Canadian experience with the North East Extreme Tee (NEXT) Beam Viaduct Replacement, Maine, USA

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St. John’s NL
TAC Structures Session
The Northeast Extreme Tee “NEXT” Beam
Development of the Northeast Extreme Tee NEXT Beam

- PCINE Technical Committee was established in 1990

- Members included State Department of Transportations Engineers from New England and New York, Consultants and Precastors

- Focus on Developing Standards for ABC Bridge Construction since 2004
Why Develop the NEXT Beam?

- Accommodation of Utilities
- Ease of Fabrication
- Reduced Installation Cost
- Accelerated Construction
- Alternative to box beam or I-girders for mid span bridges
Development of the NEXT Beam

PCI Northeast Bridge Beam Sections
Common Span Ranges

<table>
<thead>
<tr>
<th>Beam Type</th>
<th>Span Length</th>
</tr>
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<tbody>
<tr>
<td>Adjacent Slabs/Deck Beams</td>
<td>12 m - 24 m</td>
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<tr>
<td>Adjacent Box Beams</td>
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<tr>
<td>NEXT Beams</td>
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<tr>
<td>Bulb Tee Beams</td>
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12 m 24 m
NEXT Beam Bridge Profile can easily Match Existing Bridge Profiles
Development of the NEXT Beam

- Depth: 0.6 m (24”) – 0.9 m (36”) in 100 mm increments
- Width: will vary 2.4m (8’-0”) – 3.7m (12’-0”)

<table>
<thead>
<tr>
<th>NEXT BEAM - SECTION PROPERTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEAM DESIGNATION</td>
</tr>
<tr>
<td>-------------------</td>
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<tr>
<td>NEXT 36</td>
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<td>NEXT 32</td>
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<tr>
<td>NEXT 28</td>
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<tr>
<td>NEXT 24</td>
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<tr>
<td>MINIMUM WIDTH BEAMS</td>
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<tr>
<td>NEXT 36</td>
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<td>NEXT 32</td>
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<tr>
<td>NEXT 28</td>
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<tr>
<td>NEXT 24</td>
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<tr>
<td>MAXIMUM WIDTH BEAMS</td>
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<td>NOTES:</td>
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NEXT Beam Shapes

**NEXT F plus 250mm (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**
- Best Section For **ABC**
- Special Concrete for **Flange Connection**
- Matching of adjacent members
- Skew/Design

**NEXT E plus 100mm (4”) CIP Deck**
- Less Topping & Reinforcement
- **Flange Connection** with CIP
- Easily Accommodates Vertical Curve
- Easily **Accommodates Camber Variations** between members
NEXT F BEAMS (TYP)

Thicker Topping Thickness at Ends Caused by Beam Camber

8" Topping Thickness at Mid-Span

NOTES:
1. The details shown depict typical Topping detail at the mid-span. Make sure the height of the Topping Barbie will still match.
2. Topping Curve if the Camber is larger than the Curve Lyric - the details will be similar to the tangent profile form.
3. The 8" Topping Thickness at the Interchange and kayak, the thickness of the Topping Barbie is 8" and may vary, as the height of the Topping Barbie at the intersection of the Topping Barbie may be required. The same applies to the height of the Topping Barbie.

NEXT F BEAMS - TANGENT PROFILE

8" Topping Thickness at Ends if Vertical Curve Ordinate is less than Camber

Thicker Topping Thickness at Mid-Span if Vertical Curve Ordinate is larger than Camber

8" Topping Thickness if Camber is less than Ordinate

NEXT F BEAMS - CREST VERTICAL CURVE PROFILE

Thicker Topping Thickness at Ends Caused by Vertical Curve Ordinate Plus Beam Camber

8" Topping Thickness at Mid-Span

NEXT F BEAMS - SAG VERTICAL CURVE PROFILE

Option 1: Vary Topping Thickness

Constant Thickness Overlay

Constant Thickness Topping

Option 2: Vary Overlay Thickness

Curb/Barrier Height Varies

Overlay Thickness Varies
Two types of joint details

Normal Concrete

UHPC Concrete
Ultra-High Performance Concrete Connections for Prefabricated Bridge Elements

The proliferation of prefabricated bridge elements and systems (PBES) over the past four years has led to a recognition among bridge owners and specifiers that robust connection systems are a key part of any successful bridge construction project. Ultra-high performance concrete (UHPC), a steel fiber-reinforced cementitious composite with exceptionally high mechanical strength and durability properties, can facilitate simplified, effective use of PBES.

