

Systematic Development, Implementation, and Deployment of Pre-Fabricated Bridge Elements



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INGENUITY IMAGINATION

INVENTION INNOVATION

Highlights.....

- ▶ WisDOT's ABC Development of PBES – Piers
- ▶ Road of Development, Implementation, and *Institutionalization*
- ▶ Lessons Learned
- ▶ Where We Want to Go From Here



Research Initiatives for ABC

- ▶ **FHWA – IBRC** (Innovative Bridge Research and Construction)
- ▶ **FHWA IBRD** (Innovative Bridge Research and Deployment)



- ▶ **WHRP** (Wisconsin Highway Research Program)



WisDOT's ABC Initiative – 2005

- ▶ Completed – Precast full-depth deck panels



IH-39/90 (B-13-161) FHWA - IBRC

WisDOT's ABC Initiative – 2008

- ▶ Completed – Prefabricated abutments



USH 63 (B-55-217) FHWA - IBRC

WisDOT's ABC Initiative – 2009

- ▶ Completed – Prefabricated pier caps and abutments



STH 25 (B-6-157/158) FHWA - IBRC

WisDOT's ABC Initiative – 2011

- ▶ Completed – Superstructure lateral slide



STH 29 (B-5-648/649)

WisDOT's ABC Initiative – 2012

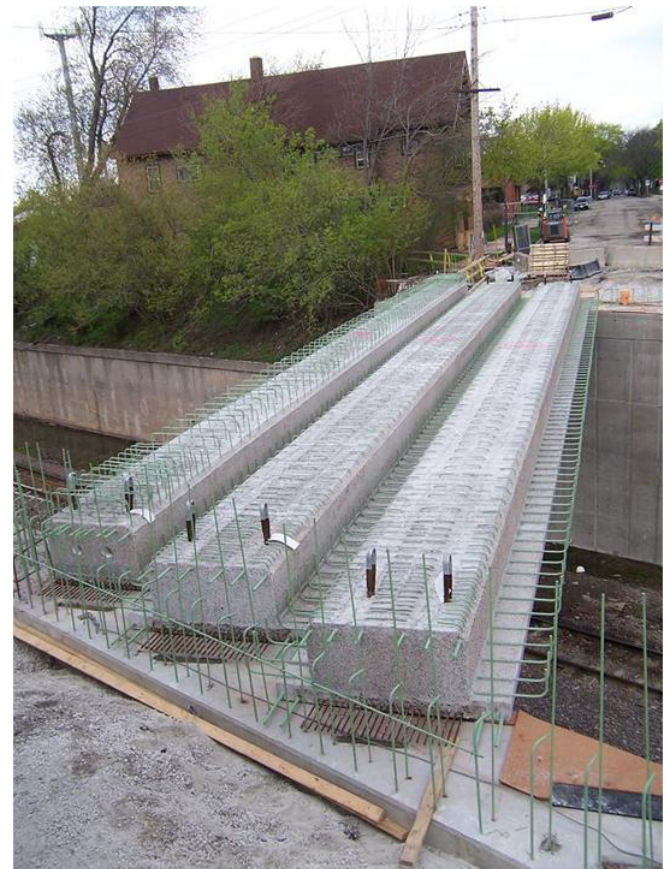
- ▶ Completed – GRS–IBS



STH 40 (B-9-380) FHWA - IBRD

WisDOT's ABC Initiative – 2013

- ▶ Completed – Inverted Tee



Lessons Learned from Research and Pilot Projects:

- ▶ These technologies can work – Meet Project Needs
- ▶ Custom details can be expensive
- ▶ Lack of experience or understanding can affect price
- ▶ Industry has some very good insight

WisDOT ABC Program



FHWA Highways for Life & EDC Initiative

- ▶ Highways for Life is aimed at improving Safety, Reducing Congestion, and Improving Quality



- ▶ Federal Highway Administration's (FHWA) Every Day Counts (EDC) initiative "aimed at shortening project delivery, enhancing the safety of our roadways, and protecting the environment."



INGENUITY IMAGINATION

INVENTION INNOVATION

WisDOT ABC Team

- ▶ The Team:
 - Guidance – State Trans. Innovation Council (STIC)
 - Department Experts (Bridge, Geotech, and Contract Administration)
 - FHWA Resources and Support
 - Consultant, Contractor, and Fabricator Support
- ▶ The Objective:
 - Get out in front of projects and develop the Policy, Guidance, Standards, and Provisions to implement ABC tools and solutions *To Meet Project Needs*

WisDOT's ABC Goals

- ▶ Develop Accelerated Bridge Construction options to facilitate safe and efficient transportation systems that better serve the public.
 - Safer projects
 - Less disruptive impacts to the traveling public
 - Higher quality
 - Potential cost savings
 - **And, potential options for the Contractors.....**

Our Process of Development:

- ▶ **Research** – Development of Technologies
- ▶ **Custom** – Project/Site Specific Details and Specifications
- ▶ **Standardize** – Program & Corridor Approach
- ▶ **Institutionalize** – System-wide Policy & Applications
- ▶ Learn, Document, and Update as Needed

Custom Application

- Rawson Avenue



WisDOT's ABC Initiative – 2013

- ▶ Precast Piers and SPMT Move





Project Summary

- ▶ I-94 North-South Corridor Mega Project
- ▶ Full Reconstruction Tight Diamond Interchange
- ▶ Replace 2 Existing Bridges
- ▶ High Volume ADT
 - I-94: 98,000 (2013)
 - Rawson Ave: 26,000 (2013)



Existing interchange

Rawson Ave Precast Piers



Pier Construction – Footings

- ▶ Cast in Place Pier Footing
 - Driven pile and cast in place pile cap
 - Pre-assembled cage
 - Detailed bar steel placement with template
 - High early strength concrete



Pier Construction – Pier Columns

- ▶ Used grouted bar couplers for connections
 - Fast erection
 - Tight fabrication tolerance (use templates)

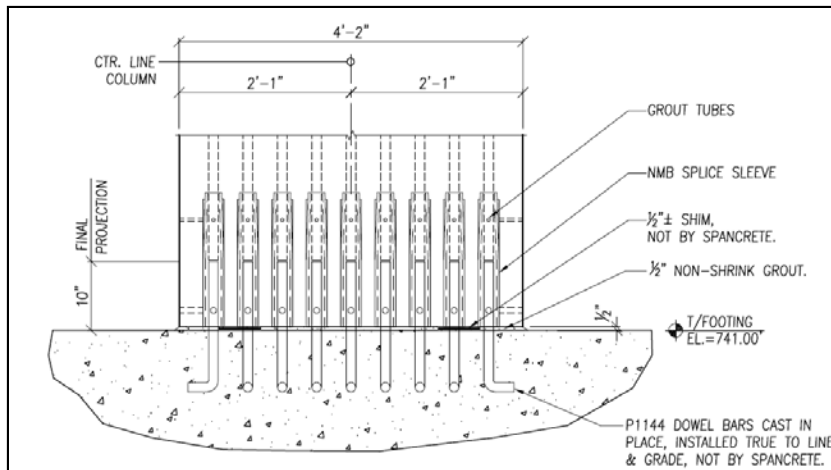
Column
base



Column erection

Construction – Connections

- NMB Splice-Sleeve (#11 Bar)
- Plumb Sleeves
- Column Shims
- Mass Grouting
- 8000 psi Non-Shrink Grout



Construction – Pier Cap

- ▶ Precast pier cap
 - Cap Steel & Couplers
 - Sections up to 45 tons – Two (2) cranes
 - Tight construction tolerances
 - Survey control



Precast Piers





Lessons Learned – Precast Piers

- ▶ Forming was unique, challenging, and costly
- ▶ Place Grouted Coupler orientation to avoid conflicts with cap reinforcement.
- ▶ Hold beam seats low and shim them upward to avoid grinding of beam seats.
- ▶ Size and Weight of Precast Elements

