An Introduction to Accelerated Bridge Construction with Precast Concrete:

Purdue Road School

Wednesday, March 16th, 2022

Daryl Burns, P.E.
Director of Codes and Standards
National Precast Concrete Association
OH You are from New York...
OH You are from New York...
National Precast Concrete Association

• Headquarters in Carmel, IN
• NPCA Members:
  – Producers
  – Associates
  – Professional Members
  – Student Members
• Plant Certification, Education, Codes & Standards, Specifications, The Precast Show, Committees, Publications
History
Frankford Avenue Bridge, also known as the Pennypack Creek Bridge, 1697 Northeast Philadelphia, still in use after 325 years
Objective Today

This presentation will provide a brief overview and introduction to Accelerated Bridge Construction (ABC) and prefabricated bridge elements and systems (PBES).

We will also look at a various projects and a couple of case studies so that you can see how easy it is to implement precast into your ABC bridge project.
Outline

1. Introduction to Accelerated Bridge Construction (ABC)
2. Introduction to Precast Concrete Prefabricated Bridge Element Systems (PBES)
3. Example Case Study I (Complete ABC Bridge)
4. Example Case Study II (ABC for Bridge Rehab)
5. Questions
6. Closing Information
1. What is Accelerated Bridge Construction (ABC)

ABC is bridge construction that uses innovative planning, design, materials, and construction methods in a safe and cost-effective manner to reduce the onsite construction time that occurs when building new bridges or replacing and rehabilitating existing bridges.
When did accelerated bridge construction start?
ABC is NOT New:
George P. Coleman Bridge, VA- 1995:

Slide credit: Keith Hoernschemeyer, FHWA
Precast Concrete Bridge Decking
circa 1990
I-35W Bridge Minneapolis
Minneapolis Franklin Ave. Bridge
What is UHPC?

Characteristics of UHPC:
- Ultra-high strength
- Durability with low permeability
- Highly moldable/flowable/dry-cast
- Better bond development
- Aesthetic design flexibility
- Quality surface aspect
UHPC in Bridge Joints

- Compressive strengths upwards of 25 ksi
- Ideal for ABC as it achieves strength very quickly. (14 ksi in 12 hours)
- Substantially reduced development length of reinforcing – smaller bridge joints
This method is Not new

Engineering techniques used in collapsed FIU bridge are common: experts
The same techniques were used in the construction of at least 800 bridges throughout the country.

April 01, 2018 09:00AM

Experts say the engineering behind the collapsed FIU bridge in Miami was nothing special.

As scrutiny turns to what led to the bridge’s collapse, the structure’s so-called unconventional engineering and construction has been put in the spotlight, but the techniques used to build the bridge, known in the business under the umbrella term of “ABC” or Accelerated Bridge Construction, are typical and longstanding practices, according to Wired.

ABC refers to a series of techniques that reduces the amount of construction that takes place on the site itself. This means prefabricating elements of the structure elsewhere and then using Self-Propelled Modular Transporter vehicles to move and install the bridge on the site. The ABC method dates back to the 1970s and, though more expensive, is favored due to its comparatively strong track record for keeping workers safe on the job.

About 800 bridges were built with federal funding using the ABC method between 2010 to June 2012,
This method is Not new

ABC milestones

1985: TRB ASTM 60 formed to remove barriers to innovation, safety, QC. 2-day seminar on


2000: First PBES Conference AASHTO, FHWA

2002: AASHTO TIG formed

2004: SHRP2 R04 Innovative Bridge Design for Rapid Renewal

2006: Highways for Life funded

2007: FHWA Framework PBES Decision Making

International Scan: movement, superstructure, hybrid

2008: FHWA - HIF-12-013 ABC Design, Fabrication & Erection

2009: NCHRP 681 - Development PC Seismic Pile Cap

2010: FHWA - HIF-17-019 ABC Design, Fabrication & Erection

2012: FHWA - HIF-17-020 ABC Contracting and Construction

2015: ABC UTC established at FIU by U.S. DOT, incl. U of NV (Reno) & Iowa State

2018: TRB AFF10-3 ABC Subcom

This method is Not new

History of ABC Implementation in U.S. - Mary Lou Ralls, P.E.
Key Factors in ABC
Identified ABC Benefits

- Reduced Road User Impacts
- Improved Worker and Motorist Safety
- Expedited Project Planning Process
- Improved Quality
- Improved Constructability
- Reduced Cost to Society

from ABC Field Manual HIF-12-013 11-01-11
How Important Is ABC?:

1. U.S. Department of Transportation launched 27.5B Bridge Plan 2022
2. Single Largest
3. 5.3B for 2022 alone
4. Some States to compare:

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<tr>
<th>State</th>
<th>Amount</th>
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<tr>
<td>Illinois</td>
<td>1,374,037,635</td>
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<tr>
<td>Indiana</td>
<td>400,638,820</td>
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<tr>
<td>New York</td>
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</tbody>
</table>

https://www fhwa dot gov/bipartisan- infrastructure- law/bridge_5year_funding_by_state.cfm
Key Factors in ABC

https://www.fhwa.dot.gov/bridge/prefab/
2. What are Precast Concrete Prefabricated Bridge Element Systems (PBES)

**Examples:**

- Precast Abutments
- Precast Wingwalls and Retaining Walls
- Precast Bridge Deck Panels
- Precast/Prestressed Bridge Beams
- Precast Approach Slabs
- Precast Traffic Barriers
- Precast as composite with steel beams
ABC Prefabricated Bridge Element Systems (PBES)
ABC Prefabricated Bridge Element Systems (PBES)

