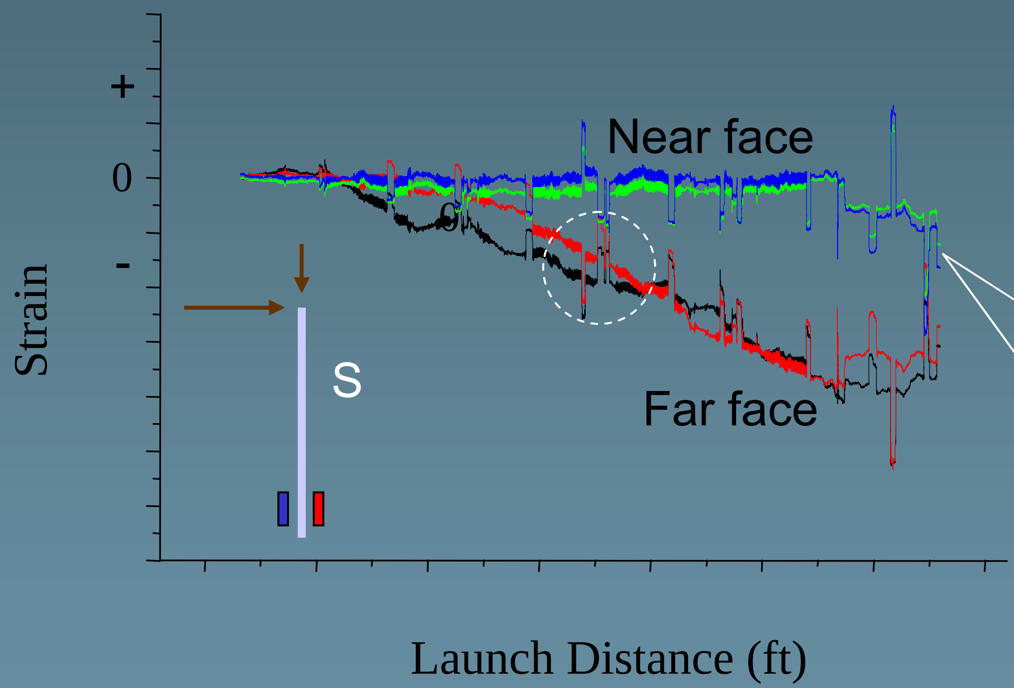
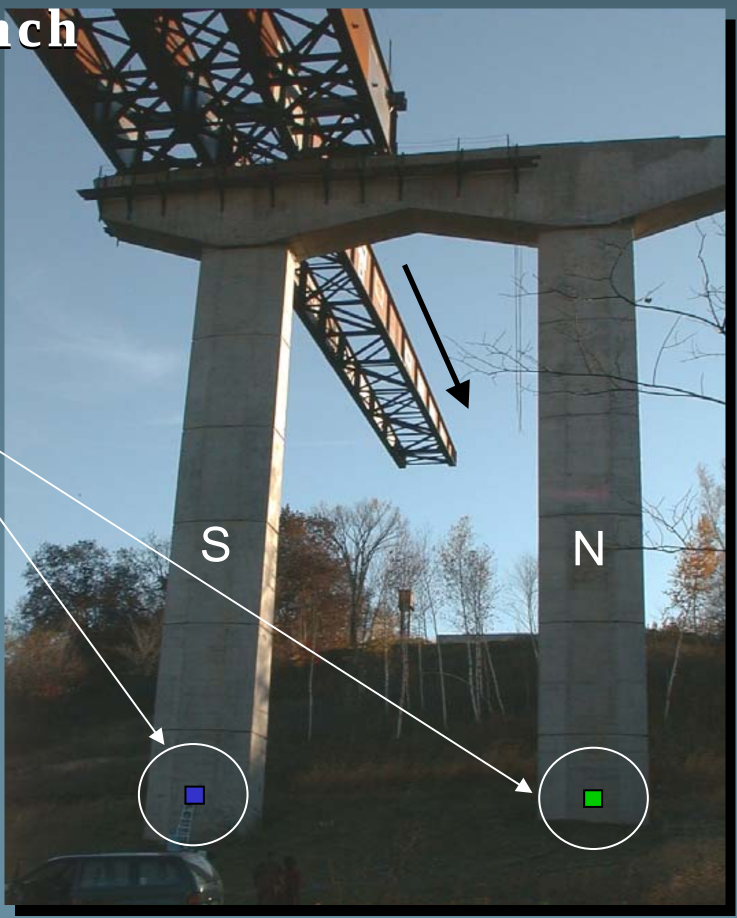
Monitoring Results - Substructure