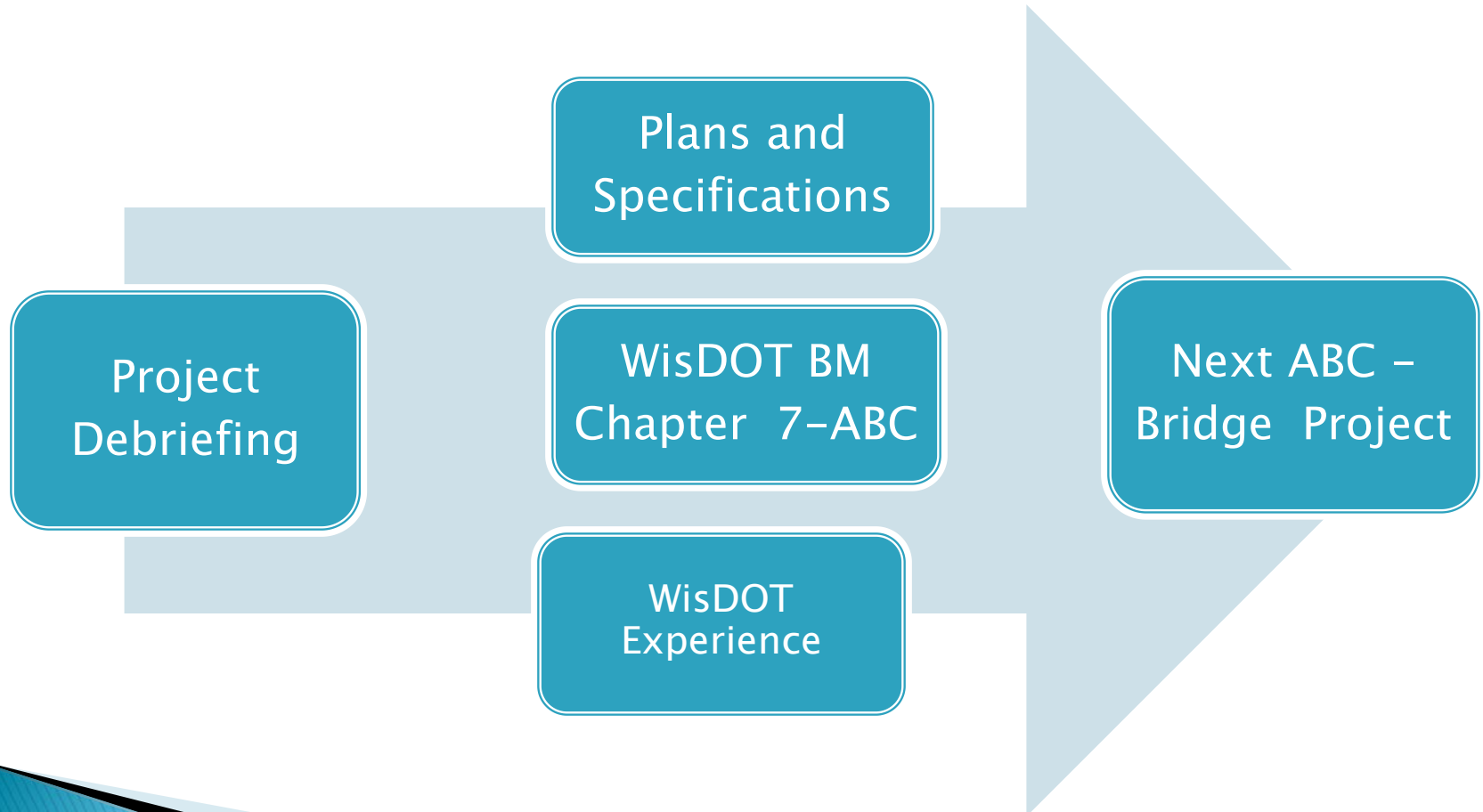
Lessons Learned – Precast Piers

- ▶ Choose a coupler systems that allow the coupler to be 1 to 2 bar sizes larger than connecting bar.
- ▶ Comprehensive Survey Control
- ▶ Saved 3 – 4 Weeks



WisDOT Perspective

▶ Lessons Learned



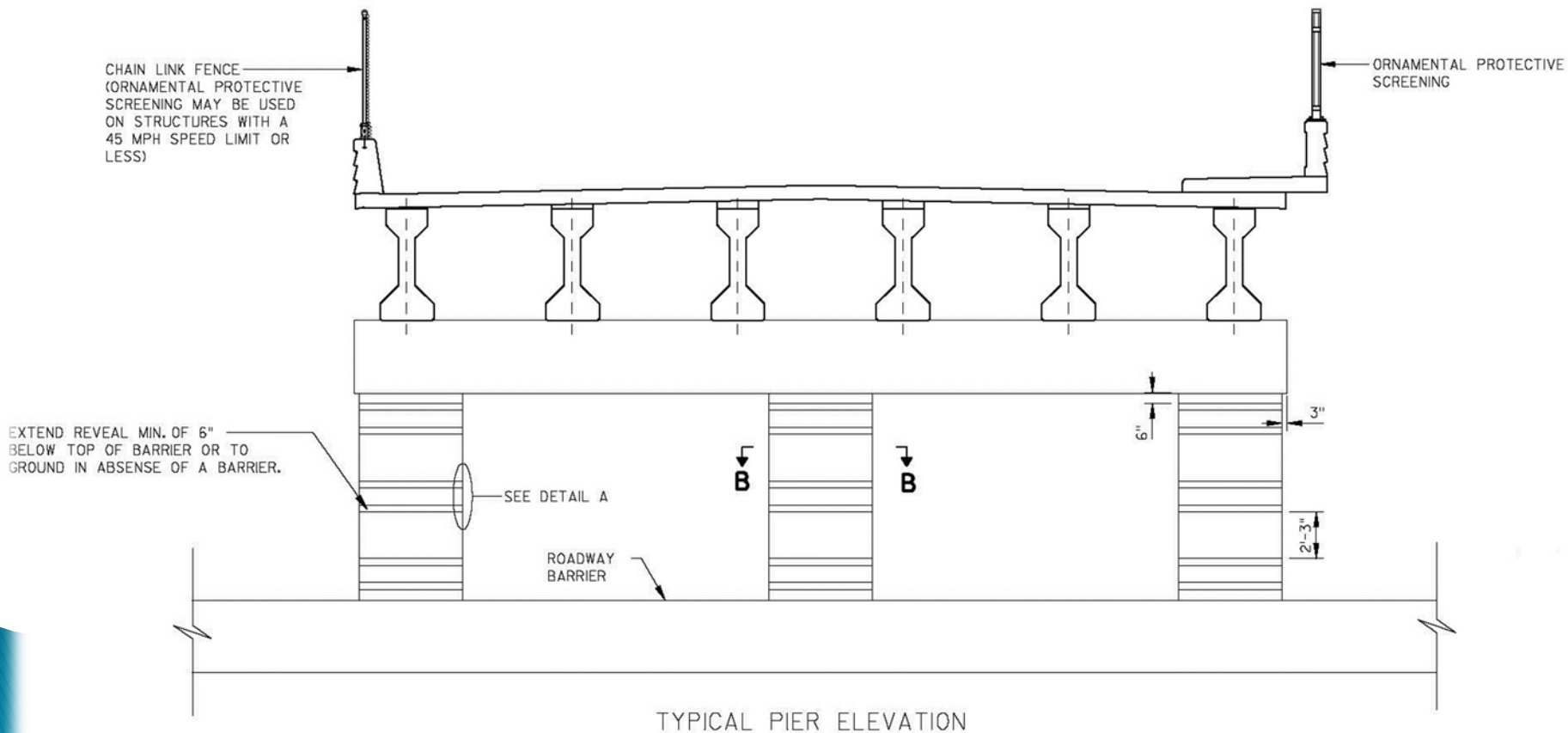
Opportunity to Apply Lessons Learned

- ▶ Precast Piers (IH-39/90 Corridor)
- ▶ Strategic Highway Research Program (SHRP2)
- ▶ R04 – Innovative Bridge Designs for Rapid Renewal
- ▶ Lead Adaptor – IH-39/90 Corridor

