Commonwealth Avenue Bridge Project
& the Use of Longitudinal Full-Depth Precast Concrete Deck Panels

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Two Projects

- Project 1: Substructure Rehabilitation
  - Advanced work to facilitate ABC
  - Conventional construction behind barriers
  - Design-Bid-Build Project

- Project 2: Superstructure Replacement
  - Design-Build Project
  - ABC

Substructure Rehabilitation Project Team
- CME – Lead Designer - Structural Design
- VHB – Traffic and Highway Design
- Nobis – Geotechnical Design

Superstructure Replacement Project Team

Preliminary Design Team:
- CME – Structural Design
- VHB – Traffic and Highway Design
- Gannett Fleming – Catenary and Overhead Contact Systems (OCS) Design
- Nobis – Geotechnical Design

Design Build Team:
- Walsh Construction - Construction Lead
- HDR – Lead Designer

Fabricator:
- Oldcastle Precast, Inc.
Multi-Phase Project Approach

Project Timeline

- **March 2012**: Feasibility study
  - **2012**: CME performs feasibility study

- **April 2014**: Substructure NTP
  - **2014**: Substructure is completed

- **June 2015**: Superstructure NTP
  - **2015**: Superstructure is completed

- **June 2016**: Substructure Completed
  - **2016**: Shutdown 1 EB/GL Completed

- **August 2017**: Shutdown 1 EB/GL Completed
  - **2017**: Shutdown 2 WB Completed

- **December 2018**: Superstructure Complete
  - **2018**: Utilities moved

- **August 2018**: Shutdown 2 WB Completed
  - **2019**: Project 2 complete
Project Site

BRIDGE NO. B-16-055
Project Site

STAGING YARD

BRIDGE NO. B-16-055

World Champs!
Project Site
115kv fluid filled power lines
36” Diameter gas line
Bridge Information

Three span, 370’ total length
• Span 1 – 90’ over Commuter Railroad
• Span 2 – 160’ over I-90 EB
• Span 3 – 120’ over I-90 WB

162’ out-to-out width
• Longitudinal joints between Comm Ave EB, Greenline, and Comm Ave WB superstructures

Bridge skew
• 60+ degrees

Bridge area = 64,000 sq. ft. (~1.47 acres)
• For reference, one football field is 1.32 acres!
Average Daily Traffic:
• Route I-90 (Mass Pike): 120,000
• Commonwealth Avenue: 28,000
• High volume of pedestrian traffic at Intersection including BU students

Railroad ridership (2014 MBTA numbers):
• Commuter Railroad: 16,000 daily inbound/outbound
• Greenline “B” branch within bus detour: 11,400 daily station entries
Project 1 – Substructure Rehabilitation

- Design-Bid-Build Project to replace two pier stems and repair abutments
- To minimize impact to traveling public, Comm Ave and Greenline remained open and I-90 was reduced to 3 lanes each direction
- 400'+ long pier stems were demolished and reconstructed in ~20’ sections with existing girders on shoring posts
- Existing pier footings were reused (structurally adequate)
- Reused existing masonry abutment (originally from 1880s)
Support of Existing Girders

• Severe skew actually facilitated the work
• Girder spacing along the skew meant that spacing of posts was reasonable
• Enabled concrete removal and placement between widely spaced posts
• Construction took 2 years (800’+ of Pier)
Project 1 – Substructure Rehabilitation
Project 2 – Superstructure Replacement

• Design-Build Project
• Replacement of all beams and deck
• Majority of on-site construction was performed during two Short Duration Shutdowns:
  • **2017**: 18-day Short Duration Shutdown – Replace Greenline and Eastbound Commonwealth Avenue
  • **2018**: 16-day Short Duration Shutdown – Replace Westbound Commonwealth Avenue
  • Shutdowns occurred in late July / early August, work was completed before move-in weekend to accommodate BU students
• Utility relocations occurred in between the shutdown windows
Staging of Short Duration Shutdowns
General Approach

Use ABC to minimize impacts to all travelers

- Interstate 90
- Commuter Railroad
- Commonwealth Avenue
- Busses
- Green Line light rail (electrified)
- Pedestrians and bicycles

Conventional staged construction estimated to be 5 years
ABC Approach

Several options were studied

• Bridge Systems
  • SPMT: No reasonable staging area
  • Lateral slide: Construction over traffic

