NY Statewide Conference on Local Bridges
Session 3
Developing Precast Guidelines for Accelerated Bridge Construction
• Define Background on PCI Northeast Bridge Technical Committee
• Understand Development of the NEXT Beam
• Understand the Development of Precast Substructure Guidelines
PCINE Bridge Technical Committee

- PCINE Technical Committee was established in 1990
- Members included State Department of Transportations Engineers from New England and New York, Consultants and Precastors
- Focus is on Updating and Developing Regional Standards for ABC Bridge Construction since 2004
PCINE Bridge Technical Committee

State DOT
- Rabih Barakat – CTDOT
- Bryan Reed - CTDOT
- Robert Bulger - Maine DOT
- Brian Reeves – Maine DOT
- Alex Bardow - MassDOT
- Maura Sullivan – MassDOT
- Edmund Newton - MassDOT
- Duane Carpenter – NYSDOT
- Michael Twiss – NYSDOT
- Jason Tremblay –NHDOT
- David Scott - NHDOT
- Mike Savella - Rhode Island DOT
- Rob Young – Vermont AOT

Precasters
- Rita Seraderian - PCI Northeast
- Joe Carrara - J. P. Carrara & Sons
- Ernie Brod - J. P. Carrara & Sons
- Chris Fowler - Oldcastle Precast
- Eric Schaffrick - Dailey Precast
- Scott Harrigan – Fort Miller
- Chris Moore – United Precast
- Bill Augustus – Oldcastle Precast

Consultants
- Michael P. Culmo - CME Associates, Inc.
- Eric Calderwood - Calderwood Eng.
- Vartan Sahakian -Commonwealth Eng.
- Darren Conboy - Jacobs Eng.
- Ed Barwicki - Lin Associates
Reports Developed by the Technical Committee

- NEBT Preliminary Design Charts
- NEBT Post-Tensioned Design Guidelines
- High Performance Concrete Specification
- Prestressed Concrete Girder Continuity Connection
- Precast Deck Panel Guidelines
- Full Depth Precast Concrete Deck Slabs Guidelines
- Bridge Member Repair Guidelines
- Accelerated Bridge Construction Guidelines
- NEXT Beam Details and Design Charts
Reports are available at www.pcine.org

Northeast Bulbtee (NEBT)

Bridge Guideline: First Issued 1998 (Revised 2008)
NEBT Northeast Bulb Tee - Section Properties (226.1kb PDF File)
Preliminary Design charts for designing the New England Bulb Tee Girders. Charts will help you determine span capabilities, spacing and preliminary number of prestressing strands required. If a State Standard exists it will take precedence over these guidelines and details.

Bridge Guideline: 1998
NEBT Load Charts for Northeast Bulb Tee - HS20 Load Charts (90.7kb PDF File)
Preliminary Design charts for designing the New England Bulb Tee Girders. Charts will help you determine span capabilities, spacing and preliminary number of prestressing strands required. If a State
PCINE Bridge Technical Committee Focused it’s work on Accelerated Bridge Construction starting in 2004.

Timeline:

- 2004 – Developed an Accelerated Bridge Guidelines Report
  Completed 2006
- 2006 – Begin Development of the NEXT “F” Beam
  Completed 2008 – First Bridge Built in 2010
- 2008 – Begin Development of NEXT “D” Beam
  Complete 2010 – First Bridge Built in 2011
- 2011 – 2nd Ed. Full Thickness Deck Panel Report Updated
- 2012 - Develop Guidelines for Precast Approach Slabs –
  Completed and Posted November- 2012

Current Work

- Update the Accelerated Bridge Guideline Report
- Develop Standard Details for Deck Bulb Tees
- Development of NEXT E
Guidelines for Accelerated Bridge Construction using Precast/Prestressed Concrete Components

- Section 1: Application Overview
- Section 2: General Requirements
- Section 3: Precast Components
- Section 4: Joints
- Section 5: Grouting
- Section 6: Seismic
- Section 7: Fabrication & Construction
The Every Day Counts Initiative

EDC is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment.

