I-64 Southside Widening and High Rise Bridge Project

Concrete Innovations
Presented by Greg Shafer, PE
Outline

- Project Description
- High Rise Bridge Overview
- Design Criteria
- Foundations and Substructure
- Superstructure
Design Build Project Overview

• Five Proposed and Three Shortlisted

• Best value approach

• Alternative Technical Concepts

• Bid Results
  - Granite-Parsons-Corman $410 million
  - Skanska/Archer Western $455 million
  - LMB Constructors $489 million

• Structures Subconsultants
  - RK&K Design of Great Bridge Blvd Bridge
  - Schnabel Geotechnical Engineering
  - Athavale, Lystad & Assoc. Bridge Load Rating
Project Location

- Bridge Widening over Military Hwy
- Bridge Widening over Yadkin Road/NSRR
- Bridge Widening over Shell Road
- Special Design Wall
- New High Rise Bridge
- Bridge Replacement carrying Great Bridge Boulevard over I-64
High Rise Bridge
High Rise Bridge

- Seven continuous units varying in length from 653 ft to 1176’
- Prestressed concrete bulb-tee girders comprise 90% of the bridge
- Navigation clearance of 125’ horizontal and 100’ vertical
High Rise Bridge
Design Criteria

- VDOT Manual of the Structures and Bridge Division
- Vessel impact
- Corrosion protection
Vessel Impact Criteria
Vessel Impact Criteria

• Characteristics of vessel travel
• Number, location and access to piers
• Flood conditions
• Pier impact analysis
• Superstructure impact analysis
• Maximum impact 2500 kips
• Drifting barge 400 kips
• Fender design
Prescriptive Approach to Corrosion Projection

- Cover
- Concrete mix
- Corrosion resistant reinforcing
  - SS or CFRP prestressing in exposed piling
  - MMFX in exposed pile caps/columns
  - SS reinforcing in decks
- Curing
Designing with CFRP Prestressing

- ACI 440.1R-15
- Carbon Fiber Composite Cable (CFCC) as produced by Tokyo Rope
  - Tensile strength of 338 ksi
  - Rupture at 1.5% strain
  - Stiffness of 22,400 ksi
  - Creep rupture at 85% strength
- Similar ductility limitations with stainless steel prestressing
CFRP Pile Design

- Controlled by FRP rupture limit state
- Controlled by concrete crushing limit state

- Tension-Controlled
- Transition Zone
- Compression-Controlled

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\[ \rho_f \]

\[ \rho_{fb} \]

\[ 1.4 \rho_{fb} \]
Foundations & Substructure

- Pile Bents
- Land Piers
- River Piers
- Special Piers
Pile Bents
Land Piers
Foundation Construction
Column Construction
River Piers

- Cylinder Piles
- SS Reinforcing
- 6.75" walls
VA Pier Cap
Superstructure

- Options considered for mainspan
  - CIP segmental box girder
  - Spliced prestressed girders
  - Structural steel plate girders
Prestressed Girders

- BT-72 with spans to 137 feet (8 girders @ 11’-4” spacing)
- BT-93 with spans to 160 feet (8 girders @ 11’-4” spacing)
- BT-95 with spans to 196 feet (11 girders @ 7’-2½” spacing)
- Stainless steel deck reinforcing
Girder Stability

Recommended Practice for Lateral Stability of Precast, Prestressed Concrete Bridge Girders

Center of Mass of Deformed Girder Arc Lies Directly Beneath Roll Axis

Support Point
Roll Axis
Center of Mass
Roll Axis
Support Point
Deformed Girder
Loads Affecting Girder Stability

Girder Rotation

Wind
Other Critical Conditions

Girder on Transporter

Girder on Bearings
Wind on Girders After Erection

Table 4.2.1-2—Base Drag Coefficient for Bridge Superstructures During Construction

<table>
<thead>
<tr>
<th>Superstructure Type</th>
<th>Base Drag Coefficient ($C_{D,base}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Plate Girders</td>
<td>2.2</td>
</tr>
<tr>
<td>Rolled I-Beams</td>
<td>2.2</td>
</tr>
<tr>
<td>Concrete I-Beams</td>
<td>2.0</td>
</tr>
<tr>
<td>Closed and Open Box-Girders</td>
<td>2.1</td>
</tr>
<tr>
<td>Round Members</td>
<td>1.0</td>
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</tbody>
</table>

Table 4.2.1-1—Wind Speed Reduction Factor During Construction, $R$

<table>
<thead>
<tr>
<th>Superstructure Construction Duration</th>
<th>Wind Speed Reduction Factor during Construction, $R$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 weeks</td>
<td>0.65</td>
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<tr>
<td>6 weeks to 1 year</td>
<td>0.73</td>
</tr>
<tr>
<td>&gt;1-2 years</td>
<td>0.75</td>
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<tr>
<td>&gt;2-3 years</td>
<td>0.77</td>
</tr>
<tr>
<td>&gt;3-7 years</td>
<td>0.84</td>
</tr>
</tbody>
</table>
Wind on Multiple Girders

\[ S/D \leq 3 \]
https://public.earthcam.net/granite-parson-corman#/

Summary and Questions