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

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Co-Author: Andrew LeVatte, Strescon, NS

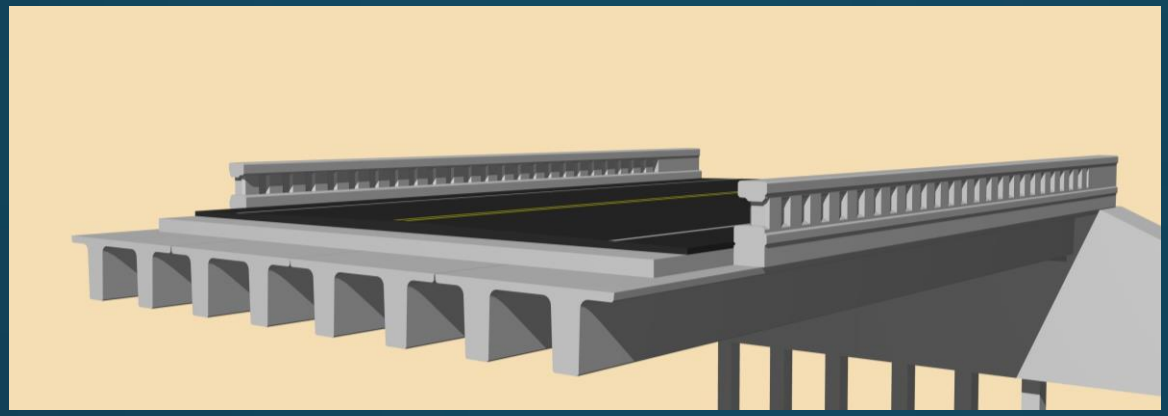
September 24-27, 2017
St. John's NL
TAC Structures Session

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

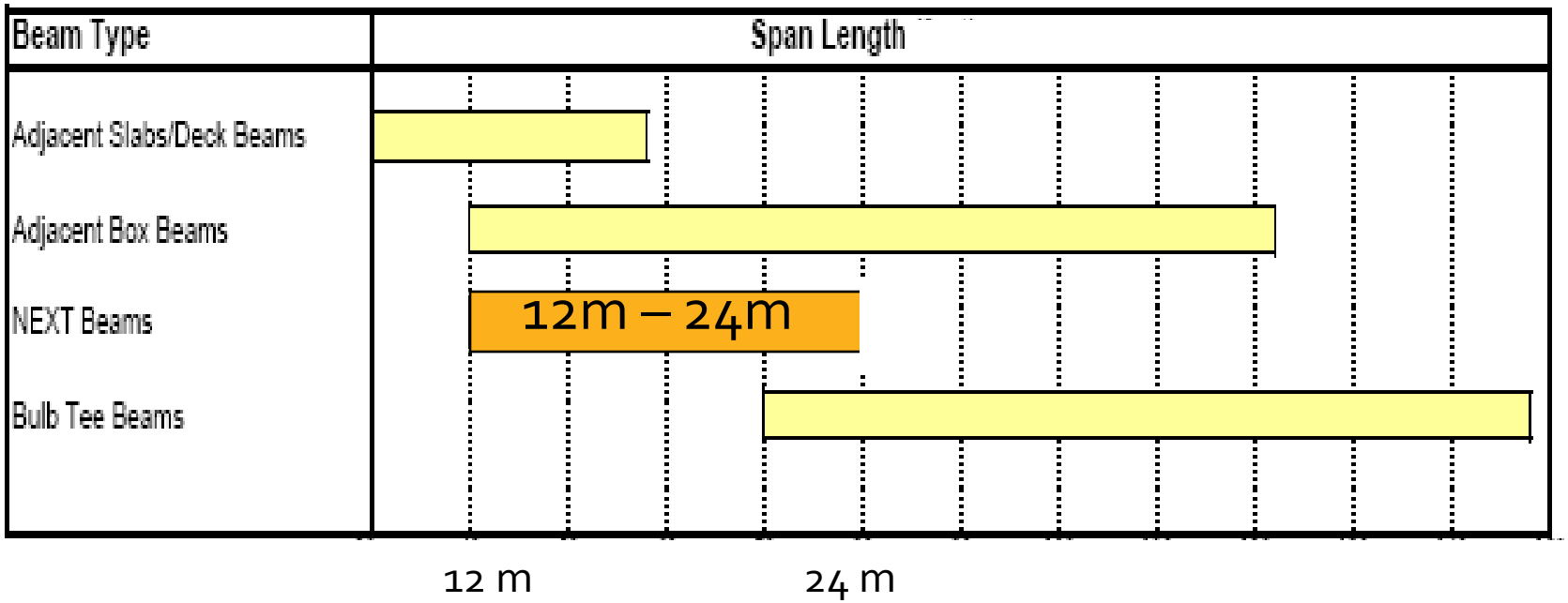
Why Develop the NEXT Beam?



