Tennessee DOT’s Fast Fix 8 Project in Downtown Nashville
Module 6 - Charlotte Avenue Bridges

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Module 6 Overview

- Project Introduction
- Design Selection Matrix / Alternate Selection
- Procurement of Materials / Equipment
- Design Elements
- Construction Execution
- Questions
Fast Fix 8 Project Project Goals

- Minimize inconvenience to the traveling public and maximize safety of workers and the traveling public.
- Facilitate a collaborative partnership with all of the members of the project team and the stakeholders.
- Provide high quality design and construction products.
- Shorten the delivery time and traffic delays by at least two years.
Pre-Construction Activities

• Working Group Meeting with:
  • TDOT Design Management Team
  • Gresham, Smith & Partners Design Team
  • Kiewit Infrastructure CM Group

• Working Group Goals
  • Identify Design / Construction Options
  • ROM Budget Impacts
  • Schedule Impacts

• Project Types Considered
  • Structural Steel Superstructure Units
  • Full Depth Deck Panels
  • Lateral Bridge Slide
  • SPMT Bridge Move
  • Bridge Reconfiguration
Pre-Construction Activities

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- **Project Types Considered**
  - Structural Steel Superstructure Units
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  - Bridge Reconfiguration
Pre-Construction Activities

- Project Types Considered
  - Structural Steel Superstructure Units
  - Full Depth Deck Panels on Existing Beams *(Eliminated due to WF Beam Issues)*
  - Lateral Bridge Slide *(Eliminated due to ROW limitations)*
  - SPMT Bridge Move
  - Bridge Reconfiguration

- Evaluation Criteria
  - Primary Construction Costs
  - Temporary Construction Costs
  - Procurement Schedule
  - Construction Schedule
  - Substructure / Geotechnical Issues
  - Impact on Existing Alignment / Profile
# Pre-Construction Activities

## Charlotte - Existing 3 Span Bridge - Steel K-Frame

<table>
<thead>
<tr>
<th>Option</th>
<th>Type</th>
<th>Type</th>
<th>Constr</th>
<th>Temp</th>
<th>$ Million</th>
<th>Cost</th>
<th>Schedule</th>
<th>Sch Combined</th>
<th>Rank</th>
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<th>Construction</th>
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<tbody>
<tr>
<td>1</td>
<td>PC</td>
<td>Full Depth Precast Deck</td>
<td></td>
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<td>2</td>
<td>PC</td>
<td>SPMT for Single Span with MSE end spans</td>
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<tr>
<td>3</td>
<td>PC</td>
<td>3-Span Precast Girder/Full Depth Panel</td>
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<td>4</td>
<td>Stl</td>
<td>Fast 14 Single Span with MSE end spans</td>
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### Legend

<table>
<thead>
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<th>(+)</th>
<th>Most desirable</th>
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<tbody>
<tr>
<td>✓</td>
<td>Acceptable</td>
</tr>
<tr>
<td>(-)</td>
<td>Least desirable</td>
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</table>

Lowest value for "Total Ranking" score is the preferred alternative
Charlotte Bridge Details

- **Selected Option** –
  - Construct New Abutments Between “K-Frame” and Existing Abutment
  - Eliminate End Spans 1 & 3
  - Use Steel Superstructure Units to Replace Existing Bridge
  - Use MSE walls to Contain New Roadway Fill

- **Superstructure Unit Considerations**
  - Longest (132’ - 7½”) and Widest (15’ – 6”) Units Utilized
  - Long Span / Slender Beams and Heaviest Pick Weights ~ 300,000 Lbs.
  - Units Needed to park on existing Bridge (Verify Gross Capacity)

- **Substructure Considerations**
  - Work Around Existing Thrust Blocks
  - Clearance with Existing K-Frames
  - Thermal Considerations
Charlotte Bridge Details

- Superstructure Unit Considerations

Framing for the bridge was simplified to aid in fabrication and to control deflections.

The bridge is located in a curve, is super-elevated and has tapers on both sides for on/off ramps.
Charlotte Bridge Details

- Superstructure Unit Considerations

Framing for the bridge was simplified to aid in fabrication and to control deflections.