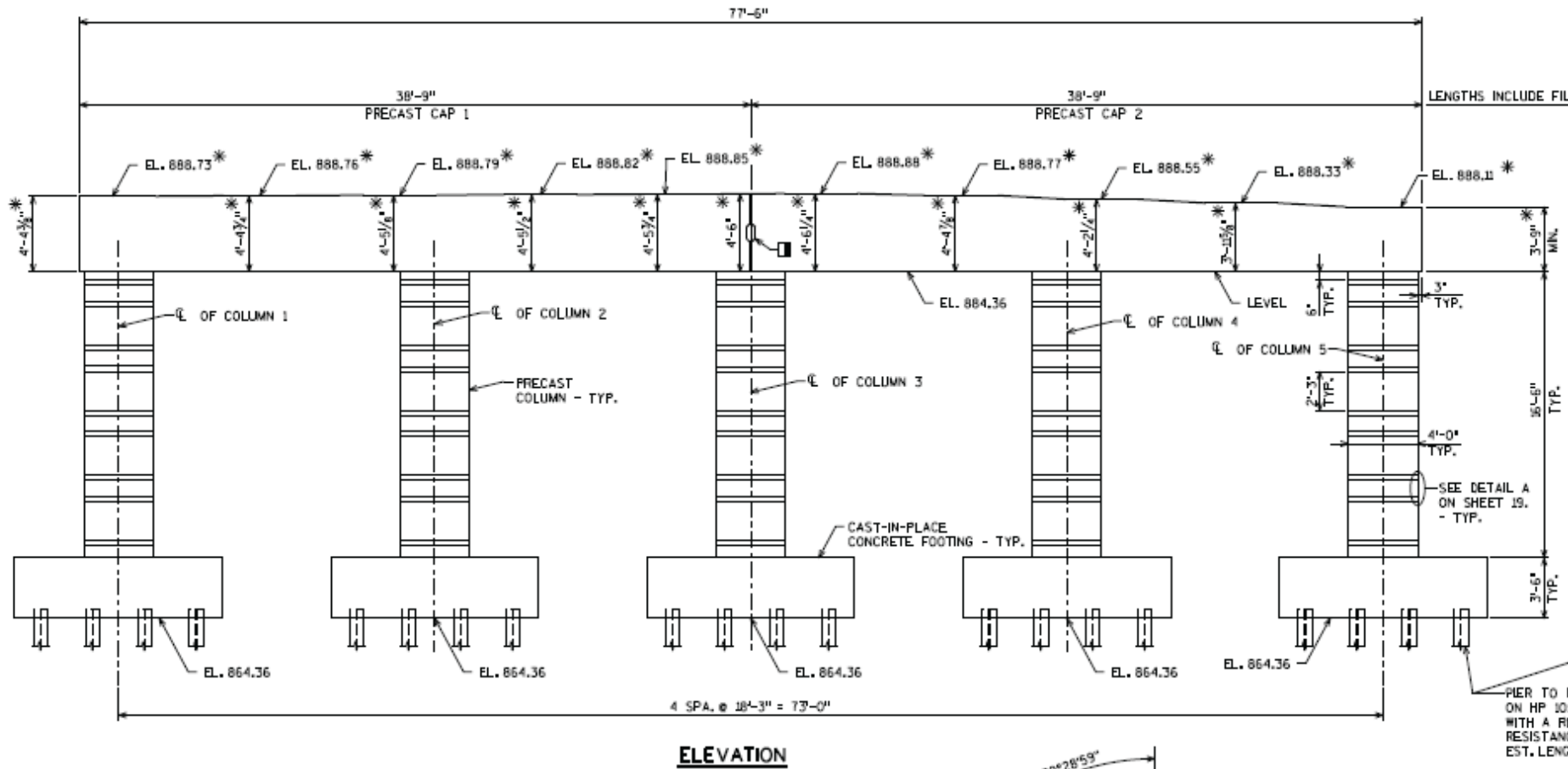


WisDOT's ABC Initiative

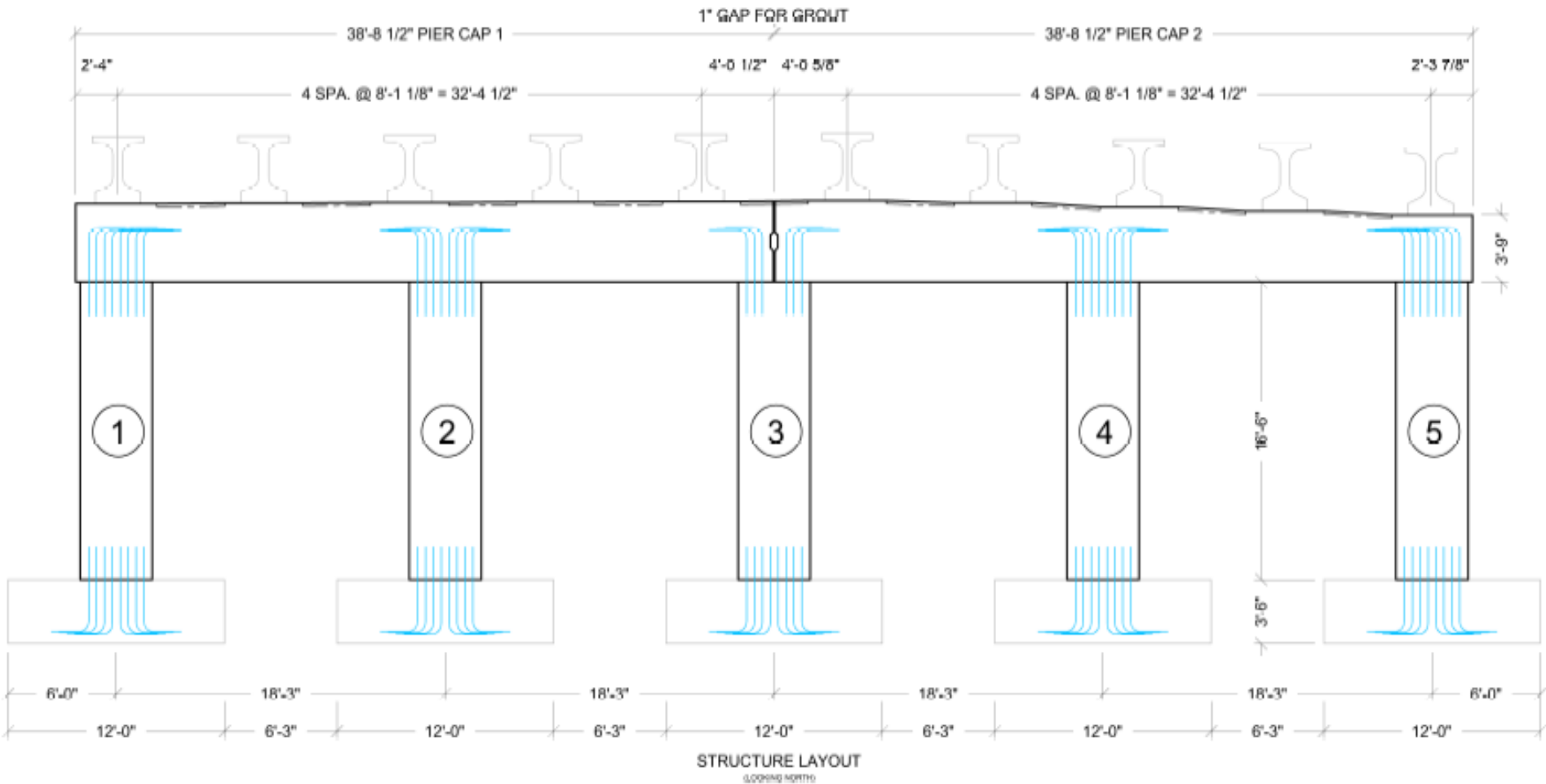
▶ WisDOT Project in Standardized Precast Piers