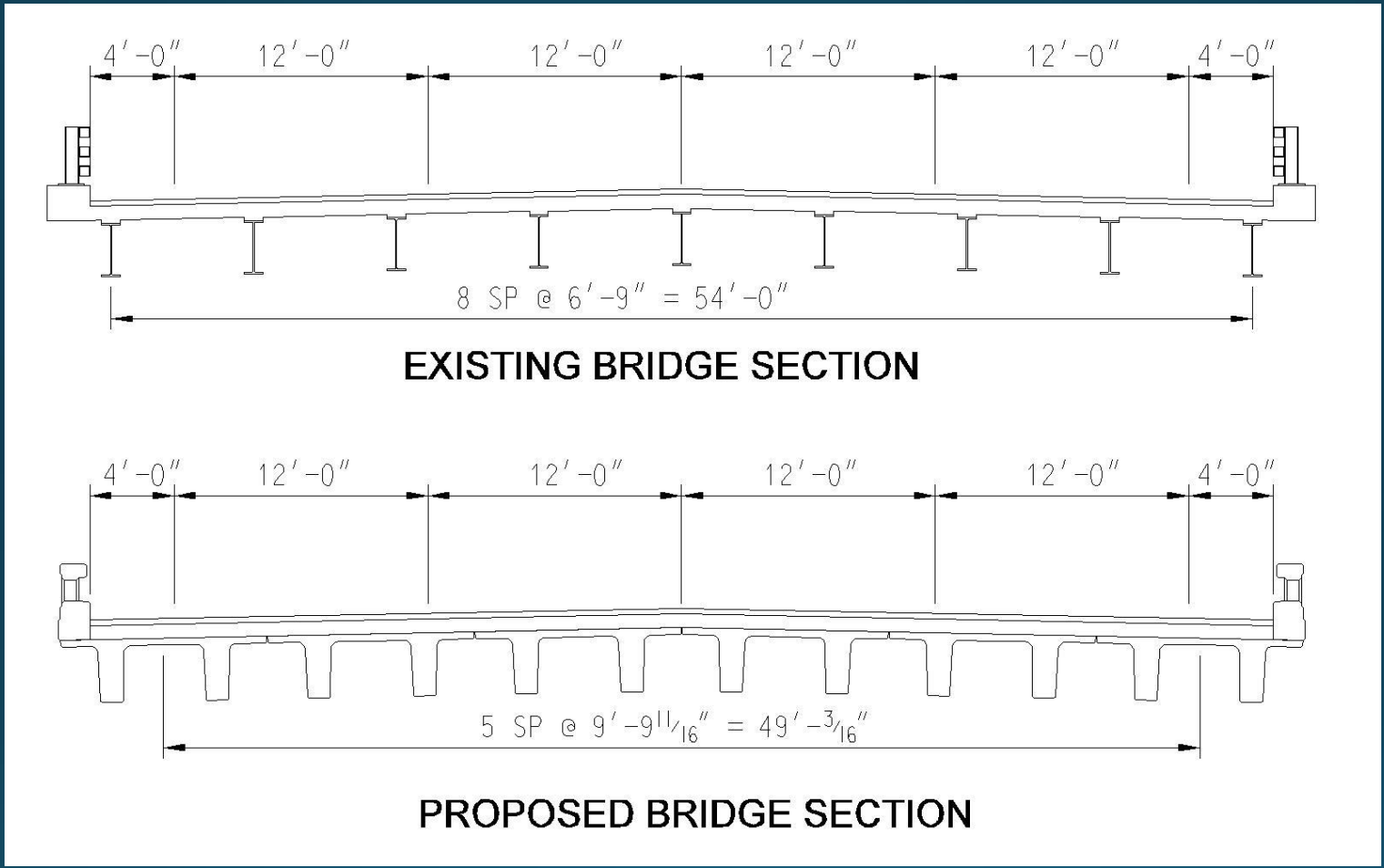
- Accommodation of **Utilities**
- Ease of **Fabrication**
- **Reduced** Installation Cost
- **Accelerated** Construction
- **Alternative** to box beam or I-girders for mid span bridges

Development of the NEXT Beam

PCI Northeast Bridge Beam Sections
Common Span Ranges



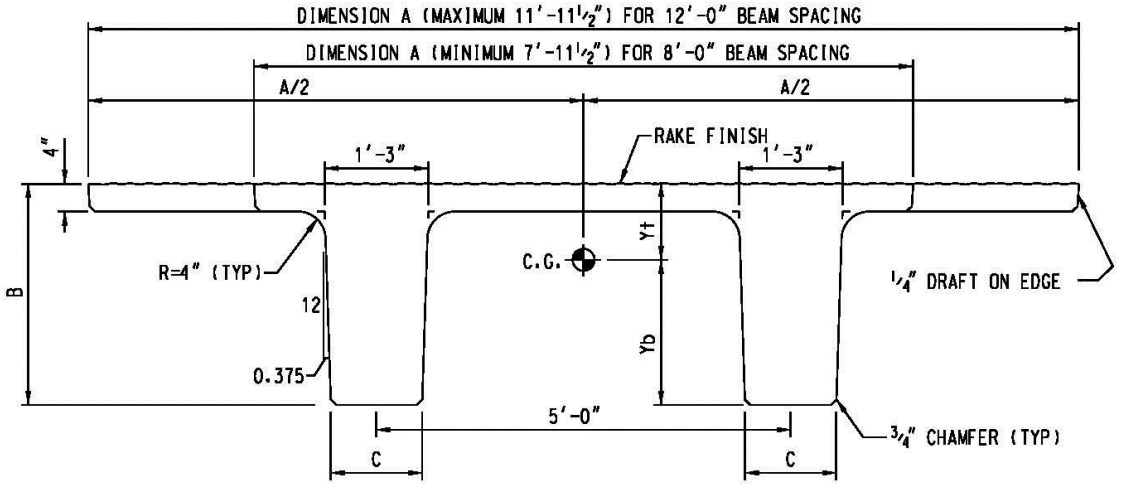
Bridge Section – Traditional "I" Girder vs NEXT



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
- 100 mm (4″) increments
- Width: will vary 2.4m (8′-0″) – 3.7m (12′-0″)