Accelerated Bridge Construction
Workers install a full-depth precast bridge deck panel, a key feature of the Iowa DOT accelerated bridge construction (ABC) plan for the 24th Street-I-29/80 interchange in Council Bluffs, Iowa.
Objective

- Develop **standardized** approaches to designing, constructing, and reusing (including future widening) complete bridge systems.
- It addresses **rapid renewal needs** and efficiently integrates **modern construction equipment**.
ABC Toolkit

• Standard Plans for ABC Modular Systems
  – Deck Bulb Tee
  – NEXT Beam
  – Steel Beam
  – Abutments
  – Piers

• Erection Concepts
• LRFD Designs (Mathcad)
• Contracting Language
• ABC Sample Design Calculations
Development of the NEXT Beam

- Started in 2006 – Completed in 2008

Benefits
- Accommodation of Utilities
- Reduce Fabrication and Installation Cost
- Works very well for Accelerated Construction.
Development of the NEXT beam
Development of the NEXT beam

Depth 24” – 36” in 4” increments
Typical Span Range 50 – 85’
Width will vary 8’-0” – 12’-0”
NEXT Beam Shapes

- **NEXT F plus 8” CIP Deck**
  - No Forming between Flanges
  - Easily accommodates Vertical Curves w/CIP Topping
  - Easily Handles Camber Variations between Members

- **NEXT D no CIP Deck**
  - No CIP Topping/Deck
  - Best Section For ABC
  - Special Concrete for Flange Conn
  - Harder to match adjacent members Skew/Design

- **NEXT E plus 4” CIP Deck**
  - Uses Less Topping & Reinforcement
  - Flange Connection Made with CIP
  - Easily Accommodates Vertical Curve
  - Easily Accommodates Camber Variations between members
NEXT Beam
Preliminary Design Charts
6000 psi
8000 psi
10000 psi

Beam Depth
24 - 36”
Beam Width 8’-0” - 12’-0”
NEXT Deck “D” beam

- Preliminary Load Charts for Normal & Light Weight Concrete
Bridge Section

EXISTING BRIDGE SECTION

PROPOSED BRIDGE SECTION
Preliminary Beam Design Charts

DESIGN PARAMETERS

1. Two lane 4 beam bridge section
2. 18 inch wide concrete curbs with steel rail
3. 8 inch thick RC deck: $f'_c = 4000$ psi
4. 3 inch thick bituminous concrete overlay
5. Beam $f'_c = 10000$ psi
6. Beam $f'_c i = 8000$ psi
7. Debond up to 25% of strand
8. AASHTO LRFD design with allowable tensile stresses for extreme exposure
9. Straight strand only
10. No utility loads
11. Design for interior beam
12. Live load distribution factor based on composite deck stringer bridge, AASHTO cross section Type K
Additional Guidance on website www.pcine.org

- FAQ
- Design Assumptions

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**NEXT BEAM FREQUENTLY ASKED QUESTIONS**

1. Why is the NEXT Beam more economical than other bridge systems?
2. Is the NEXT Beam acceptable to bridge owners?
3. When should I consider using the NEXT Beam?
4. What are the span lengths and widths?
5. What is the difference between the D and F Beam?
6. What bridge software can be used to design a NEXT Beam bridge?
7. What is the construction sequence for the NEXT F beams?
8. Are diaphragms required?
9. Can I cut back the Top Flange of the NEXT beam to accommodate casting the of the end diaphragms?
10. How do you seal the longitudinal joints between beams?
11. What is the recommended bearing?
12. How are parapets handled?
13. What is the live load distribution factor?

The AASHTO LRFD Bridge Design Specifications are not clear when it comes to the calculation of live load distribution factors for a double tee beam with a composite concrete deck. The PCI Northeast Bridge Technical Committee has contacted the original authors of the specification and found that this type of structure was not specifically investigated during the development of the code. In lieu of more precise information, the following approach for calculation of live load distribution factors was suggested.

Please reference, AASHTO LRFD 4.6.3.1 Distribution of Live Loads Per Lane for Moment in Interior Beams. For the calculation of NEXT Beam F Interior Distribution Factor use Cross Section Type K - Precast Concrete I or Bull-Tee Sections (AASHTO LRFD Table 4.6.2.2.2b-1) with the following modifications, ‘One Design Lane’ and ‘Two or More Design Lanes’.

1. Treat each stem as an individual beam and calculate Distribution Factors for each stem based
The First NEXT Beam
NEXT Beam Time Lapse Production
York Maine Project

Route 103 over York River York, ME
7 Span Structure - 510 Ft Long
Completed Ahead of Schedule November 2010
4” Additional Navigational Clearance
Case Study - Sibley Pond Bridge – Canaan-Pittsfield, ME

Design-Build Project
Opened November 21, 2011
10-1/2 months ahead schedule
The bridge was designed and completed in 15 months.
Designed for 100 year Service Life.