Adaption of Standard to Pier



Shop Drawings & Fabrication

















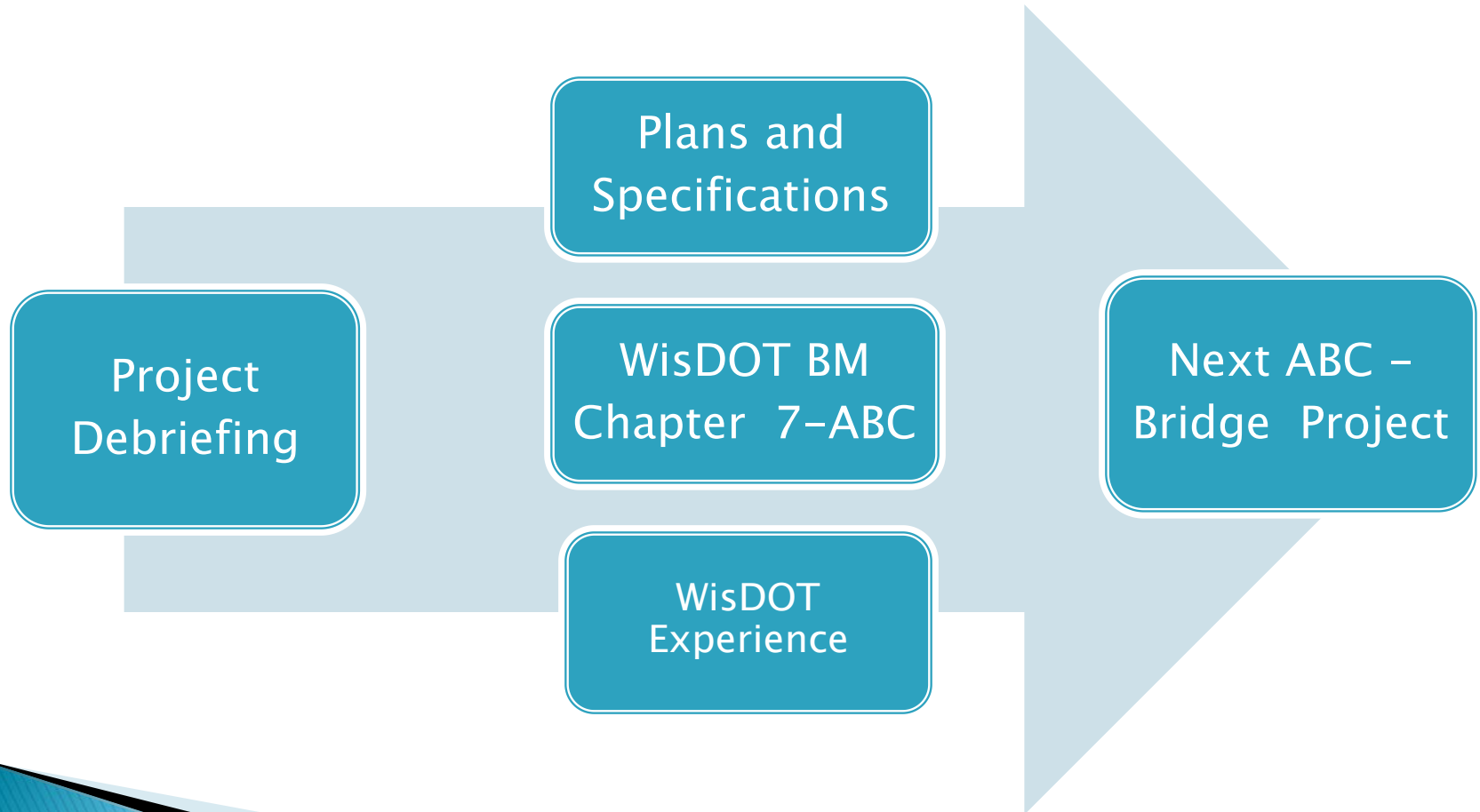


Lessons Learned

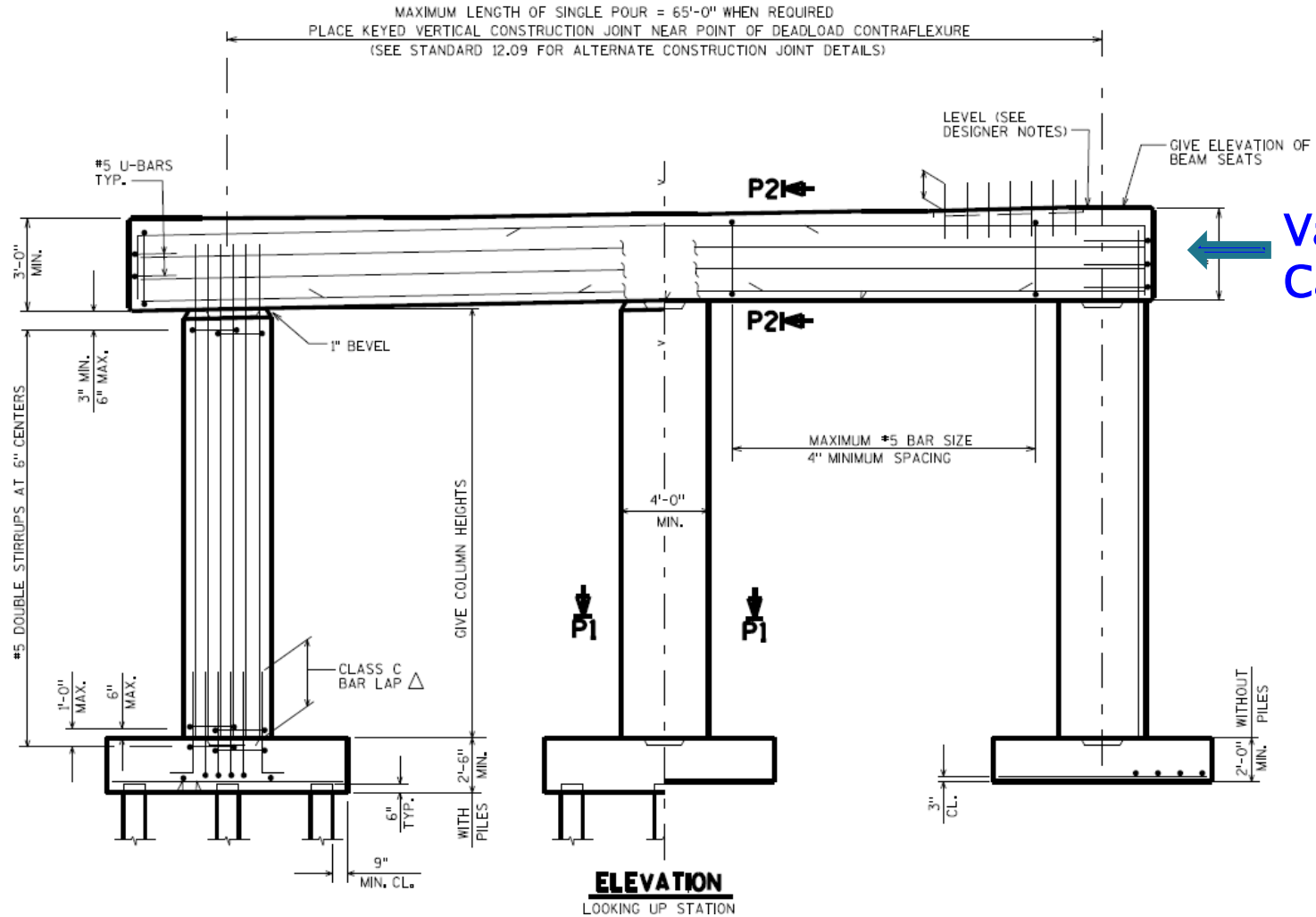
- ▶ Higher cost associated with complex forming of Pier Cap and Beam Seats
- ▶ Weight of Pier Caps still very high for long continuous Caps – Fabricator Lift Capacity
- ▶ Industry may not be distributing Capital Cost of forms over the future and many bridges
- ▶ So, this is what we did.....