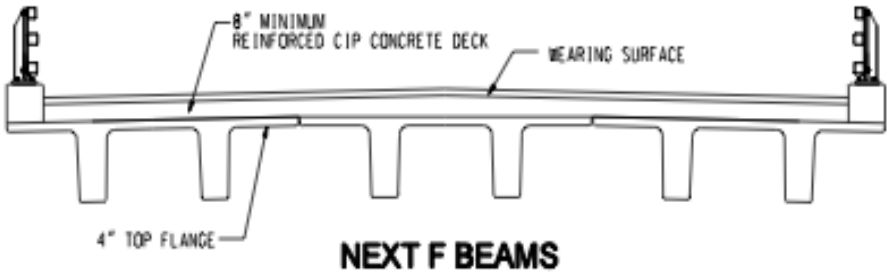


NEXT BEAM - SECTION PROPERTIES

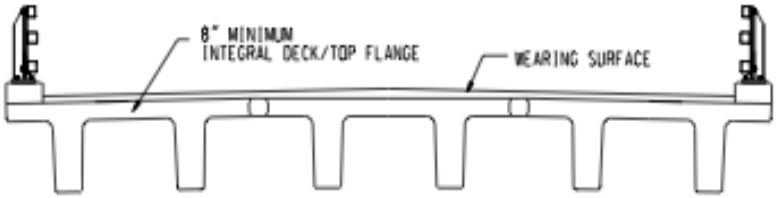
BEAM DESIGNATION	BEAM WIDTH INCHES	BEAM DEPTH INCHES	BASE STEM WIDTH INCHES	AREA IN²	I IN⁴	Yb INCHES	Yt INCHES	St IN³	Sb IN³	WEIGHT PLF
	A	B	C			D	E			
MINIMUM WIDTH BEAMS										
NEXT 36	95.50	36.00	13.00	1287	160240	21.77	14.23	11261	7361	1341
NEXT 32	95.50	32.00	13.25	1182	115813	19.51	12.49	9272	5936	1231
NEXT 28	95.50	28.00	13.50	1075	79901	17.24	10.76	7426	4635	1120
NEXT 24	95.50	24.00	13.75	966	51823	14.95	9.05	5726	3466	1006
MAXIMUM WIDTH BEAMS										
NEXT 36	143.50	36.00	13.00	1479	185525	23.36	12.64	14678	7942	1541
NEXT 32	143.50	32.00	13.25	1374	134258	20.98	11.02	12183	6399	1431
NEXT 28	143.50	28.00	13.50	1267	92661	18.57	9.43	9826	4990	1320
NEXT 24	143.50	24.00	13.75	1158	60045	16.12	7.88	7620	3725	1206

NOTES:

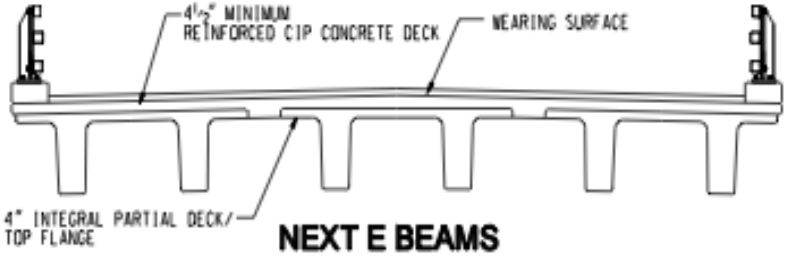
NEXT Beam Shapes



NEXT F BEAMS



NEXT D BEAMS



NEXT E BEAMS

NEXT F plus 250mm (8")CIP Deck

- **No Forming** between Flanges
- Easily accommodates **Vertical**
- **Curves** w/CIP Topping
- Easily **Handles Camber Variations** between Members

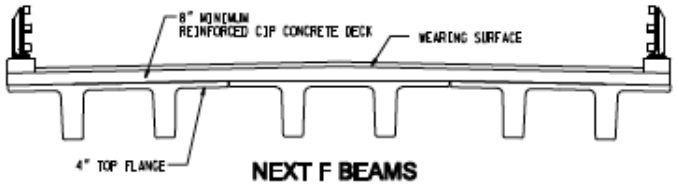
NEXT D no CIP Deck

- Best Section For **ABC**
- Special Concrete for **Flange Connection**
- Matching of **adjacent members**
- Skew/Design

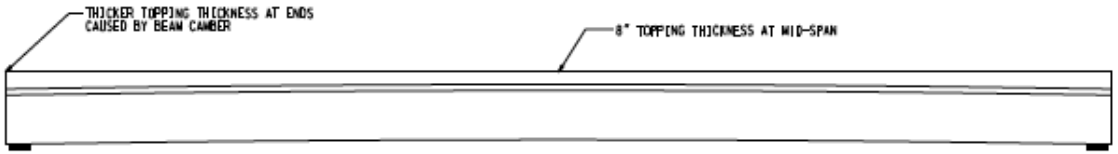
NEXT E plus 100mm (4") CIP Deck

- **Less Topping** & Reinforcement
- **Flange Connection** with CIP
- Easily Accommodates **V**ertical Curve
- Easily **Accommodates Camber** Variations between members

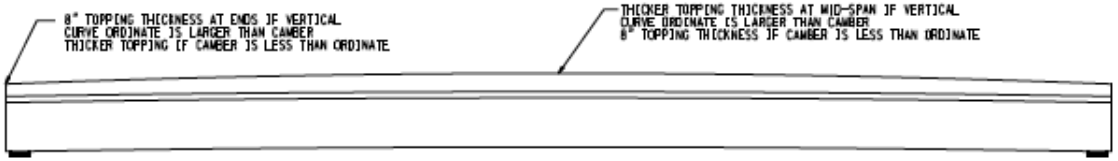
NEXT D, E, F Beams (TYP)