Field casting of UHPC connections between prefabricated components results in a strong connection and frees the owner from concerns about its short- and long-term performance. The mechanical properties of UHPC allow for redesign of common connection details in ways that promote both ease and speed of construction.
Design and Construction of Field-Cast UHPC Connections

Introduction
Advancements in the science of concrete materials have led to the development of a new class of cementitious composites called ultra-high performance concrete (UHPC). UHPC exhibits mechanical and durability properties that make it an ideal candidate for use in developing new solutions to pressing concerns about highway infrastructure deterioration, repair, and replacement. Field-cast UHPC details connecting prefabricated structural elements used for bridge construction have proven to be an application that has captured the attention of owners, specifiers, and contractors across the country. These connections can be simpler to construct and can provide more robust long-term performance than connections constructed through conventional methods. This document provides guidance on the design and deployment of field-cast UHPC connections.

UHPC
UHPC is a fiber-reinforced, portland cement-based product with advantageous fresh and hardened properties. Through the appropriate combination of advancements in super-plasticizers, dry constituent gradation, fiber reinforcements, and supplemental cementitious materials, UHPC is able to deliver performance that far exceeds conventional concrete. Developed in the late 20th century, this class of concrete has emerged as a capable replacement for conventional structural materials in a variety of applications.

The Federal Highway Administration (FHWA) defines UHPC as follows:
UHPC is a cementitious composite material composed of an optimized gradation of granular constituents, a water-to-cementitious materials ratio less than 0.25, and a high percentage of discontinuous internal fiber reinforcement. The mechanical properties of UHPC include compressive strength greater than 21.7 kPa (150 MPa) and sustained post-cracking tensile strength greater than 0.72 kPa (5 MPa). UHPC has a discontinuous pore structure that reduces liquid ingress, significantly enhancing durability compared to conventional concrete.

TABLE OF CONTENTS:
• Common Connections
• Design Guidance
• Specifying UHPC
• Construction Engineer Inspection
• Case Study
• Deployments
FHWA Deployment of UHPC

Ultra-High Performance Concrete

North American Deployments of UHPC in Highway Bridge Construction

The following interactive map displays in-service bridges in the United States and Canada that use ultra-high performance concrete.

Interactive Map
Click on an individual data point to display relevant details.

Find an Expert
Research and Development Links
- Research and Development (R&D) Offices
- R&D Experts
- R&D Laboratories
- R&D Projects
- R&D Publications
- R&D Topics
<table>
<thead>
<tr>
<th>NEXT Beam Acceptance - States with NEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>United States</strong></td>
</tr>
<tr>
<td>Massachusetts DOT</td>
</tr>
<tr>
<td>Vermont AOT</td>
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<tr>
<td>Maine DOT</td>
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<td>Rhode Island DOT</td>
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<td>Connecticut DOT</td>
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<td>New Hampshire DOT</td>
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<td>New York State DOT and NY City DOT</td>
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<td>New Jersey DOT</td>
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<tr>
<td>Georgia DOT</td>
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<tr>
<td><strong>Canada - New Brunswick</strong></td>
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Additional Guidance on website www.pcine.org

- FAQ’s
- Design Assumptions

NEXT Beam Frequently Asked Questions

General Questions
1. Is the NEXT Beam Proprietary?
2. Who supplies the NEXT Beam?
3. Is the NEXT Beam acceptable to bridge owner agencies?
4. Is the NEXT Beam more economical than other bridge systems?
5. What is the difference between the D and F Beam?
6. How do I handle utilities on my bridge?
7. Are diaphragms required?
8. What is the recommended bearing?