Credits – Parsons Brinckerhoff
Custom Gantry lifted the beams from trailers and rolled sideways across the new piers. Less costly and quicker than 2 crane pick. 4 Beams Erected in an 8 hour shift. Turnaround time of 2 days per span.
Sibley Pond Bridge – Canaan-Pittsfield, ME

- 10 spans - two 5 span continuous units and a single expansion at center
- Span Length - 79’-0” With Overall Bridge Length - 790’-0”
- Overall Width - 36’-0” curb to curb
- No. of Traffic Lanes - 2
South Worthington, MA – Total Precast Built in 60 Days
Chain Pedestrian Bridge Fairfax VA
Logan Airport Runway Extension, Boston, MA

460 x 303 ft.
- 354 18” sq. piles
- 96 cap beams
- 330 NEXT Beams
TIMELINE NEXT Beam Developed in 2008

2009
- First NEXT Beam Cast

2010
- First NEXT D bridges are Built in Maine & Vermont
- MA and NY Build first Bridges

2011
- Logan Airport uses NEXT beams for Runway Extension and new Airport Viaduct

2011-12
- NY built First Lateral Slide

2012
- NJ and RI build their first projects

2013
- First Curved Flange Project
- 25+ Projects

7 Bridges

2 Bridges

18 Bridges
NEXT Beam Acceptance - States with NEXT Beams

Massachusetts DOT
Vermont AOT
Maine DOT
Rhode Island DOT
New Hampshire DOT
New York State DOT and New York City DOT
New Jersey DOT
Delaware DOT
Pennsylvania DOT
Virginia DOT

States with NEXT Beam in Design/Construction:
Connecticut DOT

New Brunswick has also adopted the new shape for Canada
# Beam Cost Considerations

<table>
<thead>
<tr>
<th></th>
<th>Box Beam</th>
<th>Next Beam</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabrication</td>
<td>Multi-stage pour Draping</td>
<td>Simple Pour Straight Strand</td>
<td>Next Beam should have significantly lower fabrication cost per SF</td>
</tr>
<tr>
<td>Shipping</td>
<td>One beam per truck (3’-4’)</td>
<td>One beam per truck (8’-12’)</td>
<td>Next Beam reduces the number of trucks (½ to ¼)</td>
</tr>
<tr>
<td>Cranes</td>
<td>Lighter picks</td>
<td>Heavier picks</td>
<td>Probably a wash</td>
</tr>
<tr>
<td></td>
<td>Requires Transverse PT and grouting</td>
<td>Set it an move on</td>
<td>Much easier installation, no special grouts, no post-tensioning</td>
</tr>
</tbody>
</table>

*PCI*
Title: Field Monitoring of an Integral Prestressed Concrete Bridge in Massachusetts using NEXT Beams

Sponsored by: MassDOT, PCI National, PCI NE; NHDOT & CABA.
Conducted: University of Mass; Amherst, MA

Main Objective:

• Determine live-load distribution factors
• Permit calibration of a finite element model

Status: Complete - Report Submitted
Presentation was conducted at PCI Convention and PCI Journal Article this fall
Manual for the Evaluation and Repair of Precast, Prestressed Concrete Bridge Products
Including: Imperfections or Damage Occurring During Production, Handling, Transportation, and Erection

Report No: PCINER-01-BMRG
Title: Bridge Member Repair Guidelines
Developing Organization: Precast/Prestressed Concrete Institute Northeast Region Technical Committee
Phone – 888-700-5670
Email – contact@pcine.org
Report Date: October 2001
Status of Report: Final

Abstract:
This report is intended to serve as a guide to identify defects that may occur during the fabrication and handling of bridge elements. The report gives guidance on possible cause and prevention. It will help determine the consequences of the defects and assist in making a judgment as to acceptance/repair or rejection.

This report can be utilized by State Inspectors, Designers, Plant Production Managers, Plant Quality Control Inspectors and Plant Engineers.

Number of Pages: 49

PCI cannot accept responsibility for any errors or oversights in the use of this material. The user must recognize that no guidelines or regulations can substitute for experienced judgment. This guideline is intended for use by personnel competent to evaluate the significance and limitations of its contents and able to accept responsibility for the application of the material it contains.