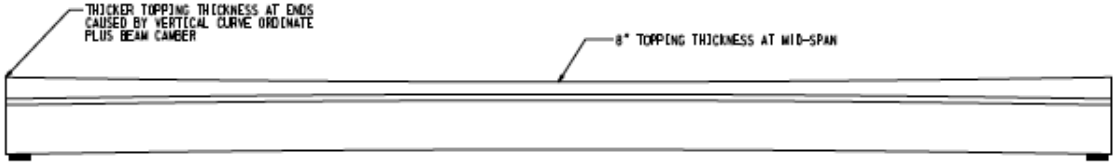
NEXT F BEAMS



NEXT F BEAMS - TANGENT PROFILE



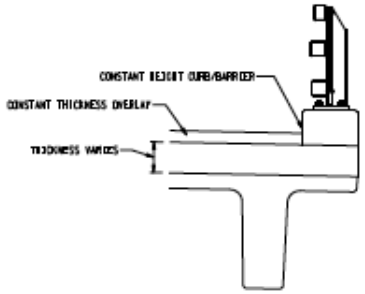
NEXT F BEAMS - CREST VERTICAL CURVE PROFILE



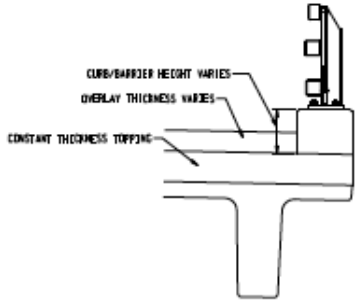
NEXT F BEAMS - SAG VERTICAL CURVE PROFILE

NOTES

1. THE DETAILS SHOWN REFLECT VARYING THE THICKNESS OF THE CONCRETE TOPPING. ANOTHER OPTION IS TO VARY THE THICKNESS OF THE OVERLAY. NOTE THAT THE HEIGHT OF THE CURB OR PARAPET WILL STILL VARY.
2. CREST VERTICAL CURVES: IF THE CAMBER IS LESS THAN THE CURVE ORDINATE, THE DETAILS WILL BE SIMILAR TO THE TANGENT PROFILE DETAILS.
3. THE ENGINEER SHOULD DETAIL THE ANTICIPATED VARIABLE THICKNESS OF THE TOPPING OR OVERLAY ON THE PLANS BASED ON THE ANTICIPATED CAMBER. THE PLANS SHOULD INCLUDE NOTES REQUIRING SURVEY OF THE BEAMS AFTER ERECTION. ADJUSTMENT OF THE TOPPING THICKNESS MAY BE REQUIRED. THE SAME APPLIES TO THE HEIGHT OF THE CURB OR BARRIER.



OPTION 1: VARY TOPPING THICKESS



OPTION 2: VARY OVERLAY THICKESS

WWW.PCINE.ORG

PCL

PRECAST/PRESTRESSED CONCRETE INSTITUTE NORTHEAST

NORTHEAST EXTREME TEE (NEXT) BEAM DETAILS

NEXT F – PROFILE ACCOMMODATION DETAILS

DISCLAIMER: The details shown are guidelines and should not be considered standards. The information has been obtained from sources believed to be reliable. PCI Northeast or its committee and staff are not responsible for any errors, omissions or misinterpretations arising out of the use of this information. PCI Northeast or its committee and staff are not responsible for any claims or damages arising out of the use of this information, including any patent infringement or other proprietary rights. Use of this information is voluntary. PCI Northeast is not rendering any engineering or other professional services through this publication. If such services are required, please seek an appropriate professional.

ISSUE DATE:

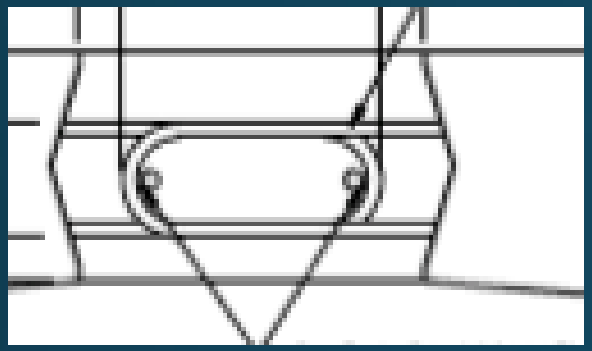
SHEET:

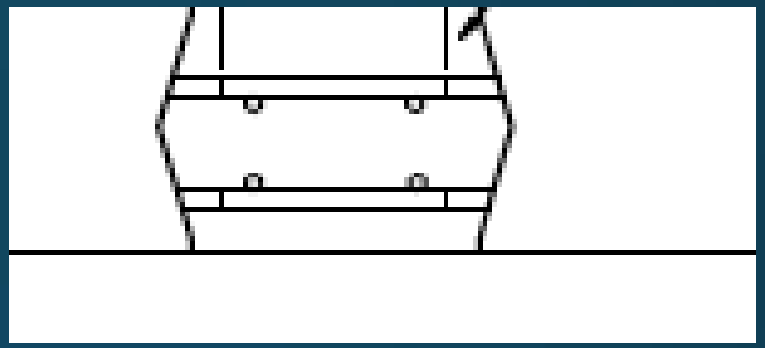
REVISIONS

NO.	DATE	DESCRIPTION

Precast Joints for Closure Pours

Two types of joint details





Normal Concrete

UHPC Concrete

FHWA EDC-3

U.S. Department of Transportation
Federal Highway Administration

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FHWA Home / Accelerating Innovation / Every Day Counts / Ultra-High Performance Concrete Connections for Prefabricated Bridge Elements

Find an Innovation | Apply for a Grant | Get Engaged | Every Day Counts | STIC Network

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.