The bridge is located in a curve, is super-elevated and has tapers on both sides for on/off ramps.

Diaphragms were placed parallel to the bridge skew and no unique details were required.
Charlotte Bridge Details

- Superstructure Unit Considerations

Framing for the bridge was simplified to aid in fabrication and to control deflections.

Building the units with uniform dimensions helped with setting the beam camber.

The contractor was able to place the reinforcing for the barrier and median rails in the units which eliminated the need for post weekend median and cantilever pours.
Charlotte Avenue Highlights

Temporary Soil Nail Wall to provide safe work zone for substructure construction.

Excavation Adjacent to Thrust Blocks to Solid Bedrock. Rock was percussion tested to verify rock quality.
Leveling Concrete was placed in the excavated area. The excavation limits were set to direct the abutment loading to the bedrock.

Isolated Footings were keyed into the leveling concrete and constructed conventionally. Round columns were then constructed to the required bottom of cap elevation.
Charlotte Avenue Highlights

MSE walls were utilized to contain the fill for the eliminated end spans. Strip footing for the MSE modular block wall were cast.

The MSE wall was built between the K-Frame and new abutment supports.
Design tolerances were tight between the existing structure and the abutment cap. The gap between some existing beams and the new bent cap is as close as 1”.

With the wall and backfill placed to the top of column, cap construction was much simpler and safer.
Charlotte Avenue Highlights
Charlotte Avenue Highlights

The “Bridge Farm” was a two acre laydown yard located in the median of I-40 within the weekend closure limits of the project. This location permitted the construction of wide units without transporting concerns.

All cross-frames were installed and block-outs were formed for the closure pour joints. The deck was cast full width with a standard screed.
Plywood block-outs (12” wide) were used to create the void for the closure pours between the units. The block-outs were constructed flush with the top of deck to allow the screed to pass over the top.

Supplemental deck reinforcing was used around the pick device block-outs.

Heavy WT sections were bolted to the top flanges and utilized as the lifting devices.

Metal deck panels were used between all bays of the bridge. Styrofoam was used to fill the flutes of the forms to lessen the pick weight of the units.
Since metal decking was also used in the bays between units, the contractor cut the panels from the bottom at the block-out locations after the deck was cast to allow the units to be separated. The panels acted as the form for the closure pour.

After the units were transported and installed, simple metal window screen was placed over the saw cut gap in the closure pour strips to prevent the cement paste from leaking through the gap. This was easily installed from the top of the unit.
Charlotte Avenue Highlights

Deck was demolished with impact hammers and shears from the top of the bridge deck.

The contractor was able to sell some of the frame members to an entity that was going to repurpose them for a pavilion. Other members were removed from the ground and processed into manageable sized pieces and recycled.
Charlotte Avenue Highlights

- Metal decking in-place for closure pour form
- Diaphragms attached to bridge to speed up installation.
- Bearings vulcanized to steel sole plates sized for needed cross slope adjustment.
Charlotte Avenue Highlights

For the first weekend of construction for the Charlotte bridge, the superstructure units needed to cross onto the remaining portion of the existing bridge. Special spreader beams were required on the SPMT’s to distribute the unit gross weight such that the existing bridge would not be overloaded.
Charlotte Avenue Highlights

Since the units were match-cast, the rebar and cross-frames join together without conflict allowing for quick placement of the five units per weekend.
Closure pour reinforcing includes overlapping bars and longitudinal lacing bars to provide a robust mechanical joint. The edges of the slab at the closure pours were chemically roughened to enhance the material bond strength.

The screen placed over the cut line in the forms was easily placed from the top of the unit.
Charlotte Avenue Highlights

The original design had the end walls cast into the superstructure units. These were redesigned to separate Precast pieces to lessen the lift and transport weights of the units – saving some 45,000 pounds per unit.
The endwall blocks were pinned to the abutment beam through holes that were cast into the endwall blocks and the abutment cap.

The projecting bars from the endwall intersected with projecting bars from the superstructure unit providing a strong mechanical connection with the closure pour.

