ABC Center Webinar

Accelerated Bridge Construction
Integral Abutments

September 18, 2013

Presenters:
Wayne B. Symonds P.E.
VTrans Structures Design Engineer
Bill Lammer
Accelerated Bridge Program Lead Designer
Presentation Outline

• Integral Abutment (IA) Use in Vermont
• Accelerating IA Bridge Construction
• VTrans simplified IA approach
• Recent Example Projects
• Current IA Details for Example Projects
• End of Bridge Details
• Lessons Learned
• Questions
Integral Abutments in Vermont

- VTrans began using integral abutments in 1998
- VTrans Integral Abutment Guidelines created in 2001 – Most recent 2008
  - “Integral abutment construction shall be considered as a first option for all slab and slab on stringer bridges.”
  - Allows for Simplified Design or complex bridges
- Cast-in-Place details are refined and standardized
- 15 years of successful projects integral abutment projects using conventional methods.
Integral Abutments in Vermont

- Eliminate joints and bearings
- Easier to permit for in-stream work than conventional.
- Contractors like IA Bridges
- Proven to be resilient type of Construction
- Tropical Storm Irene tested
Integral Abutment Resiliency
Tropical Storm Irene Damage
Integral Abutment Resiliency
Tropical Storm Irene Damage
VTrans Accelerated Bridge Program (ABP)

- VTrans created the ABP in 2012
- Key objective is to make ABC the future of bridge construction in Vermont.
- Feature use of PBES
- ABP Performance Goals:
  - Minimum 25% of all new bridge projects will be designated into the Accelerated Bridge Program.
  - Minimum 30% of all new bridge projects will include Prefabricated Elements and Bridge Systems standard elements.
Integral Abutments are still first choice
Need to accelerate IA bridge construction
Maximize the use of details and approaches that have been successful for conventional construction
Adopt new standard details that facilitate ABC
Identify new materials needed to support ABC
Develop new specifications to support ABC
VTrans needed to deliver projects immediately
Accelerating IA Construction

• Year 1 of ABP:
  – Span lengths 60’ – 80’
  – NEXT-D Prestressed Beams

• Years 2-3 of ABP:
  – Span lengths 75’ – 110’
  – Precast Deck on Steel Beams (PBUs)
  – Prestressed Deck Bulb Girders

• Year 4 of ABP:
  – Multi-span
  – precast deck panels on girders.
Accelerated IA Bridge Design

• All new details would be designed by VTrans
• Design is Similar to Conventional
  – AASHTO LRFD
  – Use VTrans Integral Abutment Manual – Simplified Approach
• All of the details need to be evaluated for constructability during design
• Need to Develop/Standardize the details as we design projects
IA Simplified Design Method

•Outlined in VTrans Integral Abutment Guidelines
  – http://vtransengineering.vermont.gov/sections/structures
  – Design Example is included

•Requirements for using Simplified Method
  – Maximum skew 20 degrees
  – Straight beams/girders
  – H piles oriented for weak axis bending
  – Parallel abutments
  – Max abutment height 13’
  – Max wingwall length is 10’
  – Minimum pile embedment is 16’
IA Abutment Details

• Need to Develop/Standardize the details as we design projects
• Many successful details have been developed
  – SHRP 2 R04 ABC Toolbox
  – PCINE
• Avoided use of proprietary products
• Listen to input of local precasters and contractors.
• When ever possible keep it simple
Brighton ER STP 034-3(25)

- NEXT-D beam w/ 70’ span
- Precast integral abutment on steel H piles
- Precast Approach Slabs
- Maintenance of Traffic via offsite detour (Closure)
- Bids opened 10/12
  - $906,252 (30% under Estimate of $1,289,102)
- Final Inspection 9/13
  - 11 months in design
  - $77,750.00 in Preliminary Engineering
    (30% less than Hancock)
Brighton Existing Bridge:
- Constricted river channel
- Fairly shallow foundation

Brighton Bridge After TS Irene

Temporary bridge installed
Framing Plan

**Deck Plan**
- Scale 1" = 1'-0".

**Bridge Typical Section**
- Scale 1" = 1'-0".

**Legend**
- Special Provision (Bituminous Concrete Pavement, Small Quantity)
- RPC = Special Provision (High Performance Concrete, Rapid Set)
- Groting Shear Keys