Contact

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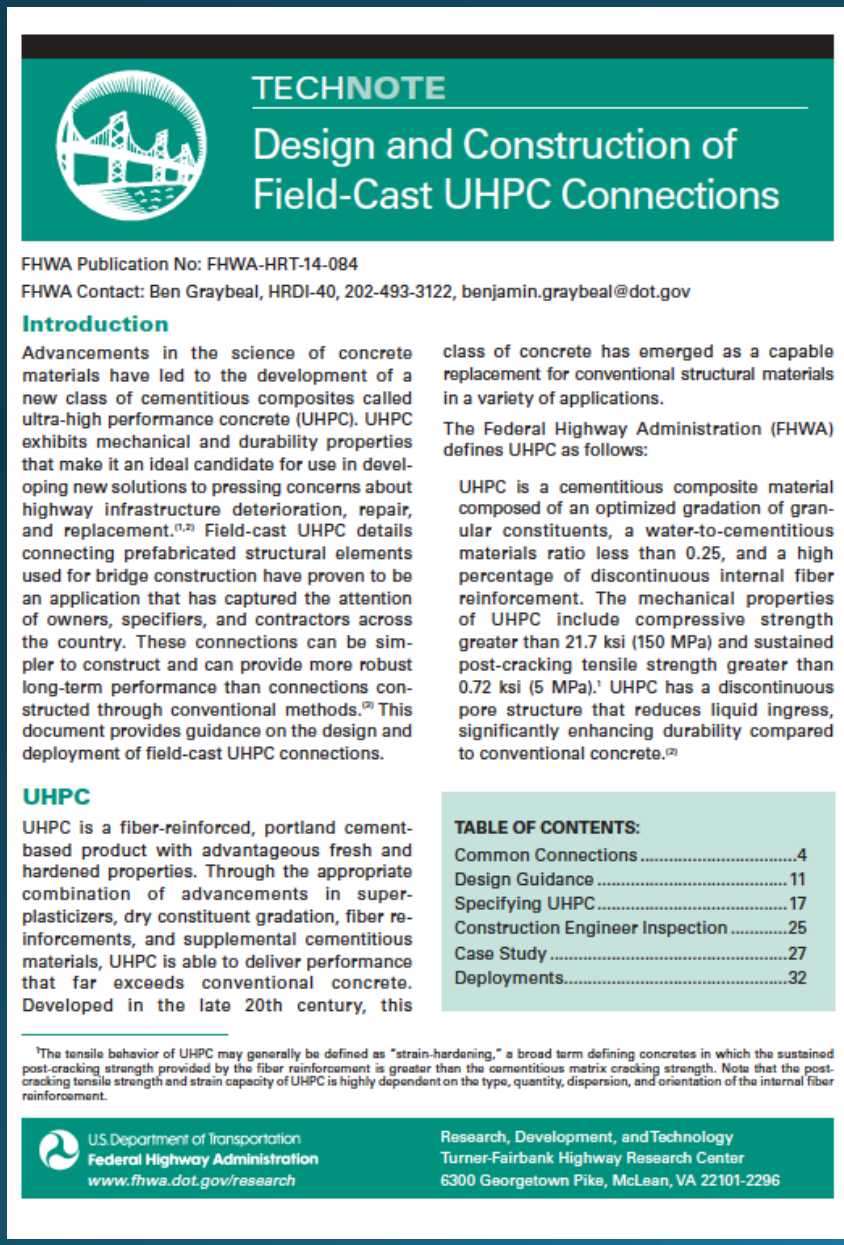
FHWA Resource Center
(404) 562-3930
Benjamin.Beerman@dot.gov

Resources

Fact Sheet

EDC Regional Summit Presentation

New Reference From FHWA



TECHNOTE

Design and Construction of Field-Cast UHPC Connections

FHWA Publication No: FHWA-HRT-14-084

FHWA Contact: Ben Graybeal, HRDI-40, 202-493-3122, benjamin.graybeal@dot.gov

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.[1,2] 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.[2] 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 superplasticizers, 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 ksi (150 MPa) and sustained post-cracking tensile strength greater than 0.72 ksi (5 MPa).[1] UHPC has a discontinuous pore structure that reduces liquid ingress, significantly enhancing durability compared to conventional concrete.[2]

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[1]The tensile behavior of UHPC may generally be defined as "strain-hardening," a broad term defining concretes in which the sustained post-cracking strength provided by the fiber reinforcement is greater than the cementitious matrix cracking strength. Note that the post-cracking tensile strength and strain capacity of UHPC is highly dependent on the type, quantity, dispersion, and orientation of the internal fiber reinforcement.