Additionally, the beam bearings were connected to the abutment beam with anchor bolts.
Since the abutments were newly constructed, the precast endwall blocks were able to be cast flat on the bottom and the cross-slope was set on top.
Charlotte Avenue Highlights

The end wall blocks are pinned to the abutment cap and the approach slabs will be pinned to the end walls. A closure pour ties the superstructure unit to the end wall units.
Charlotte Avenue Highlights

Two feet of reinforced backfill (GRS) was placed under the approach slab zone in lieu of using a concrete sleeper slab. Once the fill was in-place and compacted, the precast slab sections were installed and joined together using the same detail used between the superstructure units.

The GRS extended 5 feet beyond the approach slab to limit settlement between the rigid slab and the flexible asphalt approach.
Charlotte Avenue Highlights

Closure pour connecting the end blocks with the deck units and precast approach slabs.
Charlotte Avenue Highlights
NCHRP 10-71 Cast In Place Connections For Precast Deck Systems

One of the outcomes of the project was a new concrete mix (TDOT Class X) that meets the requirement for project performance requirements with the bonus of being batched from a plant, delivered by truck and reaching 4000 psi in 4 hours with exceptional shrinkage and bond strength characteristics.

<table>
<thead>
<tr>
<th>PERFORMANCE CHARACTERISTIC</th>
<th>TEST METHOD</th>
<th>PERFORMANCE CRITERIA</th>
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</thead>
<tbody>
<tr>
<td>COMPRESSIVE STRENGTH (CS) KSI</td>
<td>ASTM C39 (MODIFIED)</td>
<td>6.0 ≤ CS @ 8 HOURS (OVERNIGHT CURE)</td>
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<tr>
<td>SHRINKAGE (S) (CRACK AGE, DAYS)</td>
<td>AASHTO PP34 (MODIFIED)</td>
<td>20 &lt; S</td>
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<tr>
<td>BOND STRENGTH (BS), PSI</td>
<td>ASTM C882 (MODIFIED)</td>
<td>300 &lt; BS</td>
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<tr>
<td>CHLORIDE PENETRATION (ChP) (DEPTH FOR PERCENT CHLORIDE OF 0.2% BY MASS OF CEMENT AFTER 90 DAY PONDING), (IN)</td>
<td>ASTM C1543 (MODIFIED)</td>
<td>ChP ≤ 1.5</td>
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<tr>
<td>FREEZING AND THAWING DURABILITY (F/T), (RELATIVE MODULUS AFTER 300 CYCLES)</td>
<td>ASTM C666 PROCEDURE A (MODIFIED)</td>
<td>GRADE 1 70% ≤ F/T</td>
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</table>
Charlotte Avenue Highlights

NCHRP Synthesis 333 suggest membranes have a longer live if applied right after construction.

First use of spray applied membrane by TDOT.

The product is applied in three layers with a total thickness of 120 mils.
Lessons Learned

- Early Coordination and Community Outreach
- Communication between owner, designer, and contractor is imperative all of the way through the project.
- Set the maximum allowable construction and traffic lane closure times at the beginning of the project planning and stick to it.
- Work operations were improved from weekend to weekend by observations and time studies.
- Keep the door of innovation open during the planning and design phases.
Fast-Fix 8 Questions

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The America’s Transportation Awards competition is presented by the American Association of State Highway and Transportation Officials (AASHTO), and co-sponsored by the AAA motor club and the U.S. Chamber of Commerce. It recognizes projects completed by state transportation departments that improve travel safety, reduce roadway congestion and provide more travel options to consumers. These projects are entered under three categories: Quality of Life/Community Development, Best Use of Innovation and Under Budget and grouped into three sizes: small for projects costing less than $25 million, medium for those between $26 million and $199 million and large for those costing $200 million or more.
Fast-Fix 8 Questions

Confirm Your Selection
You can vote one time per Project per 24 hours.

Project
Fast Fix 8

Category
Southern Assoc. of State Highway and Transportation Officials > Best Use of Innovation - Southern > Medium Project

[Buttons] Cancel And Go Back  Confirm Vote
Fast-Fix 8 Questions