• Modular Deck Beams
  • Spans were too long, weights were too high for reasonable cranes
  • Considered squaring beams to substructure (utilities prevented this)

• Metalized conventional steel framing with a precast deck
  • Feasible
  • Used for Base Technical Concept development
General Traffic Management Approach

Interstate 90
- Maintain 2 lanes in each direction during peak periods
- Use cross overs to give contractor access to entire spans

Railroad
- Short duration closure during demolition
- Reduced speed work zone during rest of shutdown

Commonwealth Avenue
- Maintain 2 Lanes and sidewalks during shutdown
- Busses, Bicycles, Pedestrians, Emergency Vehicles

Green Line
- Full closure during shutdown
- Use busses instead

**Extensive Public Outreach effort was undertaken to reduce volumes.**
Typical I-90 Crossover
Utility Management Approach

11 bays carry utilities, including gas, water, and various electrical and communications lines:

- Utilities located mostly under WB side of bridge
- Build new EB structure during first shutdown
- In the year between shutdowns, relocate utilities to newly constructed EB bays
- Two (115kV) fluid-filled electric lines had to remain in service at all times
- Temporary supports were used
Protection of railroad during demolition

- Masonry Abutment Re-used
- Looking South
- New Piers
- Timber Crane Mats

Looking North
Construction Considerations

Construction over railroad:

• Train reduced speed in work zone

• Flagger would signal brief stoppage of work while train within work zone limits
Structural Considerations

Precast concrete full-depth deck panels:

• **2017**: 235 panels erected
• **2018**: 214 panels erected
Timeline Photos

Commonwealth Avenue Westbound Construction

Day 1- Day 16

Photo Credits to Boston University
Day 3: Spans 1 & 2 Steel Removal
Day 4: Span 1 Steel, Span 2 Steel Removal
Day 7: Span 1 & 2 Deck, Span 3 Demolition
Day 10: Span 2 Deck Finishing, Span 3 Steel Erection
Day 11: Span 2 Deck Finishing, Span 3 Deck Erection
Day 13: Deck Finishing and Sidewalks
Before and After Photos
Longitudinal Deck Panels

- To date most deck panels have been detailed as transverse to the supporting girders
- Causes issues:
  - Difficult to detail for skewed bridges
  - Difficulties with fitting shear connectors
  - One option – larger pockets
  - Some wish to eliminate PT
  - UHPC gaining popularity
• Previous use of longitudinal deck panels
• Similar details developed by several agencies
  • Tennessee DOT
  • NY State DOT
  • Utah DOT
Longitudinal Deck Panel - Concept

- Run panels parallel and between girders
  - Similar to partial-depth panels, but full thickness
- Use reinforced concrete connections
  - Normal concrete, high early strength concrete, and UHPC
- **Use girder flanges as closure joint form (eliminate pockets)**
  - Shear connectors can be placed where needed (no pockets)
  - Transverse closure joints located approx. 30 feet on center
  - Spray applied membrane with asphalt overlay used for this project
- Profiles can be accommodated with grinding or overlay
- Links slabs can be used for multi-span bridges
  - Works for continuous spans as well

Used for Comm. Ave.
• Great for high skews: Transverse joints can be virtually anywhere
• Repetition: Leads to reduced fabrication costs
• Length of panels can be adjusted to accommodate crane capacities
Longitudinal Deck Panels

Overhang Panels

Ease of Shear Stud Placement
Longitudinal Deck Panels

- MassDOT Standardization
  - To be added to the MassDOT Bridge Manual
Longitudinal Deck Panels

• Standardization

Simple forms that can be attached to the underside of panel

Draft Details
• Leveling Devices
  • Commonwealth Ave. had wide flanges
  • Details being developed for narrow flanges
  • Strongbacks
  • Cantilever leveling devices
  • Contractor design and option
Lessons Learned and Conclusions

• There were minor issues during construction
  • Forming method of beam haunches led to issues with shear connectors in the overhang blockouts
  • Specialized materials for setting flush rail on the deck
• The longitudinal panels were a great success
• Cost
  • $95 Million
  • Boston is pricey
  • The speed and complexity contributed to the cost
• Both phases were completed on time
• Public perception was very positive
Thank You

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