U.S. Department of Transportation
Federal Highway Administration
www.fhwa.dot.gov/research

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike, McLean, VA 22101-2296

TECHNOTE:

Design and Construction of Field-Cast UHPC Connections

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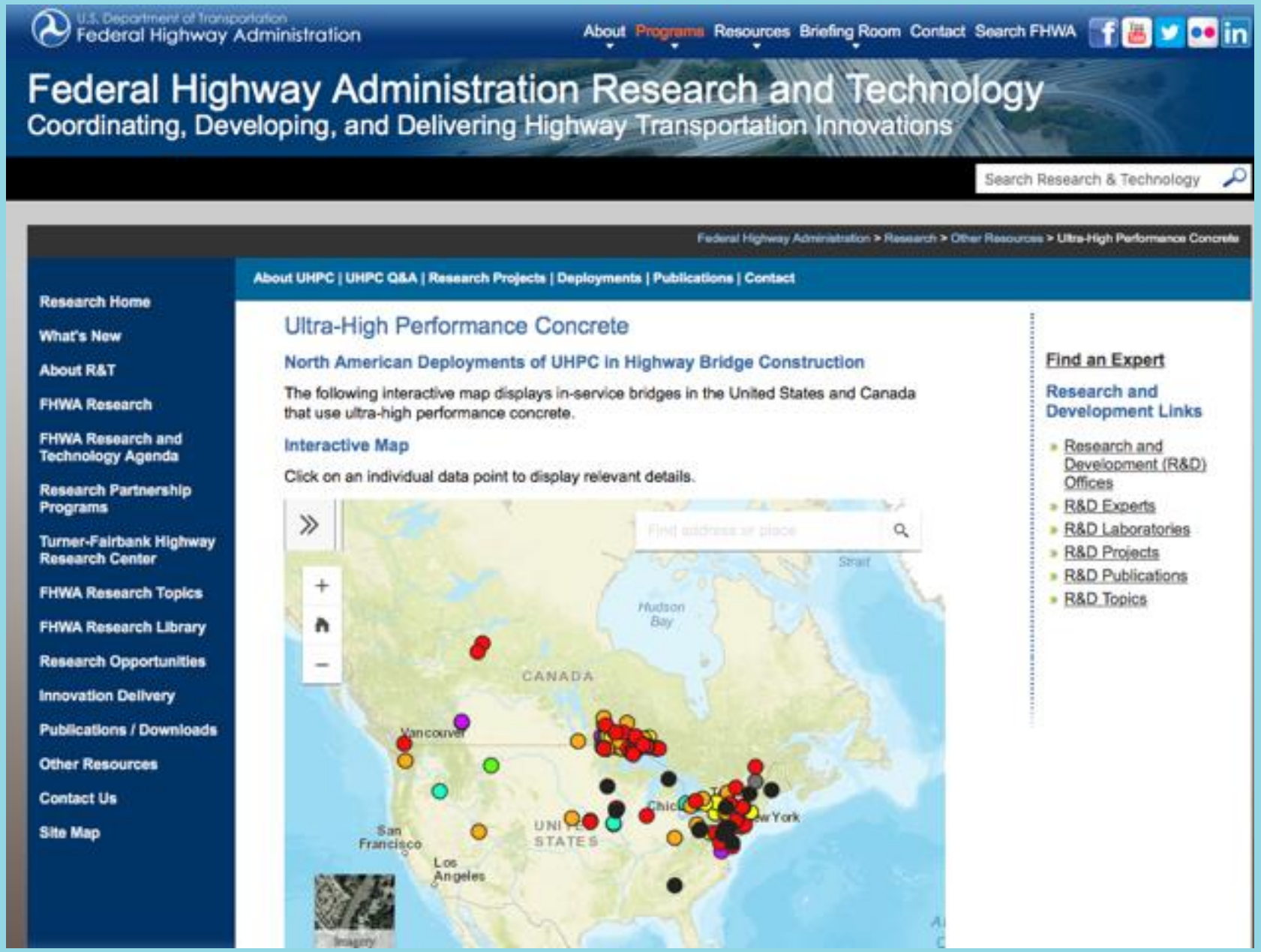
FHWA Deployment of UHPC