Largest day launch cumulative column stress measured was 600 psi

Residual stress at end of day launch

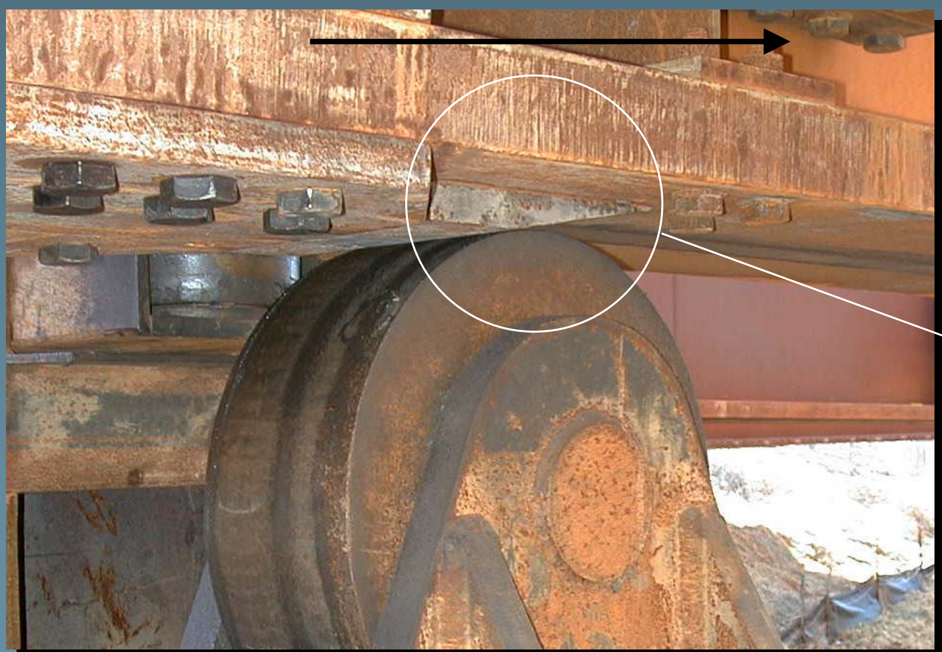


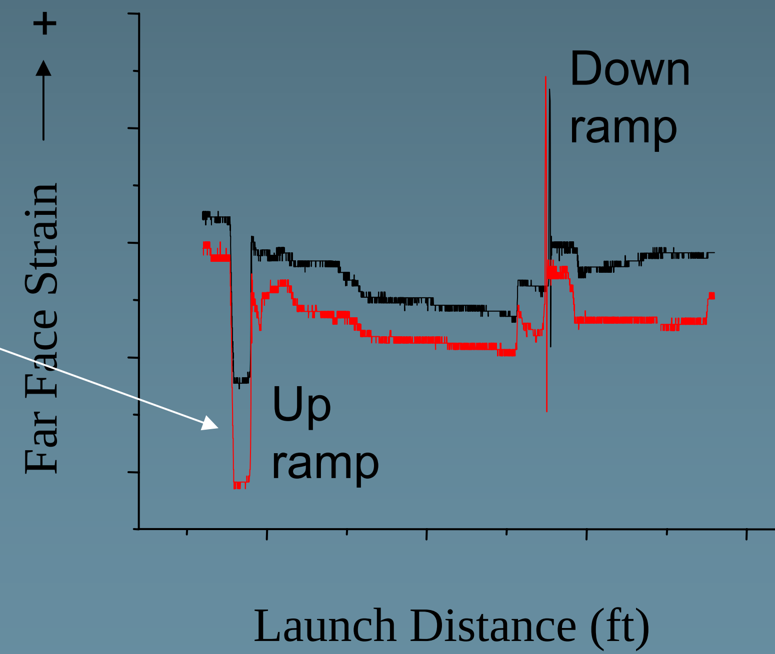


Monitoring Results - Substructure

Max. measured column stresses of approx. 260 psi due to applied launch force “spikes”; similar to calculated values

