U.S. 20 Iowa River Bridge

2ND National Prefabricated Bridge Elements and Systems Workshop

New Brunswick, New Jersey

September 8-10, 2004
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
Archeological Restrictions

- Indian burial mounds
- Ancient native american campsites
- Headstones
Bridge Details (One Superstructure)

12 000 Roadway

(39’-4”)

3600 3600 3600

(3 @ 11’-10”)

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Bridge Details

Longitudinal Section

18 500 (60’-8’’)

5 Spans @ 92 000
(5 Spans @ 301’-10”)

18 500 (60’-8’’)

Longitudinal Section
Bridge Details (Piers)

- 24 MPa (3500 psi) concrete
- Tapered Columns

Typical Pier

- 26 160
- 85'-10"

19 410 to 32 450
63'-8" to 106'-5"
Geotechnical Analysis & Recommendations
Launching Pit Excavated at East Abutment
Girders Assembled in Launching Pit
Girders Supported Rollers
Ramp Plates Aid Transition at Field Splices
Girders Supported by Rollers
Girders Guided by Horizontal Rollers
Monitor Girder Position During Launching
Jacking System Used for Launching
Jacking System Used for Launching
Launching Nose Accommodates Deflection
Deflection of WB Span 1 During Launch
Launching Nose Landing at Final Pier
Looking East From Beneath Girders at Pier 1
Rollers Removed After Launching Completed
Bearings Inserted and Girders Jacked Down
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

near face

far face
Substructure Monitoring

Magnitude of launch induced forces
- At hydraulic jacks
- At pier cap
Monitoring Results - Substructure

Largest day launch cumulative column stress measured was 600 psi

Residual stress at end of day launch

Strain vs. Launch Distance (ft)

Near face

Far face

S

N

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BRIDGE
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

Monitoring Results - Substructure

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

Longitudinal Strain

CL of Roller at Pier 6

Launch distance (ft)

Strain

-1200
-800
-400
0
400
800
1200
730 750 770 790 810 830 850
**Monitoring Results - Superstructure**

**Significant longitudinal flange strain measured > F_y**

![Graph showing longitudinal strain vs launch distance](image)

- Longitudinal Strain
- CL of Roller at Pier 6
- Significant longitudinal flange strain measured > F_y
- Strain values: -7634 με

**Launch distance (ft)**

- 823
- 823.25
- 823.5
- 823.75
- 824

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**BRIDGE**
Monitoring Results - Superstructure

Significant vertical strain measured

![Graph showing vertical strain measurements](image)

-1838 με
-2037 με

Distance above the bottom of the flange plate (in.):
0.00 1.50 3.00 4.50 6.00 7.50 9.00

Strain:
-2400 -2000 -1600 -1200 -800 -400 0.00 1.50 3.00 4.50 6.00 7.50 9.00
Cross-frame behavior is complex and sensitive - axial forces, biaxial bending, and torsion

Measured values exceeded design values

Design assumed AASHTO loads only

<table>
<thead>
<tr>
<th>Member Type</th>
<th>Design Force</th>
<th>Calculated Force (WB1)</th>
<th>Calculated Force (WB5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Chord</td>
<td>20 kips C</td>
<td>42.6 kips T</td>
<td>86.2 kips T</td>
</tr>
<tr>
<td>Diagonals</td>
<td>38 kips T or C</td>
<td>56.2 kips T</td>
<td>172.1 kips T</td>
</tr>
<tr>
<td>Bottom Chord</td>
<td>20 kips T or C</td>
<td>31.1 kips T</td>
<td>39.7 kips C</td>
</tr>
</tbody>
</table>
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