NEXT Beam Acceptance - States with NEXT

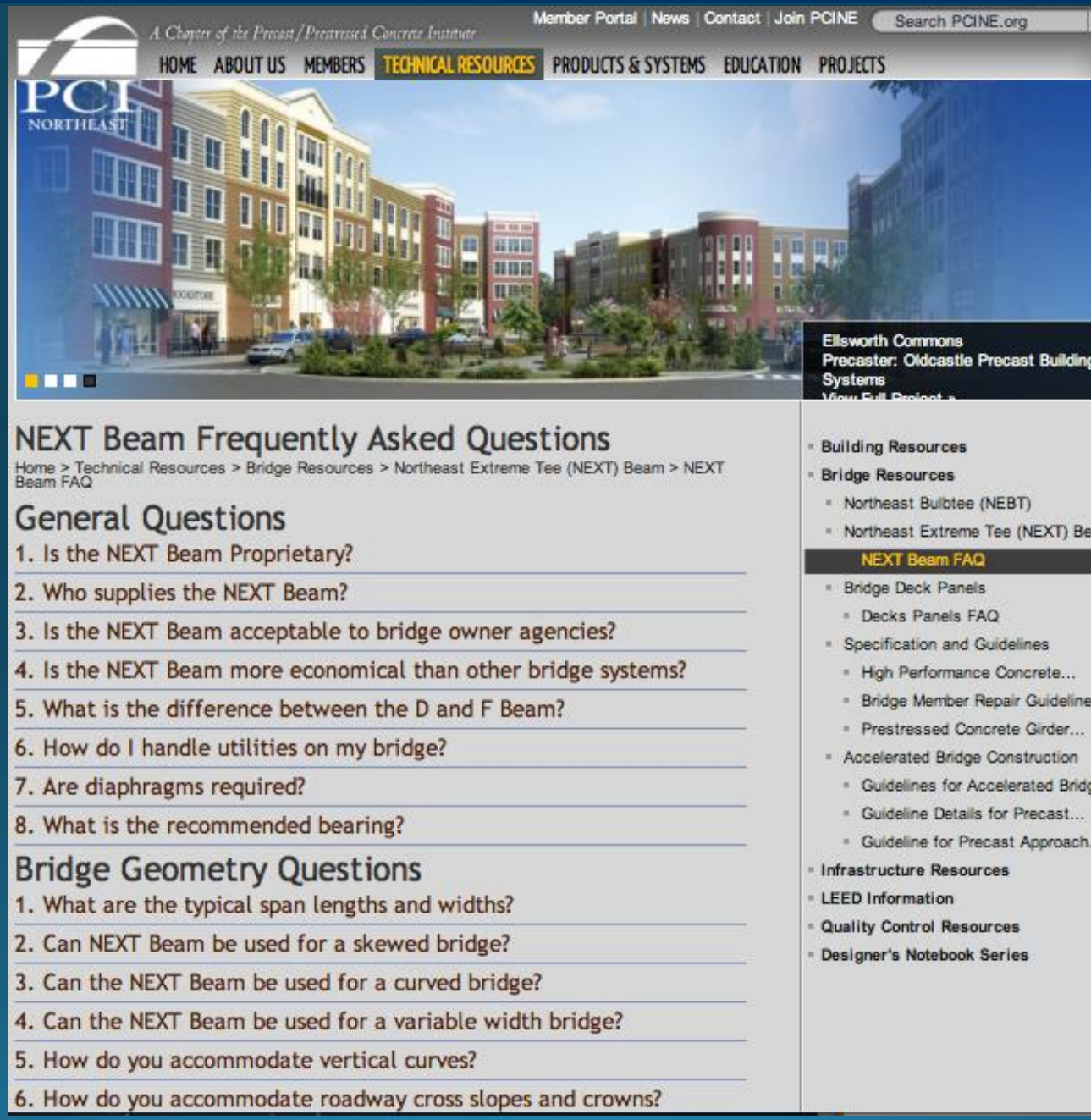
United States

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

Canada - New Brunswick

Additional Guidance on website www.pcine.org

- FAQ's
- Design Assumptions



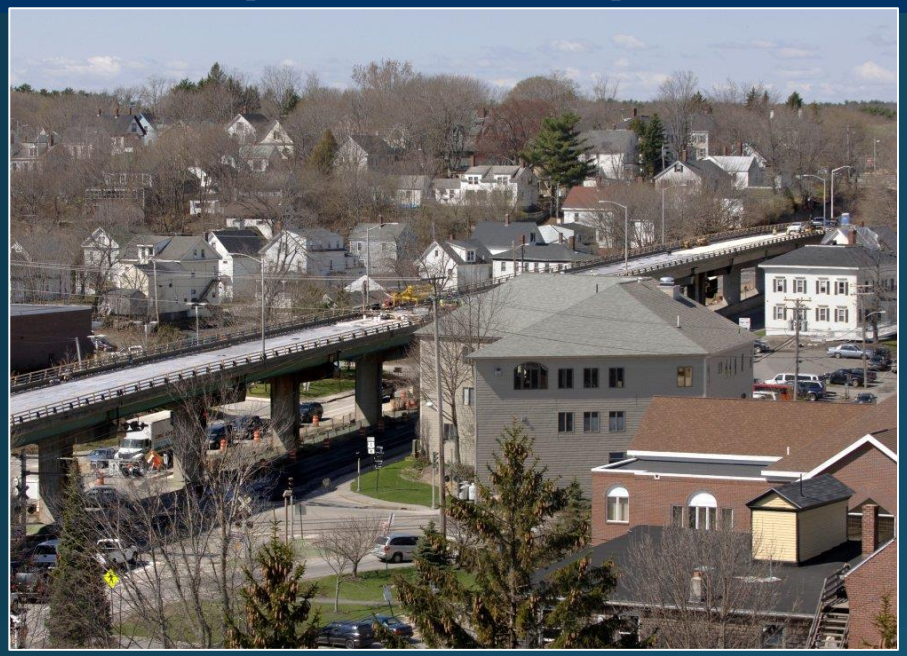
Typical NEXT Beam Production

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

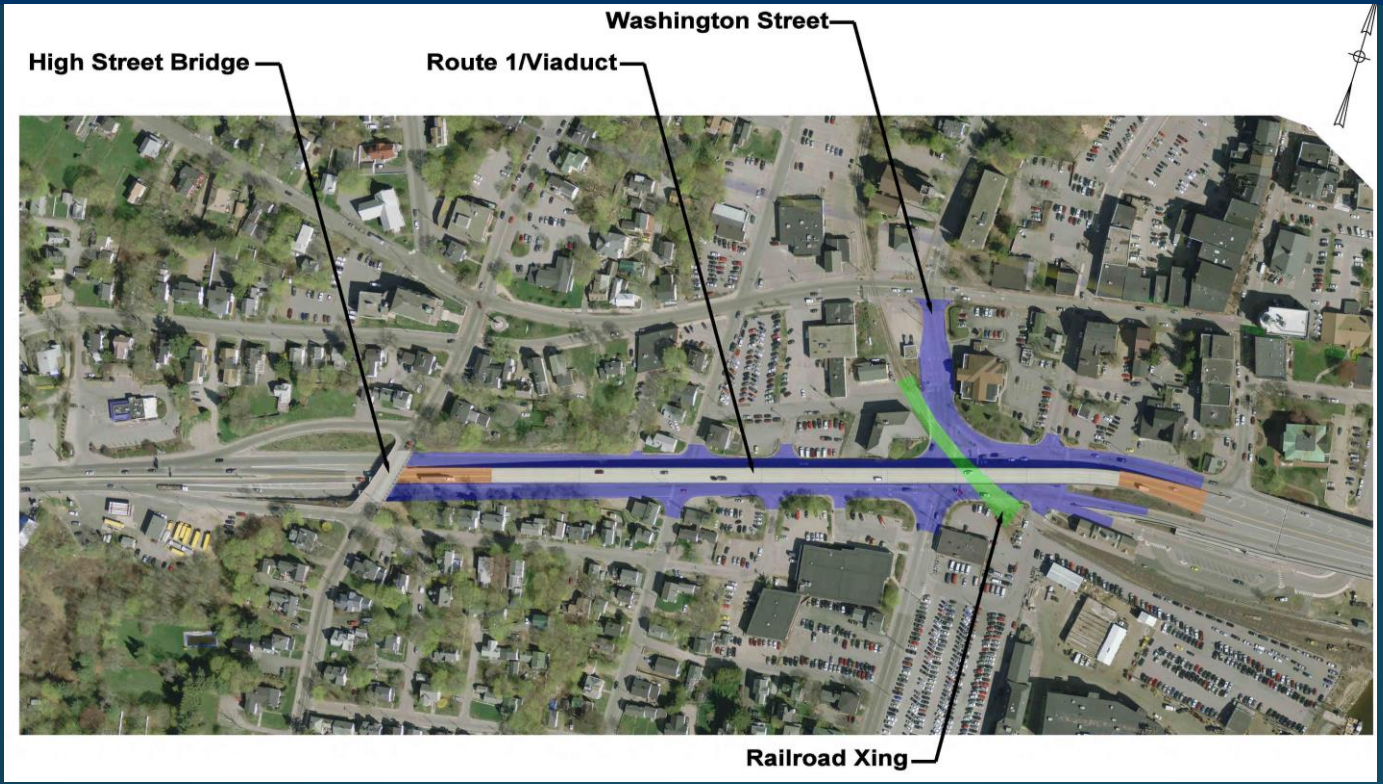


Vital transportation link for Bath, Maine since 1958

2006 – Surface replacement

2016 - $12 million complete re-construction