Pier design controlled by AASHTO loads
-design checks considered ramp crossing loads





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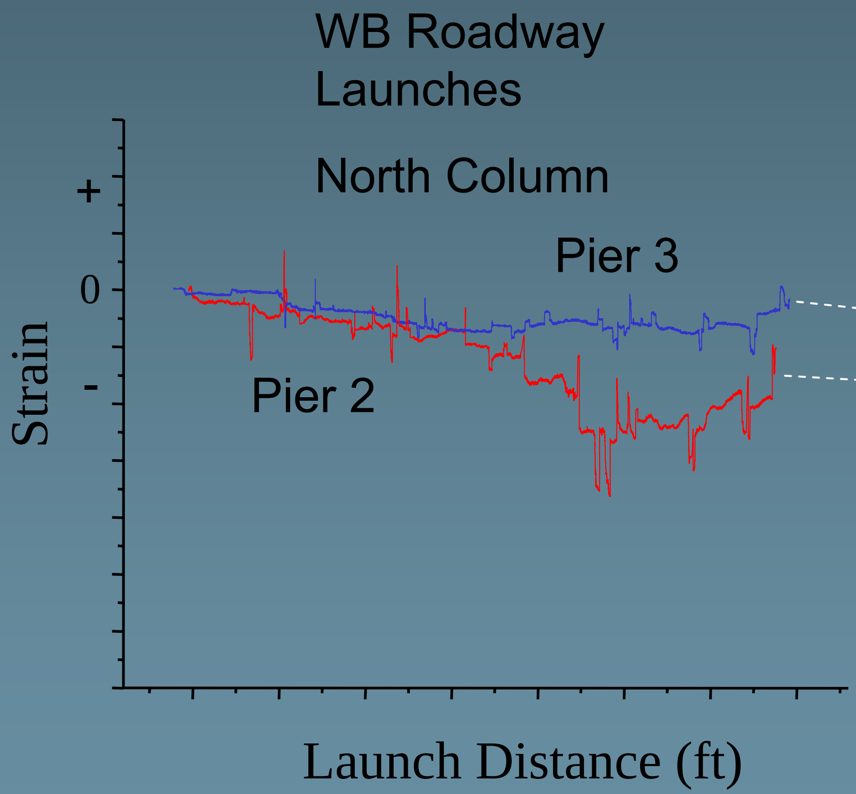
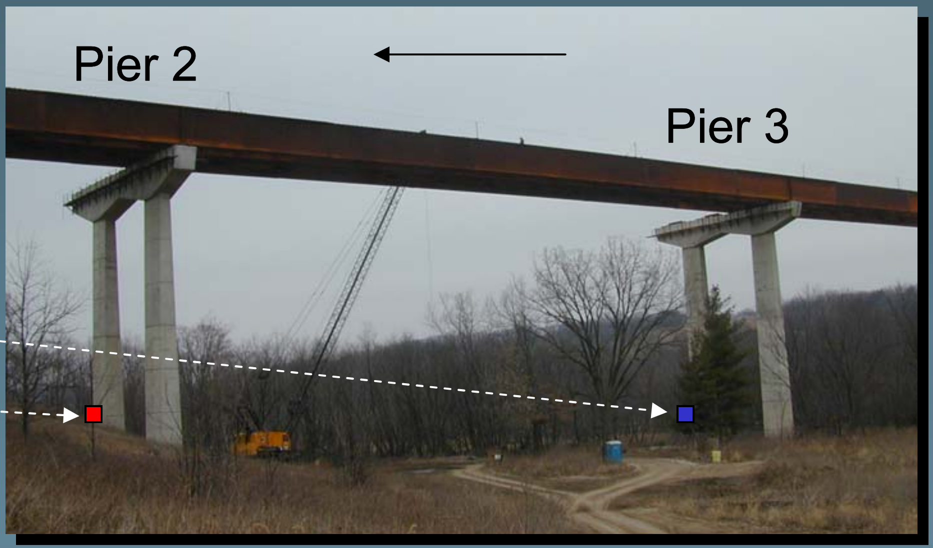
Monitoring Results - Substructure

Drilled shaft foundation more "flexible" than pile group foundation in resisting launch forces