WisDOT Perspective

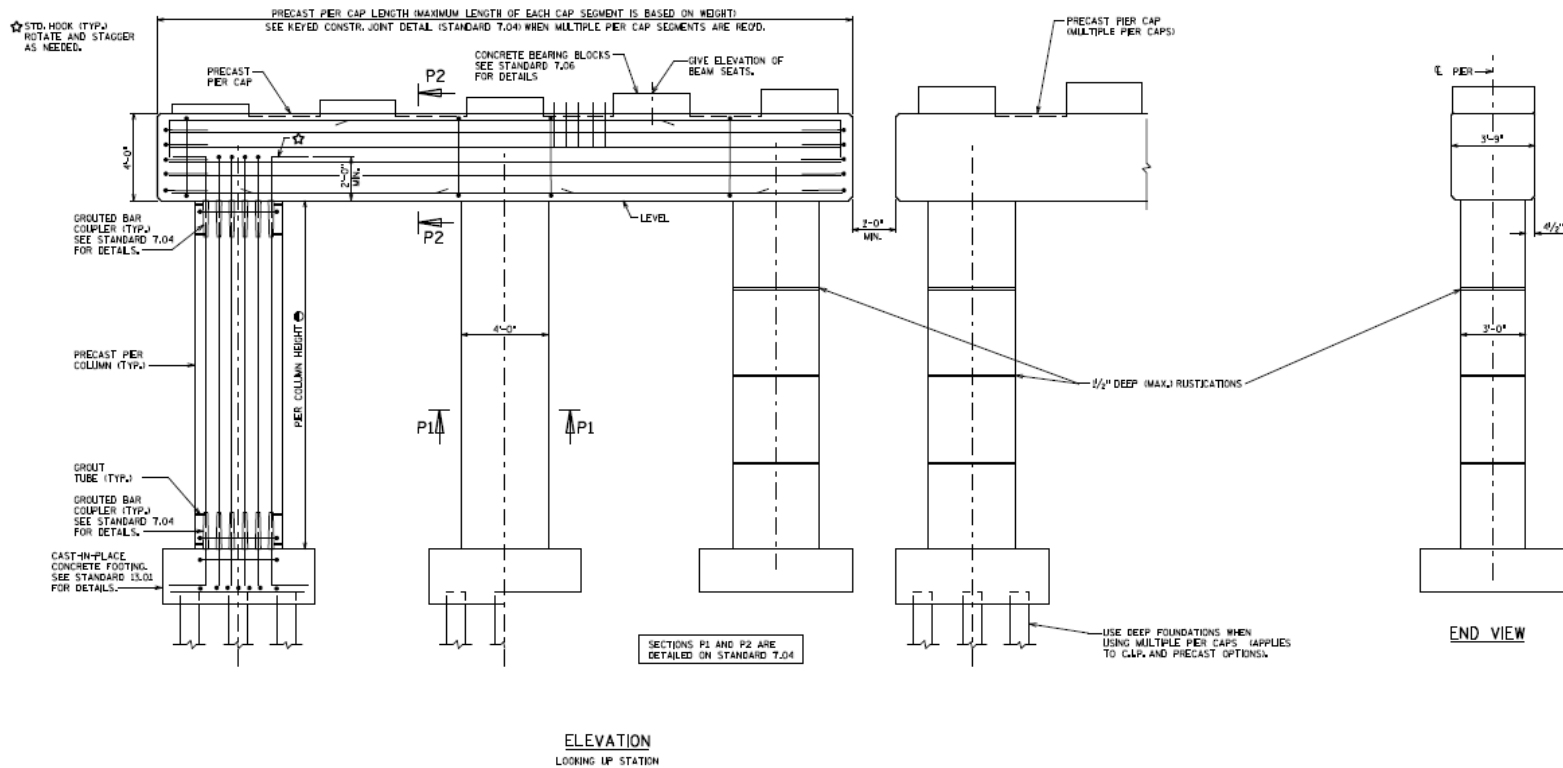
▶ Lessons Learned



Conventional Cast In Place Pier

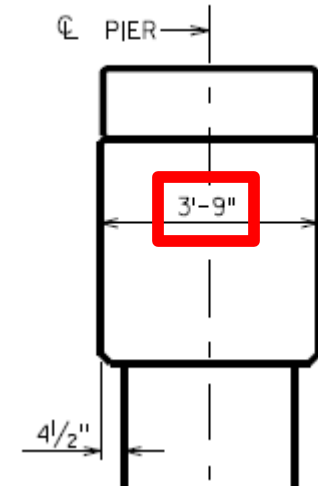
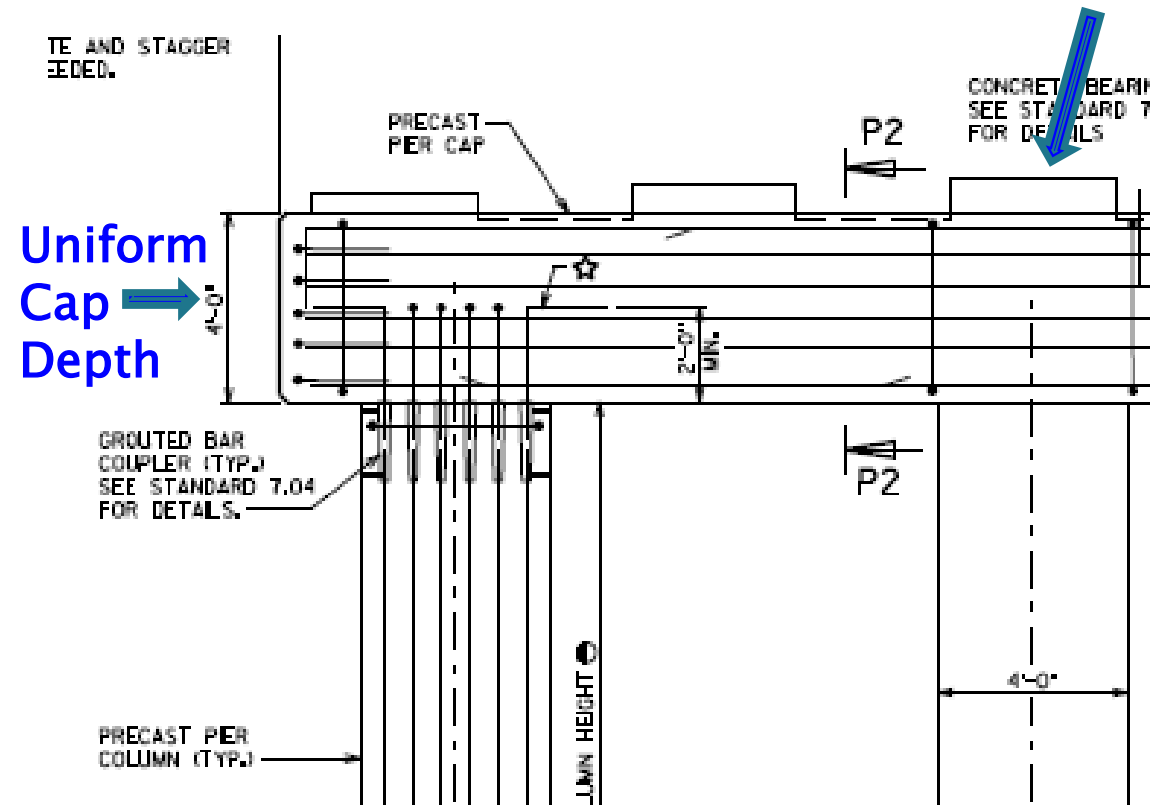