Bridge Geometry Questions
1. What are the typical span lengths and widths?
2. Can NEXT Beam be used for a skewed bridge?
3. Can the NEXT Beam be used for a curved bridge?
4. Can the NEXT Beam be used for a variable width bridge?
5. How do you accommodate vertical curves?
6. How do you accommodate roadway cross slopes and crowns?
Typical NEXT Beam Production
Typical NEXT Beam Production
Typical NEXT Beam - Time Lapse Production
Bath Viaduct Replacement, Bath Maine

First Canadian Produced NEXT Beam Project, Produced at Strescon, Saint John, NB

Vital transportation link for Bath, Maine since 1958
2006 – Surface replacement
2016 - $12 million complete reconstruction
Bath Viaduct Replacement, Bath Maine

Tender called in Spring 2016
Reed & Reed, Woolwich Maine, awarded contract
Strescon, Saint John, NB awarded supply of 80 Beams
Bath Viaduct Replacement, Bath Maine

May 2016: Start of site preparation

Critical to minimize impact on local traffic

October 2016: Closure of existing viaduct

May 2017: Scheduled re-opening of new viaduct
Bath Viaduct Replacement, Bath Maine

Demolition of Existing
Bath Viaduct Replacement, Bath Maine

19 new CIP pier shafts on the existing footings
Bath Viaduct Replacement, Bath Maine

19 new precast concrete pier caps
Bath Viaduct Replacement, Bath Maine

Strescon NEXT
D36 Beam production:
Started June 19, 2016

Deck: Poured to compensate for natural prestress camber
Bath Viaduct Replacement, Bath Maine

- NEXT D36 is a full-depth deck beam
- Approximately 45 metric tonnes each
- One beam cast per day
- 55 MPa (8000 psi) design strength
- 41.4 Mpa (6000 psi) release strength
- 36 -16mm (5/8 in) prestressed strands per beam
Bath Viaduct Replacement, Bath Maine

Production completed October 2016
Bath Viaduct Replacement, Bath Maine

Shipment:
December 2016;
two girders shipped/day
Bath Viaduct Replacement, Bath Maine

Integral tying of NEXT Beams with 138 MPa (20,000 psi) UHPC closure strips
Bath Viaduct Replacement, Bath Maine

April 2017: Guardrail installation and installation of the final closure strips

3 weeks ahead of schedule
Thank-You for your Attention
Questions?

Rita Seraderian, PE, FPCI
Precast/Prestressed Concrete Institute
Northeast
www.pcine.org

Andrew LeVatte,
Strescon Limited
Time Permitting

Some additional noteworthy projects using NEXT Beams

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Precast/Prestressed Concrete Institute
Northeast
www.pcine.org

Andrew LeVatte,
Strescon Limited
Other interesting and notable NEXT Beam infrastructure applications

• Logan Airport Runway Extension, Boston, MA
• NEXT Beam for High Level RR Platforms
• New York Wheel - Staten Island NY
Logan Airport Runway Extension, Boston, MA

One runway not compliant with FAA
Need to be extended by 140m x 92 m (460 ft. x 303 ft.)

- 354 18” sq. piles
- 96 cap beams
- 330 NEXT Beams
NEXT Beam for High Level RR Platforms

Littleton, MA Station
NEXT Beams were 9.1m (30 ft.) long non-prestressed
New York Wheel - Staten Island NY

Green Garage Roof and Ramp

- 4-story, 32,000 sq. m. (337,800 sf) garage
- (950 cars) garage
- Spanning the adjacent roadway & MTA tracks
- Featuring a green roof designed for a park-like setting for various events.

World’s Largest 192 m (630 ft) tall observation wheel.
Green Garage Roof and Ramp

Design Loads
20 KN/sq.m (430 LBs SF) DL
4.8 KN (100 LBS SF) LL

Designed for 450 mm (18 inches) of soil and a variety of trees, paving stones, and other landscaping features.