Pile Group Foundation

Drilled Shaft Foundation

Superstructure Monitoring

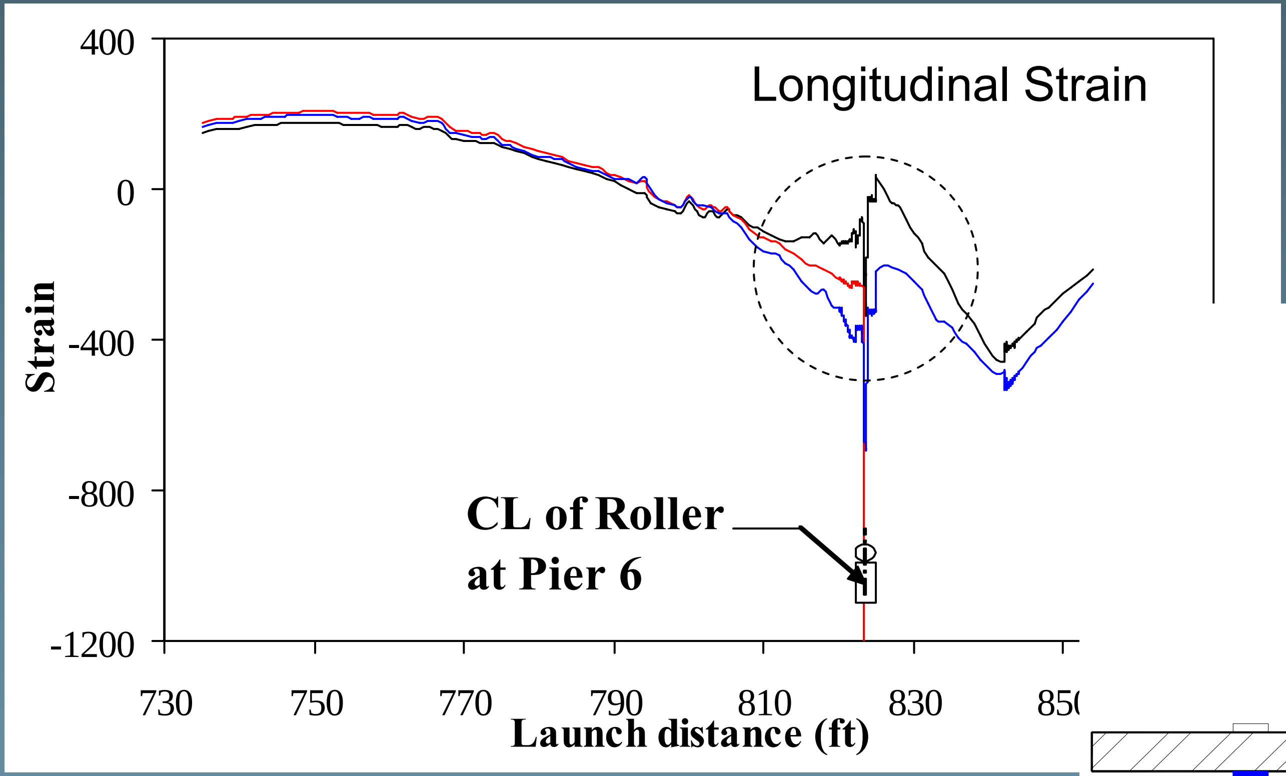
Girder load distribution
- Bending

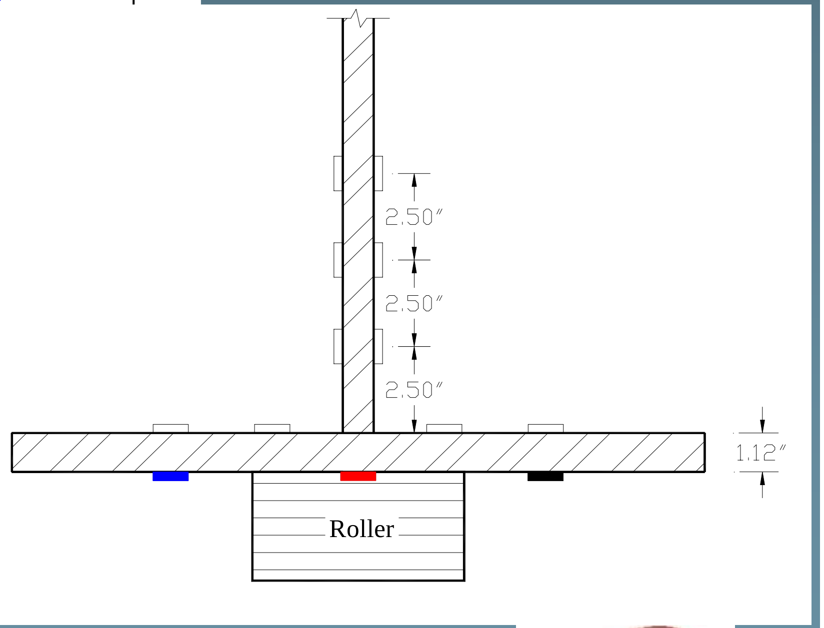
Cross-frame behavior

Roller contact stresses
- Bottom flange
- Web
- Flange to web welds

Monitoring Results - Superstructure