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

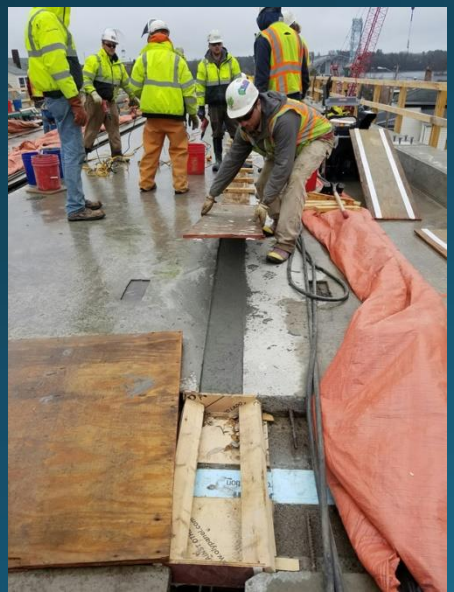
Shipment:
December 2016;
two girders
shipped/day

Bath Viaduct Replacement, Bath Maine

Shipping complete in February 2017

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

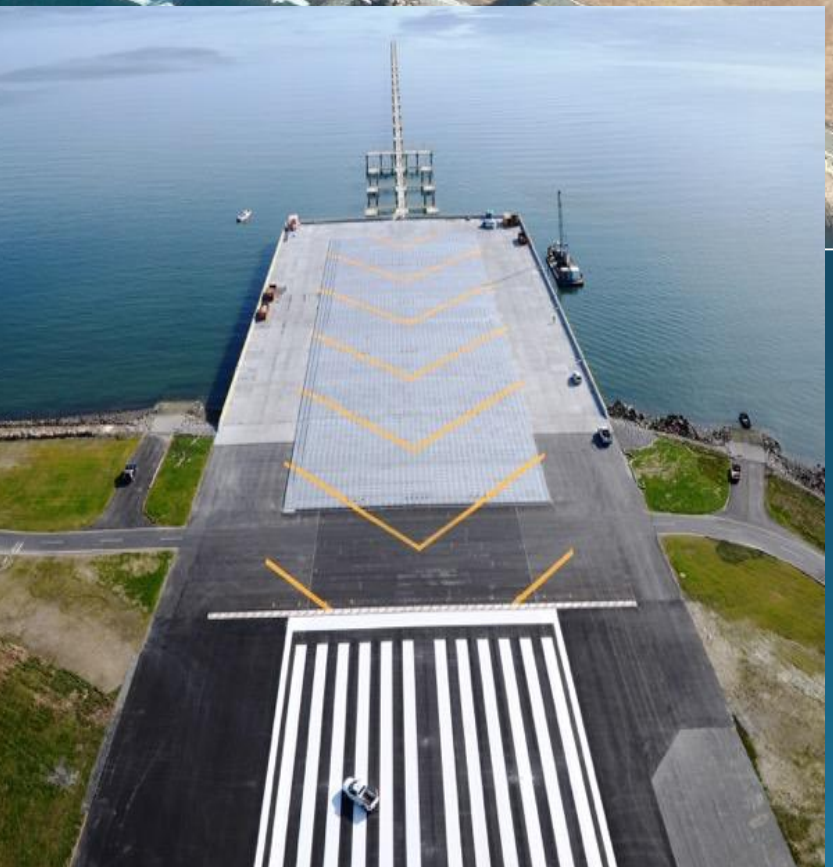
Rita Seraderian, PE, FPCI
Precast/Prestressed Concrete Institute
Northeast
www.pcine.org

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) (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.

New York Wheel Staten Island NY

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.