**Project Details**
- Project Name: BRIGHTON
- File Name: ER STP 034-325
- Plot Date: 0-06-002
- Designed by: W. LAMMER
- Checked by: W. LAMMER
- Framing Plan
- Sheet 15 of 16
Precast Abutment complete

Bars for Wingwall Attachment
Precast Wingwall Details

PCU 2 ELEVATIONS

<table>
<thead>
<tr>
<th>WW1</th>
<th>WW2</th>
<th>WW3</th>
<th>WW4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEV &quot;A&quot;</td>
<td>1176.25</td>
<td>1176.25</td>
<td>1174.75</td>
</tr>
<tr>
<td>ELEV &quot;B&quot;</td>
<td>1176.25</td>
<td>1176.25</td>
<td>1174.75</td>
</tr>
<tr>
<td>ELEV &quot;C&quot;</td>
<td>1165.78</td>
<td>1165.78</td>
<td>1165.33</td>
</tr>
<tr>
<td>DIST &quot;X&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
<td>10'-0&quot;</td>
</tr>
</tbody>
</table>

PCU 2 PLAN

Scale 1" = 1'-0"

PCU 2 ELEVATION

Scale 1/8" = 1'-0"

PCU 2 TYPICAL

Scale 1/8" = 1'-0"

NOTES:
1. EPOXY SHALL BE INCIDENTAL TO THE PRECAST CONCRETE STRUCTURE.
Precast Wingwall Details
Precast Wingwall Mechanical Connectors
Precast Wingwall Connection
NEXT D Beam is being utilized due to its shallower depth.

Shallower depth beam works against developing negative moment reinforcing, as well as reinforcing up from pile cap.

Negative moment reinforcing extends from deck, bending 90° down. This may cause issues in casting beds and with shipping.
Closure Pour Details

DECK CLOSURE POUR
REINFORCING PLAN
SCALE 1/8" = 1'-0"

DECK CLOSURE POUR
REINFORCING ELEVATION
SCALE 1/8" = 1'-0"

NOTE:
NF = NEAR FACE
FF = FAR FACE
ET = EACH FACE
△ = CUT TO FIT IN FIELD
3" CLEAR, UNLESS OTHERWISE SPECIFIED ON THE PLANS.
2"-2" BAR LAP UNLESS OTHERWISE SPECIFIED ON THE PLANS.

PROJECT NAME: BRIGHTON
PROJECT NUMBER: ER STP 034-3(25)
FILE NAME: ClosurePour
PROJECT LEADER: K. HEDING
DRAWN BY: A. SALVATON
DESIGNED BY: K. LAMANN
CHECKED BY: K. LAMANN
DECK CLOSURE POUR DETAILS
SHEET 21 OF 36
Reinforcing Typical
End Closure Reinforcing
**Approach Slab Details**

**Approach Slab Plan View**

- Scale 1/8" = 1'-0"
- Alternate lifting points may be submitted with calculations for new locations.

**Approach Slab Elevations**

**Section A-A**

**Approach Slab Elevations**

All elevations are top of slab.

<table>
<thead>
<tr>
<th>Station</th>
<th>15'-0&quot; Left</th>
<th>15'-0&quot; Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begin 1</td>
<td>55+42.67</td>
<td>1174.81</td>
</tr>
<tr>
<td>End 1</td>
<td>55+48.67</td>
<td>1174.71</td>
</tr>
<tr>
<td>Begin 2</td>
<td>56+21.33</td>
<td>1174.26</td>
</tr>
<tr>
<td>End 2</td>
<td>56+41.33</td>
<td>1174.11</td>
</tr>
</tbody>
</table>

**Approach Slab Details**

- Note:
  - NF = Near Face
  - FF = Far Face
  - EF = Each Face
  - ▲  = Cut to fit in field
  - 3" clear, unless otherwise specified on the plans.
  - 2"-2" bar lap unless otherwise specified on the plans.
Approach Slab
VT Rte. 105 Closed for Bridge Replacement

Brighton New Bridge:
- All Precast Bridge Elements
- ABC project – 21 day closure
- 18+ days for 2.8 day BONUS

New 70’ Precast Structure
Hancock ER BRF 0174(16)