Design bearing for vertical compressive stress
- closed form solution of equivalent line load
- reaction at Pier 6 for Pier 5 touchdown





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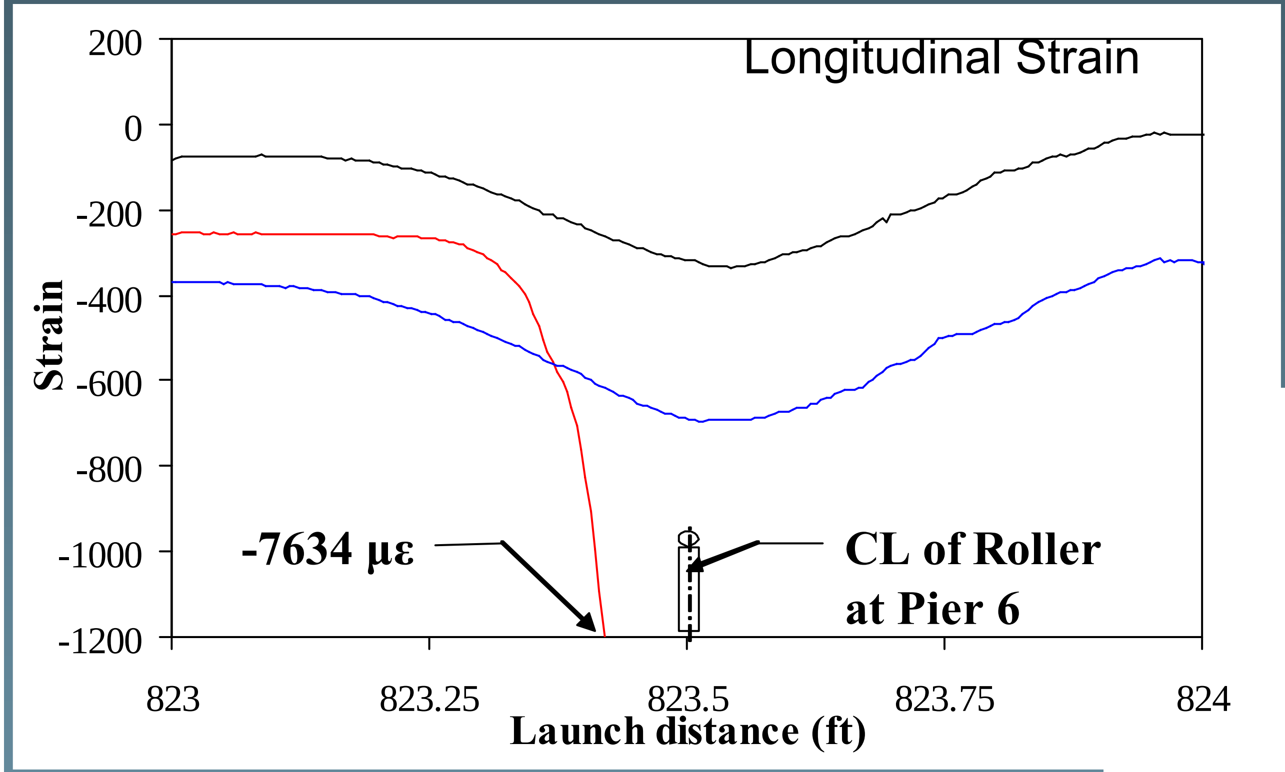
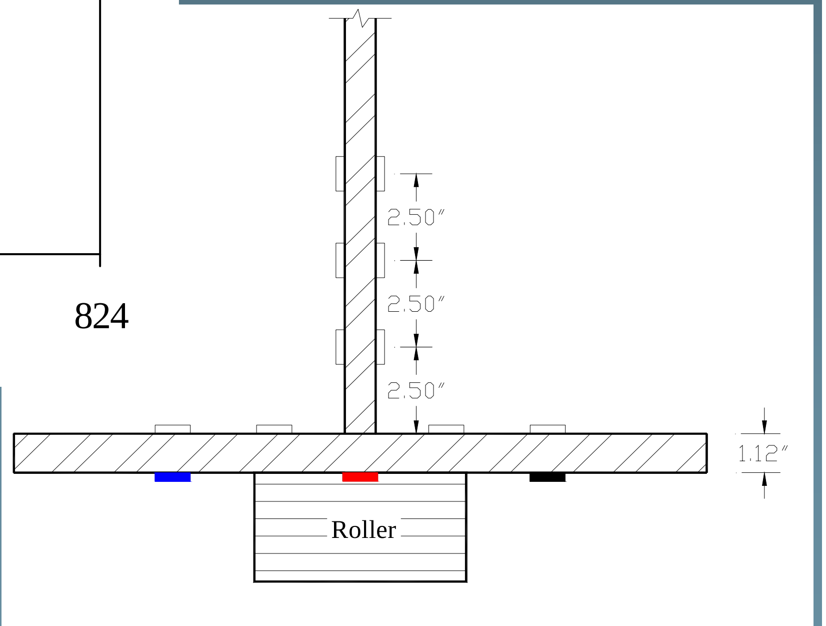
Monitoring Results - Superstructure