Bridge Member Repair Guidelines
Report Number PCINER-01-BMRG
Northeast Region
NEXT Beam Quality Control

TS #12
TROUBLE SHOOTING PARTIALLY CRACKED TOP FLANGES – NEXT BEAMS

Description – Crack running parallel to beam centerline along inside face of stem. This crack is expected in obtuse corners of skewed beams adjacent to the interior face of the stem, but can occur in any beam.

CAUSE

A. Detensioning


PREVENTION

A. Adjust Reinforcement and detensioning sequence

1. Place additional transverse steel reinforcement in flange to intercept and minimize crack width. The bars should be located as close to the bottom of the top flange as allowed by state specifications for deck reinforcement (1” is recommended).

Consider adding FRP reinforcement along inside radius with minimal (1/2”) cover to intercept crack near surface of concrete.

Note: The reinforcement described above was added to the typical details on October 25, 2012.

2. Release one strand at a time alternating from stem to stem.


B. Shrinkage

1. Shrinkage of top flange concrete restricted by the fixed 2 stem form.

ENGINEERING EFFECT

1. For beams that will be topped with a composite concrete slab (NEXT F), there are no concerns. These cracks will be covered by the slab in composite construction.

2. For beams whose top flange is to be used as the riding surface of the completed bridge (NEXT D), cracks in the top flange can affect durability, if not repaired

REPAIR CONSIDERATIONS

1. Where a composite concrete deck is embedded in concrete in the finished structure (integral abutment), no structural repairs are needed.

   a. NEXT F. If the crack is exposed on the underside of the finished structure and the bridge is in a corrosive environment:

      • Cracks less than 0.006 inch wide should be ignored (See Note).

      • Cracks greater than or equal to 0.006 inch wide and less than 0.016 inch wide should be sealed with epoxy paste. See Repair Procedure #14.

      • Cracks greater than or equal to 0.016” wide should be sealed using epoxy injection by the pressure injection method. See Repair Procedure #10.

3. NEXT D: Where the top flange will be the riding surface and the crack width is greater than 0.006 inches, the crack at the top surface of the deck can be sealed with a low viscosity epoxy or methylmethacrylate product. See Standard Repair Procedure 14.

Note: The AASHTO LRFD Bridge Design Specifications limits crack widths in Class 2 exposure conditions (bridge decks) to 0.0085 inches (Article 5.7.3.4). Therefore these recommendations are conservative.
PBES

- **Superstructures**
  - Deck Panels: Partial & Full-Depth
  - Prefabricated Beams
  - Total Superstructure Systems:
    - Composite Units, Truss Spans

- **Substructures**
  - Pier Caps, Columns, & Footings
  - Abutment Walls, Wing Walls, & Footings

- **Totally Prefabricated Bridges**
Available Standard and Guideline Details

- **Utah DOT**
  - Complete Standards available on-line
  - Including seismic details
  - Specs are also available

- **PCI Northeast Guide Details**
  - Based on experience in Utah and the NE region
States using Accelerated Construction

- States using ABC
- MassDOT
- VAOT
- MEDOT
- CTDOT
- RIDOT
- NHDOT
- NYSDOT
- NJDOT

MassDOT Released Part III of their bridge design manual – Prefabricated Bridge Elements
Design with Prefabricated Elements

- Most details are based on emulative design
  - Emulate CIP
  - Convert construction joints to connections

- Basic design of the structure does not change

- Connections to emulate a construction joint
  - Mechanical connectors
  - Researched connections
  - FHWA manual
Connection Technologies

- Grouted Couplers
  - Emulates a reinforcing steel lap splice
  - No special design required
  - Multiple companies
    - non-proprietary
  - Used in vertical construction for many years
  - Seismic
    - Used in buildings (ACI)
    - Previously tested in Japan
Based on experience in Utah and the NE region
Precast Piers
Typical Connections

NOTES:

1. ADJUST SHIM STACK HEIGHT TO CONTROL ERECTION ELEVATIONS.
2. END DOWEL BARS LONGER THAN REQUIRED AND CUT TO PROPER HEIGHT AFTER INSTALLATION OF LOWER ELEMENT.
3. COLUMN TO COLUMN SPLICE SHOWN. THIS DETAIL MAY BE USED FOR TALL COLUMNS. COLUMN TO FOOTING DETAILS SIMILAR.
4. SHEAR REINFORCEMENT TO BE SPIRALS OR HOOPS WITH RESISTANCE BENT MELDED.
5. SEE SHEET 5 FOR GRouted SPLICE COUPLER CONNECTION SEQUENCE.
Abutments