Bridge Girders

Full Depth Bridge Deck Panels
ABC Prefabricated Bridge Element Systems (PBES)

Piers and Abutments

Pier Caps
ABC Prefabricated Bridge Element Systems (PBES)
ABC Prefabricated Bridge Element Systems (PBES)

Precast Footings

Bridge Railings
ABC Prefabricated Bridge Element Systems (PBES)

Geofoam Embankments

MSE Walls

Large Modular Block
ABC Prefabricated Bridge Element Systems (PBES)
Precast Soil-Structure Bridges

Precast Footings
ABC Prefabricated Bridge Element Systems (PBES)
Precast Soil-Structure Bridges

BRIDGE BUNDLING
ABC Prefabricated Bridge Element Systems (PBES)

Full Depth Bridge Deck Panels, Hybrid Bridge Girders, Pier & Caps, Abutments, Approach Slabs

Photo courtesy of Johnson, Mirmiran & Thompson, Inc.
Forward:
This manual has been developed for the purposes of enhancing the use of Prefabricated Bridge Elements and Systems (PBES) as part of accelerated construction projects.

Users of this manual will be able to perform the following tasks:
• Understand the different types of ABC technologies that are in use today
• Understand the various types of prefabricated elements used in bridges
• Assess specific sites for the most appropriate ABC technology for the project
• Plan and implement an accelerated bridge construction program using PBES.
Forward:
This manual is a follow-up of a previously completed manual on Accelerated Bridge Construction (ABC). The purpose of this manual is to provide more in-depth information on the design, fabrication and erection of PBES.

Users of this manual will be able to perform the following tasks:
• Understand the different materials used in the construction of prefabricated bridge elements and systems.
• Understand the design requirements for the most common PBES technologies in use today.
• Understand how to specify PBES and design them for shipping and erection.
Forward:
The purpose of this manual is to provide more in-depth information on Contracting and Construction of Accelerated Bridge Construction with Prefabricated Bridge Elements and Systems.

Users of this manual will be able to perform the following tasks:
• Understand the different contracting methods and contracting provisions that are commonly used with ABC projects.
• Understand the various construction methods used for ABC with PBES.
• Understand how to manage an ABC construction project.
2018 AASHTO LRFD Guide Specifications for Accelerated Bridge Construction

This is not a stand-alone design specification.
This document is intended to supplement the AASHTO LRFD Bridge Design Specifications and the AASHTO LRFD Bridge Construction Specifications.
3. Example ABC Case Study #1

South Creek Road over Clockville Creek

- Owner: NYSDOT Madison County DPW
  » Town of Lincoln, NY
- Bridge Information
- Completed in 2015
- Construction Cost: $500,000
- Awards
- Construction Duration: **14 DAYS!**
Case Study #1

- Simple
- Economical
- Fast Solution
Case Study #1

Bridge Data:
- Year Built: 1950
- Steel Stringers
- Timber Deck
- Span Length: 30 feet
- Out to Out Width: 23.6 feet
- Skew Angle: 30 Degrees
- Abutment Height: 14 Feet
- Posted for 5 Tons
- Founded on Spread Footers
Case Study #1

Bridge Replacement Alternatives:

• Precast Concrete Four-Sided Double Barrell Box Culvert
• Precast Concrete Three-Sided Structure (Flat Top or Arch)
• Integral Abutment with Prestressed Beams
• Non-Conventional System
Case Study #1

Main Components:

- Precast Concrete Footings
- Precast Concrete Lagging
- Precast Concrete Cap
- H-Piles Embedded In Concrete Footings
- Precast Deck Slabs or Beams
Case Study #1

How It Works:

- Precast Deck Beams: Carry the bridge live loads
- Precast Lagging: Designed to Retain The Soil and Resist Lateral Forces from Soil
- H-Piles: Designed to Carry the Cap Beam Which Carries The Super Structure
- Precast Footings: Designed to Distribute the Load to The Bearing Stratum
- Mechanical Couplers: Connects The Units Together
Case Study #1

**Pros:**
- Simple and Flexible Design
- Easy To Handle and Install
- Small Sections Compared to Conventional Design
- Fast Construction Time
- Economic Design
- Concrete Cap To Accommodate Bridge Seat Requirements
- Can Be Installed with Mid Size Excavator

**Cons:**
- Aesthetics
Case Study #1
Case Study #1
Case Study #1
Case Study #1
Case Study #1
Case Study #1
Case Study #1
Case Study #1
Case Study #1
Case Study #1
Country Club Road over Patterson Creek Bridge

- Owner: NYSDOT Town of Union
  » Endwell, NY
- Bridge Rehabilitation Information
- Completed in 2019
- Construction Cost: 1.3M
- Construction Duration of 21 DAYS
Case Study #2
Case Study #2
Case Study #2
Case Study #2
Case Study #2

TYPICAL TRANSVERSE JOINT

ULTRA HIGH PERFORMANCE CONCRETE

CLEAN INTERIOR OF SHEAR KEY AS PER SECTION 6.2.1 OF THE NYS DOT PCNL

1/4" (NOW) FOR DIAMOND GRINDING, ITEM 502.8201.0018

NPCA
Precast ... The Concrete Solution
Case Study #2
Case Study #2
Case Study #2
Case Study #2
Case Study #2
Case Study #2
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Case Study #2
Case Study #2
Case Study #2
What’s Next for ABC?

Outskirts of Wuppertal, Germany
Questions?
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