Simplified Standard Precast



Simplified Standard Precast

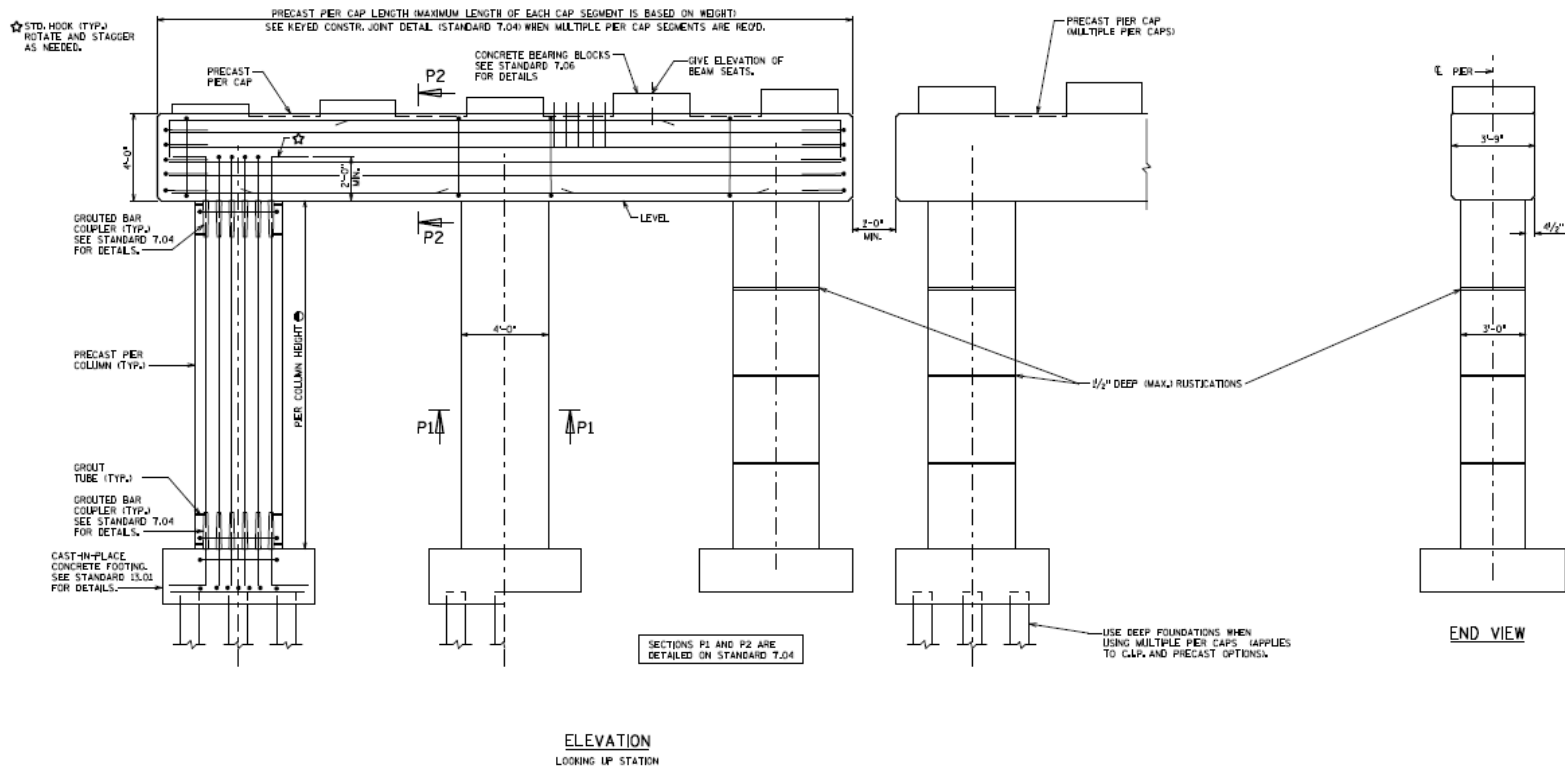
Precast Bearing Blocks



Constant Cap Width

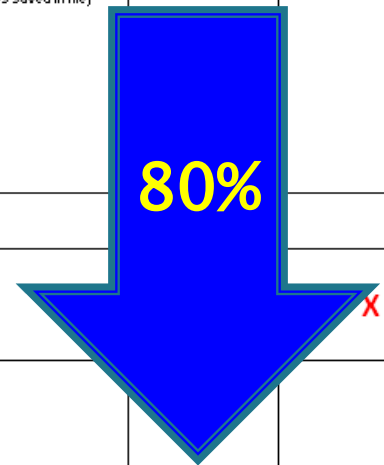
Uniform Depth allows for Greater Length for given Maximum Weight

Simplified Standard Precast



Pier Design Policy (2 vs. 3 Columns)

State	Bridge Manual on File?	Contact	Website	Reference	Text	FHWA ABC Project Exchange	Allow 2-Column Piers	Do Not Allow 2-Column Piers
Utah	ABC Manual, no general manual found	Utah Department of Transportation 4501 South 2700 West P.O. Box 148460 (Standards and Specifications) Salt Lake City, UT 84114 Wm. Michael Hedges	udot.utah.gov/main/#?ps100.pg0	Section 2 Precast Substructures Pier Cap Section	Show pier bents as single, double, or triple column bents. The intent is to use combinations of these to make up any particular pier. The designer can choose to use two independent double column pier bents if four columns are required in a pier.	Riverdale Road over I-84 used precast pier cap/columns with 2 columns per cap (see pictures saved in file)	X	
Vermont	X	Phone: (802) 828-2621 Fax: (802) 828-3566 Email: mike.hedges@state.vt.us	engineering.vermont.gov/sections/structures					
Virginia	X	Prasad L. Nallapaneni, P.E. 804-371-2770	vadot.org/business/bridge-man	Geometrics Bridges over Railroads Crash Wall Requirements	When two or more light columns compose a pier, a wall at least 2'-6" thick for Norfolk Southern Railway or the greater of column width or 2'-6" for CSX Transportation shall connect the columns and extend at least 2'-6" beyond the outermost columns. LMK: (This text is referencing crash walls, but appears that they allow 2-column piers)		X	
Washington	X	Washington State Department of Transportation Bridge and Structures Office PO Box 47340 Olympia, WA 98504-7340 Phone: 360-705-7753 Email: sargenw@wsdot.wa.gov	dot.wa.gov/Publications/Manual	2.3.1 Highway Crossings H. Bridge Redundancy 2.7.1 Design Elements B. Round Columns	Design bridges to minimize the risk of catastrophic collapse by using redundant supporting elements (columns and girders). For substructure design use: One column minimum for roadways 40' wide and under. Two columns minimum for roadways over 40' to 60'. Three columns minimum for roadways over 60'. Collision protection or design for collision loads for piers with one or two columns. Round Columns - Columns shall be 3' to 6' inch diameter. Dimensions are constant full height with no tapers. Bridges with roadway widths of 40' or less will generally be single column piers. Bridges with roadway widths of greater than 40' shall have two or more columns, following the criteria established in Section 2.3.1.H. Oval or rectangular column may be used if required for structural performance or bridge visual.	US 12 over I-5 at Grand Mound used precast pier cap/columns with 2 columns per cap (see pictures saved in file)		
West Virginia	X	Could not find contact	www2Ehighways2EEngineering	2.4.4.1 Cap-and-Column Type Piers	Cap-and-column type piers have two or more circular or rectangular columns connected on top with a cap (a reinforced concrete beam that supports the superstructure).			
Wisconsin	X	David Kiekbusch Phone: (608)266-5084 Email: david.kiekbusch@dot.wi.gov	wvdotid_bos/extranet/structures	13.2.1 Multi-Column Piers 13.4.10 Extreme Event Collision Loads	A minimum of three columns shall be provided to ensure redundancy should a vehicular collision occur. Designs for bridge piers adjacent to roadways with a design speed of 40 mph need not consider the provisions of LRFD [3.6.5]. As for all multi-columned piers, a minimum of 3 columns is still required.			X
Wyoming	X	Keith R. Fulton, P.E. State Bridge Engineer WYDOT Bridge Program 5300 Bishop Blvd, Bldg 6100, Room 233 Cheyenne, WY 82009-3340 (307) 777-4427 or (307) 777-4489	wyoengineering.technical_programs/bri	Chapter 4.08-Bent/Pier	MULTICOLUMN BENTS, occasionally referred to as frame bents, have two or more concrete columns that support the cap.			
Total	38					Total	18	5