Significant longitudinal flange strain measured > F_y





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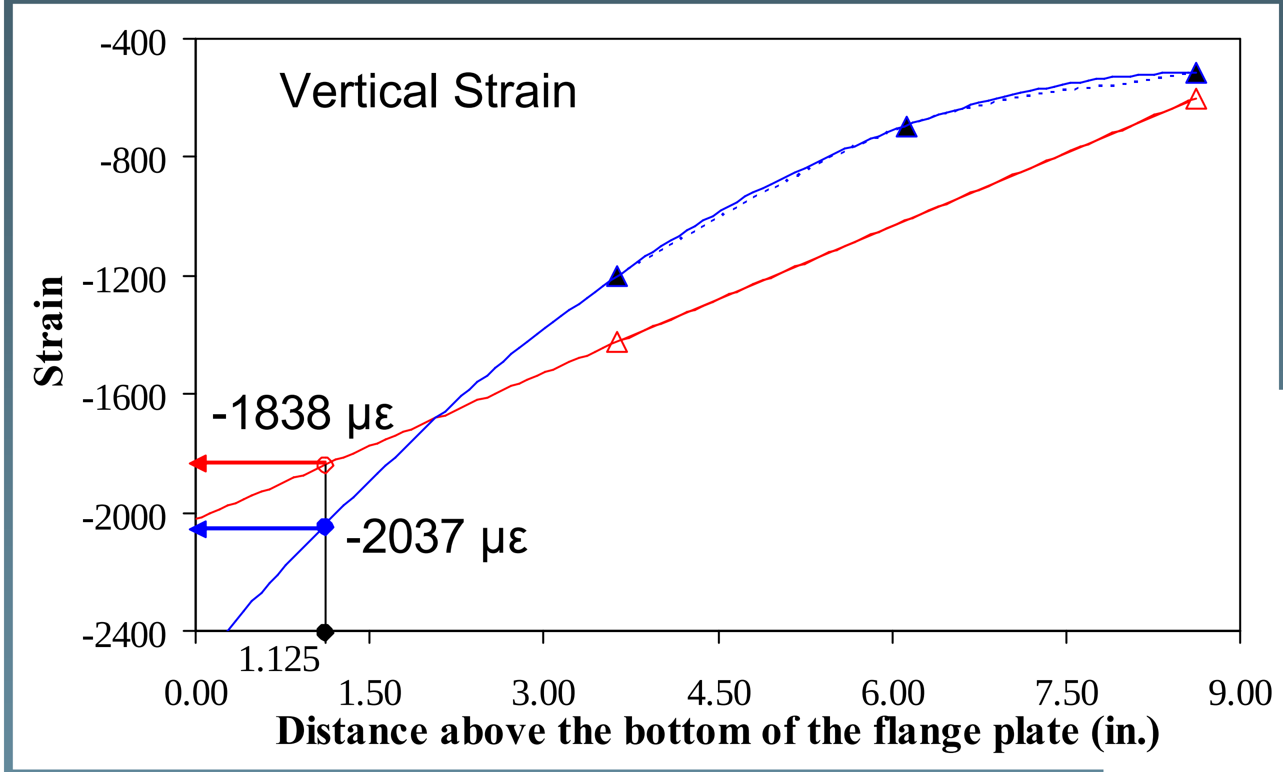
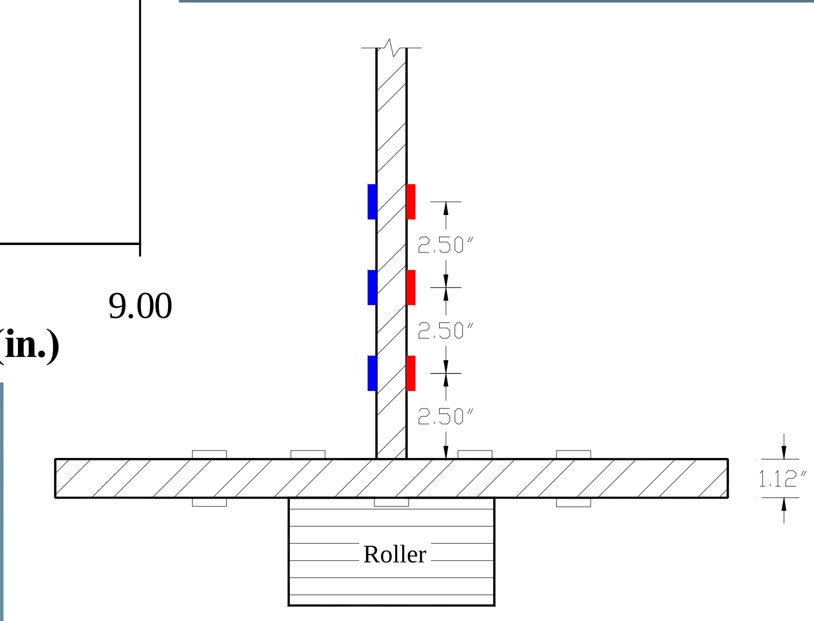
Monitoring Results - Superstructure

Significant vertical strain measured





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Monitoring Results - Superstructure

Cross-frame behavior is complex and sensitive
-axial forces, biaxial bending, and torsion

Measured values exceeded design values

Design assumed AASHTO loads only

Member Type	Design Force	Calculated Force (WB1)	Calculated Force (WB5)
Upper Chord	20 kips C	42.6 kips T	86.2 kips T
Diagonals	38 kips T or C	56.2 kips T	172.1 kips T
Bottom Chord	20 kips T or C	31.1 kips T	39.7 kips C

Action Related to Contact Stress Issue

Post-construction inspection

- Visual and magnetic particle
- No signs of cracking or other damage

High stresses can result in "cold work" region

- Fracture characteristics not impacted

Launch Project Recommendations

Use large contact surface area for launch rollers

Design crossframe members/connections to support the weight of one girder supported only by crossframe

Provide comprehensive monitoring program

- Identify potential problematic issues
- Alert contractor during launch

Launch Project Recommendations

Develop a launching system that is reversible

Use a set of mirrors or other system to monitor the "plumbness" of piers

Use constant width bottom flanges for I-girders

Conclusion

- This project is proof that the incremental launching erection method can be successfully performed on longer span steel I-girder bridges. It is anticipated that this method of construction will become more commonplace in the U.S. as bridge owners recognize its potential benefits. Incremental launching is applicable to either environmentally sensitive areas or locations limited by restricted access.

Acknowledgements

- Jensen Construction
- HNTB