• NEXT-D beam w/ 70’ span
• Precast integral abutment on steel H piles
• Precast Approach Slabs
• Maintenance of Traffic via Temporary bridge (Adjacent)
• Bids opened on 9/12
  • $1,247,020  (15% under Estimate of $1,470,887)
• Final Inspection 9/13
  – 11 months in design
  – $124,000.00 in Preliminary Engineering
Hancock Bridge

- All Precast Bridge Elements
- Not an ABC project

Hancock Bridge After TS Irene

New Bridge Opened July 2013
Hancock Precast Details

Precast Abutments match cast

Sections set then post tensioned
Hancock Precast Details

NEXT D Beams

Precast Approach Slabs
Precast Abutment Units on Site

Abutment Delivered

Abutment set into place
Precast Abutments Complete

Post Tensioning Complete

Wingwalls Grouted
Setting the First Beam

NEXT D Beams Delivered

Good Alignment and No Differential Camber Between Units
Hancock Finished Bridge
2013 ABP Projects

- Plymouth ER BRF 0174(16)
  - 60’ NEXT D Beam Superstructure (20 deg skew)
  - Precast Abutments on Piles – Contractor self performed Precast Concrete Abutments on site
  - 11 months in design
  - Maintenance of Traffic via Temporary bridge (Adjacent)
Negative Moment Reinforcing
PBU End Beam Detail

Marlboro (43)        Bearing Backwall
  - 12 girders would require 12 steps in precast pile cap
  - Bearing backwall stabilizes end of beams during installation
  - Phased construction
PBU End Detail

1. PBU 1 SHOWN, PBU 6 SIMILAR.

BEARING

8 @ 12"

6 @ 12"

11 @ 12" FF

NOTE:

1. ONE M9 MECHANICAL SPILCE CONNECTOR MAY BE OMITTED ON FRONT FACE OF ABUTMENT AND FRONT FACE OF PBU BACKWALL AT EACH BEAM LOCATION.

CONNECTION DETAIL

SCALE 1" = 1'-0"

1 1/2 CLEAR (TYP)

14 MECHANICAL SPILCE CONNECTOR (TYP)

1 MECHANICAL SPILCE CONNECTOR (TYP)

11 DOWEL FF

6 DOWEL NF

PLAIN ELASTOMERIC PAD

NOTE:

NF = NEAR FACE
FF = FAR FACE
EF = EACH FACE
A = CUT TO FIT IN 1 3/4 CLEAR, UNLESS SPECIFIED ON THE PL.

BRIDGE END TYPICAL

SCALE 1" = 1'-0"
Materials

• Avoid proprietary materials
• Approved Products List
  – Spray Applied Membranes
  – Grouts
• Rapid Set High Performance Concrete
• Design details and schedules dictate materials
Specifications

• Some Current Specifications can be a challenge for ABC projects.
  – We have broken some when necessary
  – Continuing to identify issues and address them

• New Specifications already developed:
  – Construction Schedule Specification
  – High Performance Concrete, Rapid Set
  – Membrane Waterproofing, Spray Applied
  – Self performing for precast concrete fabrication

• Collaboration – Design, Materials, Construction
Lessons Learned

• End closure concrete and deck joints can be done in one operation with same material
• Approved Products list helps contractors
• Evaluate the effect of tolerances on details
• Optional construction joints allow flexibility
• Tolerances on pile driving have not been a problem.
Lessons Learned

• Keep details simple when possible
• Approach slab – fine grading is working
• Planning and detailing for constructibility and erection needs to start in design.
• Should expect that details will need customization for each state.
Questions?
SHRP 2 Renewal Project R19A Design Guide for Bridges for Service Life
http://www.trb.org/Main/Blurbs/168760.aspx

VTrans 2008 Integral Abutment Bridge Design Guidelines
VTrans 2010 Structures Design Manual
http://vtransengineering.vermont.gov/sections/structures

VTrans Accelerated Bridge Homepage
http://acceleratedbridge.vermont.gov/

VTransTV “Nextbeams”
http://www.youtube.com/watch?v=FVrHCTa4H90&list=UUKnAQcn3p5ePl3ezFJJashg&index=2

VTransTV “Hancock Abutment”
http://www.youtube.com/watch?v=vggAHbXa1q0&list=UUKnAQcn3p5ePl3ezFJJashg&index=3
Contact Us?

• Wayne B. Symonds
  – Wayne.symonds@state.vt.us

• Bill Lammer
  – William.lammer@state.vt.us