Benefits of Optimal Pier Policy

- ▶ Reduce Temperature Force effects from longer continuous caps –
- ▶ Weight of Cap Elements with Uniform Cross Section – **Allows Longer Lengths for Given Weight (Beam Seat Weight)**
- ▶ Allows for Interchangeability between Cast In Place and Precast from the **Design Standpoint**

Interchangeability of Elements

- ▶ Cast In Place vs. Precast
- ▶ Without Redesign of pier geometry or Primary Reinforcement
- ▶ This literally means that the reinforcement design and geometry is consistent between CIP and Precast – **with minor modification for the connections (Couplers) and diaphragms**

Interchangeability of Elements

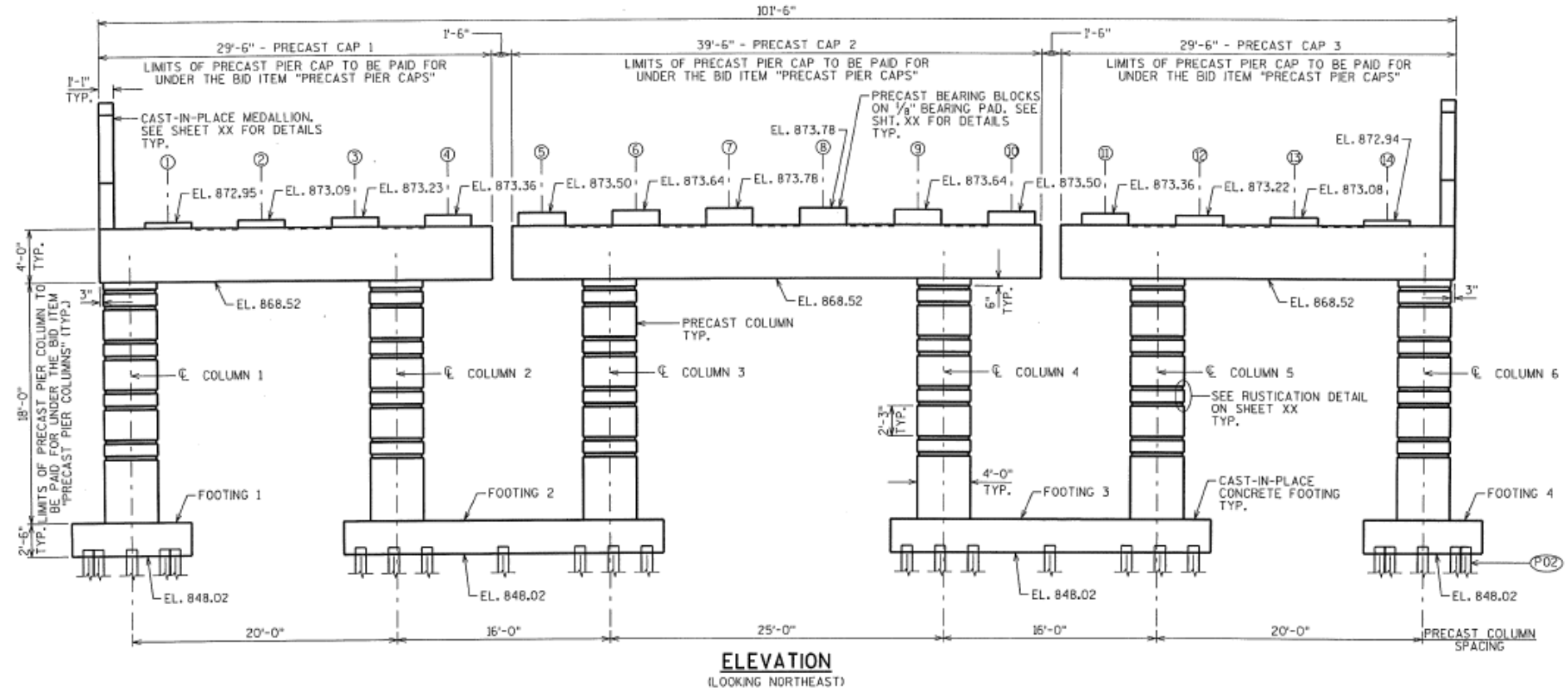
GENERAL NOTES – Contractor

THE **CONTRACTOR** MAY FURNISH A PRECAST PIER (CAP AND COLUMNS ELEMENTS) IN LIEU OF THE CAST-IN-PLACE PIER WITH THE ACCEPTANCE OF THE SHOP DRAWINGS BY THE STRUCTURES DESIGN SECTION.

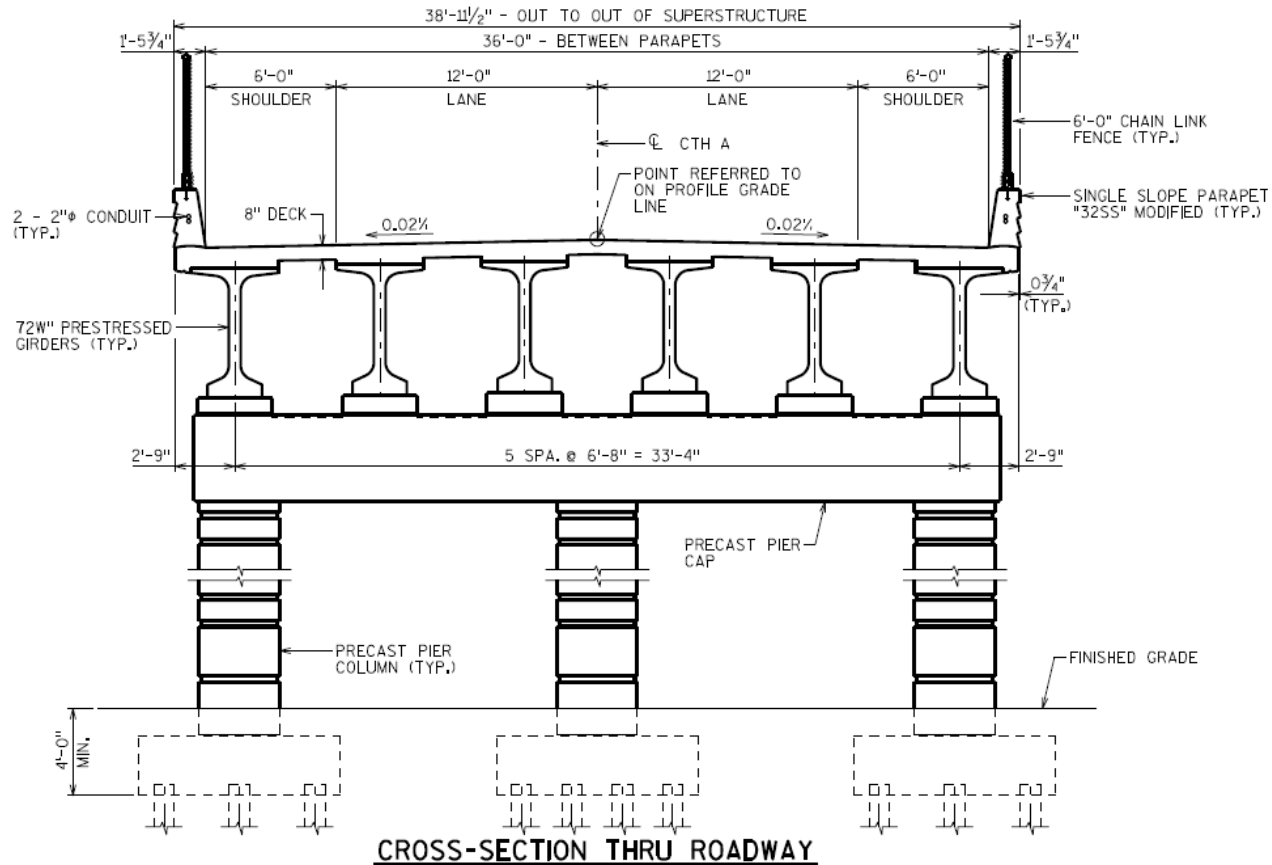
THE PRECAST PIER SHALL **CONFORM TO** PRECAST DETAILS IN CHAPTER 7 **STANDARDS** OF THE CURRENT WISCONSIN DOT BRIDGE MANUAL.