45 minutes to grout
130 sleeves
Integral Abutments

INTEGRAL ABUTMENT NOTES:
1. ABUTMENT DIAGRAMS NOT SHOWN FOR CLARITY.
2. DIFFERENT FOUNDATIONS ARE SHOWN TO DEPICT DIFFERENT DESIGNS.
3. ALL REINFORCEMENT NOT SHOWN FOR CLARITY.
4. ALL ABUTMENT REINFORCEMENT NOT SHOWN FOR CLARITY.
5. BACKWALL MAY BE PRECAST INTEGRALLY WITH THE ABUTMENT CAP.
6. MECHANICAL BUR SPLINTERS MAY BE USED FOR BARS EXTENDING INTO NEW CONCRETE.
7. DETAILS FOR PRECAST VENTS SHALL BE BASED ON THE SPECIFIED FILED VENTING REQUIREMENTS.
8. COUPLERS TO BE USED WITH PRECAST BACKWALLS ONLY.

SECTION A: INTEGRAL ABUTMENT

NOTE: 1. THIS DETAIL IS BASED ON DETAILS FROM SEVERAL STATES.
2. ALL ABUTMENT REINFORCEMENT NOT SHOWN FOR CLARITY.
3. BACKWALL MAY BE PRECAST INTEGRALLY WITH THE ABUTMENT CAP.
4. MECHANICAL BUR SPLINTERS MAY BE USED FOR BARS EXTENDING INTO NEW CONCRETE.
5. DETAILS FOR PRECAST VENTS SHALL BE BASED ON THE SPECIFIED FILED VENTING REQUIREMENTS.
6. COUPLERS TO BE USED WITH PRECAST BACKWALLS ONLY.

SECTION B: SEMI-INTEGRAL ABUTMENT

NOTE: BACKWALL MAY BE PRECAST INTEGRALLY WITH THE ABUTMENT USING A SECONDARY POUR. SPECIAL DETAILING OF JOINTS BETWEEN BACKWALLS WILL BE REQUIRED.
Integral Abutments

- Corrugated Void Pockets
Cantilever Abutments
### Column Fabrication Tolerances

<table>
<thead>
<tr>
<th>Column</th>
<th>Tolerance</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>± 1/8&quot;</td>
</tr>
<tr>
<td>B</td>
<td>± 1/4&quot;</td>
</tr>
<tr>
<td>C</td>
<td>± 1/4&quot;</td>
</tr>
<tr>
<td>D</td>
<td>± 1/16&quot; per 12&quot; inch width, ± 1/2&quot; maximum</td>
</tr>
<tr>
<td>E</td>
<td>± 1/2&quot; per 10 feet, ± 1/2&quot; maximum</td>
</tr>
<tr>
<td>F</td>
<td>± 1/8&quot;</td>
</tr>
<tr>
<td>G</td>
<td>± 1/4&quot;</td>
</tr>
<tr>
<td>H</td>
<td>± 1/4&quot; in 10 feet</td>
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</tbody>
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### Column Erection Tolerances

<table>
<thead>
<tr>
<th>Column</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>Top elevation from nominal top elevation, maximum low, maximum high</td>
</tr>
<tr>
<td>K</td>
<td>Maximum plumb variation over height of column</td>
</tr>
<tr>
<td>L</td>
<td>Plumb in any 10 feet of column height</td>
</tr>
</tbody>
</table>

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**Diagram**

- **Elevation**
- **Section**
- **Grouted Splice Coupler**
Easthampton MA Deck Bulb Tee

Eight – 1220 mm NEBT 5’ wide 95’ long Deck Bulb Tees  8000 psi Concrete – UHPC Joint
Q. The PCI Northeast Bridge Committee is made up of?

A. Department of Transportations
B. Design Consultants
C. Precast Manufactures
D. All of the above

Answer: D
Q & A

Q. Prefabricate Bridge Elements and Systems are (PBES)?

A. Superstructures
B. Substructures
C. Both

Answer: C
Q & A

Q. Grouted Mechanical Couplers commonly used to connect precast sections act as a...

A. Moment Connection
B. Pin Connection

Answer: A
Q & A

Q. What guide is used to design accelerated bridge structures?

1. PCI Northeast Guide Details  
2. SHRP 2 - Innovative Bridge Designs for Rapid Renewal ABC Toolkit  
3. FHWA Manuals on Accelerated Bridge Construction  
4. All of the above

Answer: D
Thank-You for your Attention
Questions?

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