PAYMENT FOR THE PRECAST PIER SHALL BE BASED ON THE QUANTITIES AND PRICES BID FOR THE ITEMS LISTED IN THE "TOTAL ESTIMATED QUANTITIES".

Application of Standard Precast Pier



Application of Standard Precast Pier



The Lesson and Message.....

- ▶ Work Closely With Industry in developing effective details – We are in this together
- ▶ Standardize and Simplify the Details of the Precast Elements
- ▶ Make the Precast Interchangeable with Cast In Place from a Design and Bid ability perspective

The Lesson and Message.....

- ▶ Make sure all the Stakeholders know about the
 - Benefit of ABC Tools in the Overall Project
 - Improvements to details
 - **Opportunity** to Incorporate and Deploy
- ▶ **Get the word out** to Industry on what the “Game Plan” is and what the opportunities are for implementation.

The Implementation (I-39/90 Corridor)

- ▶ Design Guidance
- ▶ Identify Projects (Required & Optional)
- ▶ Policy

**I-39 Project
C.I.P./Precast Concrete Pier
Design Requirements**

Introduction

The BOS Accelerated Bridge Construction (ABC) Team & I-39/90 Project Team, in an effort to implement the allowance of precast concrete pier element substitutions in-lieu of traditional cast-in-place (C.I.P.) concrete construction methods, has begun the process of developing standards and additional guidance for this effort. This effort consists of providing traditional C.I.P. concrete construction details and noting external references for precast pier element options. Contract plan details shall be compatible for both C.I.P. and precast plan deliveries. This guidance will evolve with the project and shall be used only as considerations at this time.

General - Single Pier Cap Unit

- Detail cap and column elements following C.I.P. construction methods with references to precast alternatives.
- Precast alternative maximum weight of each precast element shall be 90 kips.
- Cap to be supported by a minimum of 3 columns.

General - Multiple Pier Cap Units

- See applicable "General - Single Pier Cap Unit" notes
- Cap may be supported by a minimum of 2 columns
- Deep foundations are required when using multiple pier caps. This applies to C.I.P. and Precast options
- Provide 1'-0" min. gap between columns

Design Requirements

- Concrete: Fc=3,500
- Reinforcement: fy=60,000
- Cap: 4'-0" depth
- Column: 4'-0" width

Wisconsin Department of Transportation
39/90 Precast Piers
IMPROVING at gateway to Wisconsin
I-39/90 Expansion Project
Wisconsin Statewide to USH 12/18 Interchange
Rock and Dane County

January 2015

PROJECT REQUIREMENTS

The Wisconsin Department of Transportation (WisDOT) is requiring the I-39/90 Expansion Project to deliver bridge plans that are interchangeable between cast-in-place and precast construction.

PRECAST PIER BREAKDOWN*

Project Segment	Cast	Precast	Total
Central	112	273	385
South	35	131	166
Total	147	404	551

Project Letting Year

Year	Cast	Precast	Total
2014	1	17	18
2015	142	212	354
2016	1	1	2
2017	1	1	2
Total	145	401	546

PRECAST PIER SCHEDULE*

*Estimates based on preliminary data (January 2015)

Wisconsin Department of Transportation - Dedicated people creating transportation solutions through innovation and exceptional service.

WisDOT policy item:

At this time, evaluation and plan preparations for accommodating a noted allowance for a precast pier option as indicated in this section is only required for I-39/90 Project bridges. All other locations statewide may consider providing a noted allowance for a precast option. Contact the Bureau of Structures Development Section for further guidance.

Evolution of the Elements:

Custom Application

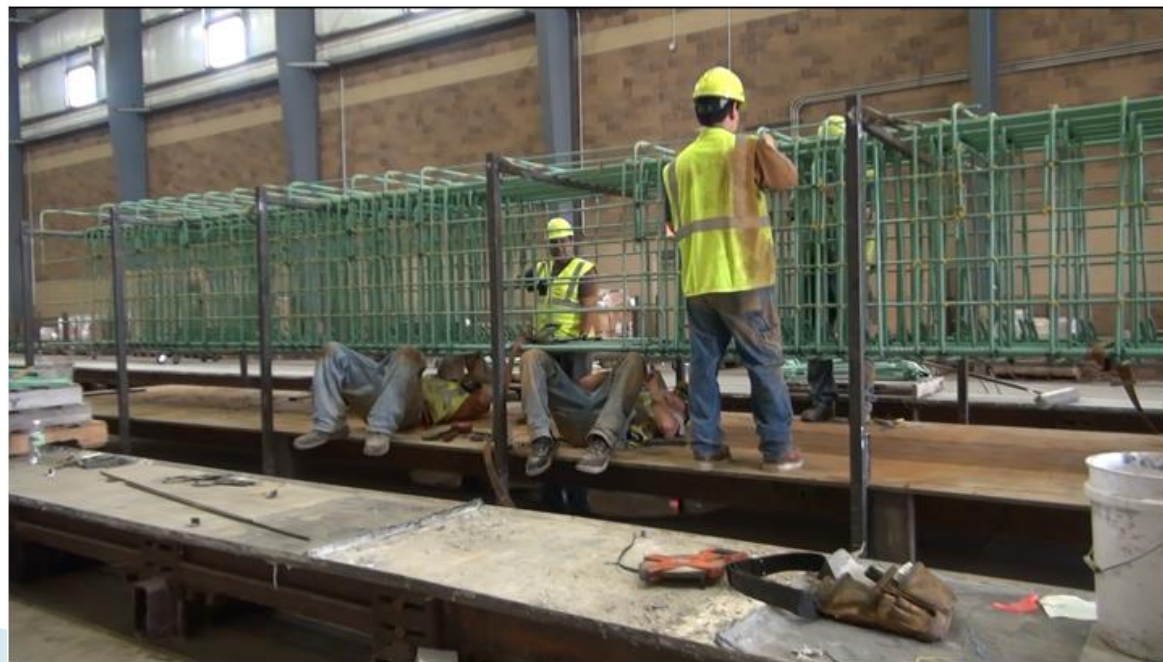
Standardization of Details

Simplification of Details

Institutionalization

The Concept is not new.....





Future Objectives–Precast Piers

- ▶ Additional Guidance/Policy
- ▶ Program Deliveries
- ▶ Statewide Implementation

Future Objectives–ABC

- ▶ Refinement of Precast Box Girders
- ▶ GRS–IBS Super Structure Options
- ▶ Development of Abutment Standards
- ▶ Precast Decks – UHPC
- ▶ Precast Approach Slabs

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Questions?

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