Delivery of ABC: WSDOT Workshop

Using the SHRP2 *ABC Toolkit*

Bala Sivakumar

HNTB Corp.

SHRP2

STRATEGIC HIGHWAY RESEARCH PROGRAM

INNOVATIVE BRIDGE DESIGNS FOR RAPID RENEWAL

2007 -- 2013

HNTB (Prime)

Iowa State University

Structural Engineering Assoc.

Genesis Structures, Inc.

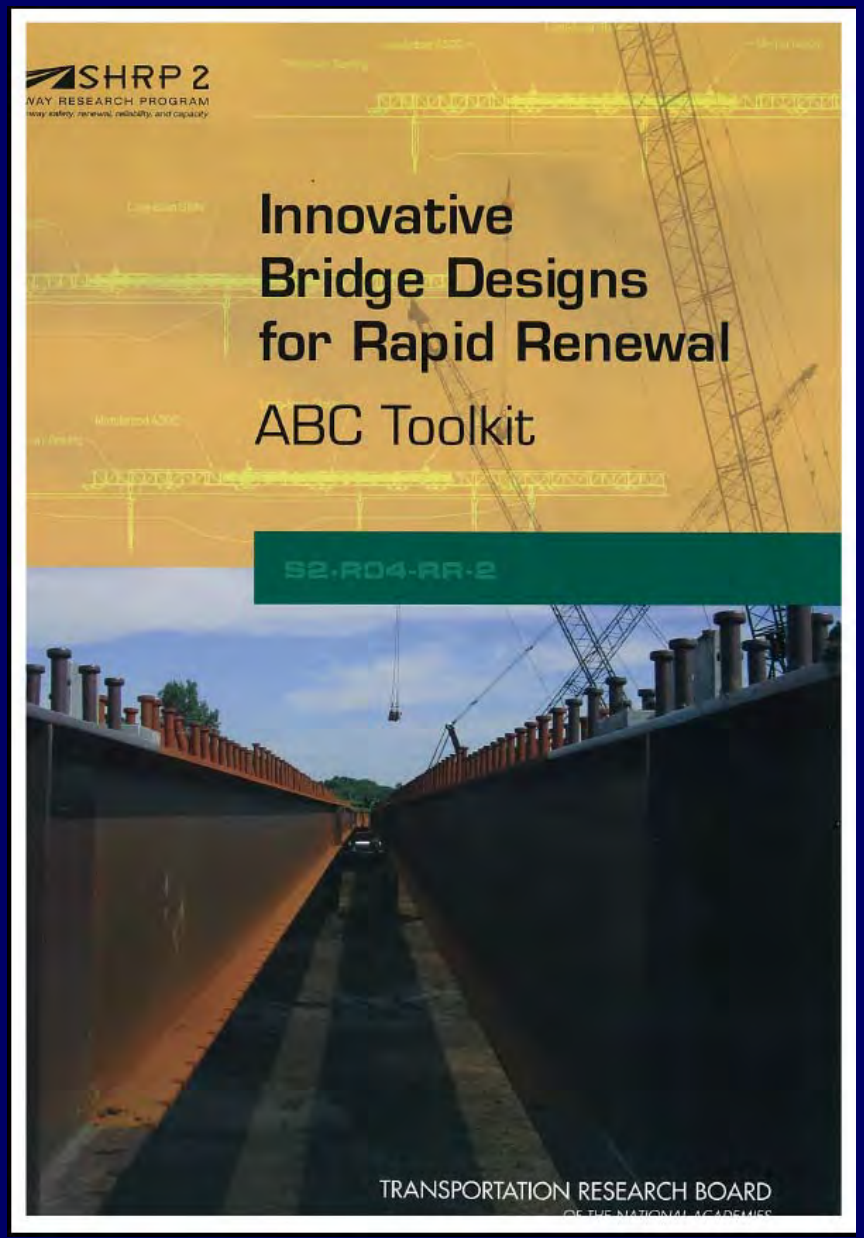
SHRP2 Project R04

Goal

To develop standardized approaches to designing and constructing complete bridge systems that address rapid renewal needs

Make Accelerated Bridge Construction Standard Practice

SHRP2 ABC TOOLKIT



- Published by TRB in 2012
  - ABC concepts for PBES
- Addendum in 2014 to cover Slide-In Bridge Construction

SHRP2 R04 Website

http://www.trb.org/Main/Blurbs/168046.aspx

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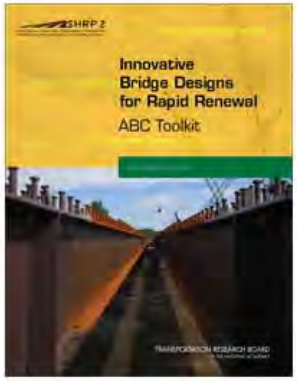

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Innovative Bridge Designs for Rapid Renewal Toolkit

TRB's second Strategic Highway Research Program (SHRP 2) SHRP 2 Report S2-R04-RR-2: Innovative Bridge Designs for Rapid Renewal: ABC Toolkit describes standardized approaches to design

The report includes design standards and design examples for complete prefabricated bridge systems, and proposes specification language for accelerated bridge construction systems, which adheres Resistance Factor Design (LRFD) Bridge Design and Construction Specifications.

ABC Standard Concepts: The Lateral Slide, produced as an addendum to the Innovative Bridge Designs for Rapid Renewal: ABC Toolkit, provides additional detail on the lateral slide construction tech

An e-book version of this report is available for purchase at Amazon, Google, and iTunes.

The R04 MathCAD files for the SHRP 2 Report S2-R04-RR-2 are available to help illustrate the sample accelerated bridge construction (ABC) design calculations. The sample design calculations serv

A demonstration project on US 6 over the Keg Creek near Council Bluffs, Iowa used the accelerated bridge construction standards developed as part of Renewal Project R04.

The following three videos were produced related to the Keg Creek project:
- ABC for Everyday Bridges (18:39) highlights the specific techniques used to deliver a new bridge with only a 10-day closure.
- One Design—10,000 Bridges (9:46) describes a tool kit for designing and constructing bridges that brings home the benefits of accelerated bridge construction techniques so local contractors can use
- Time-Lapse Video (1:30) shows ABC techniques being used by a local contractor with standard equipment to replace the Keg Creek three-span bridge.

A second demonstration project on I-84 in New York also used the ABC Toolkit in applying bridge slide technologies, which were used over two weekend nights to save millions of dollars and two years A case study I-84 bridge project in also available.

The R04 Renewal project also developed a half- and full-day presentations to help facilitate training on of the accelerated bridge process to interested parties.

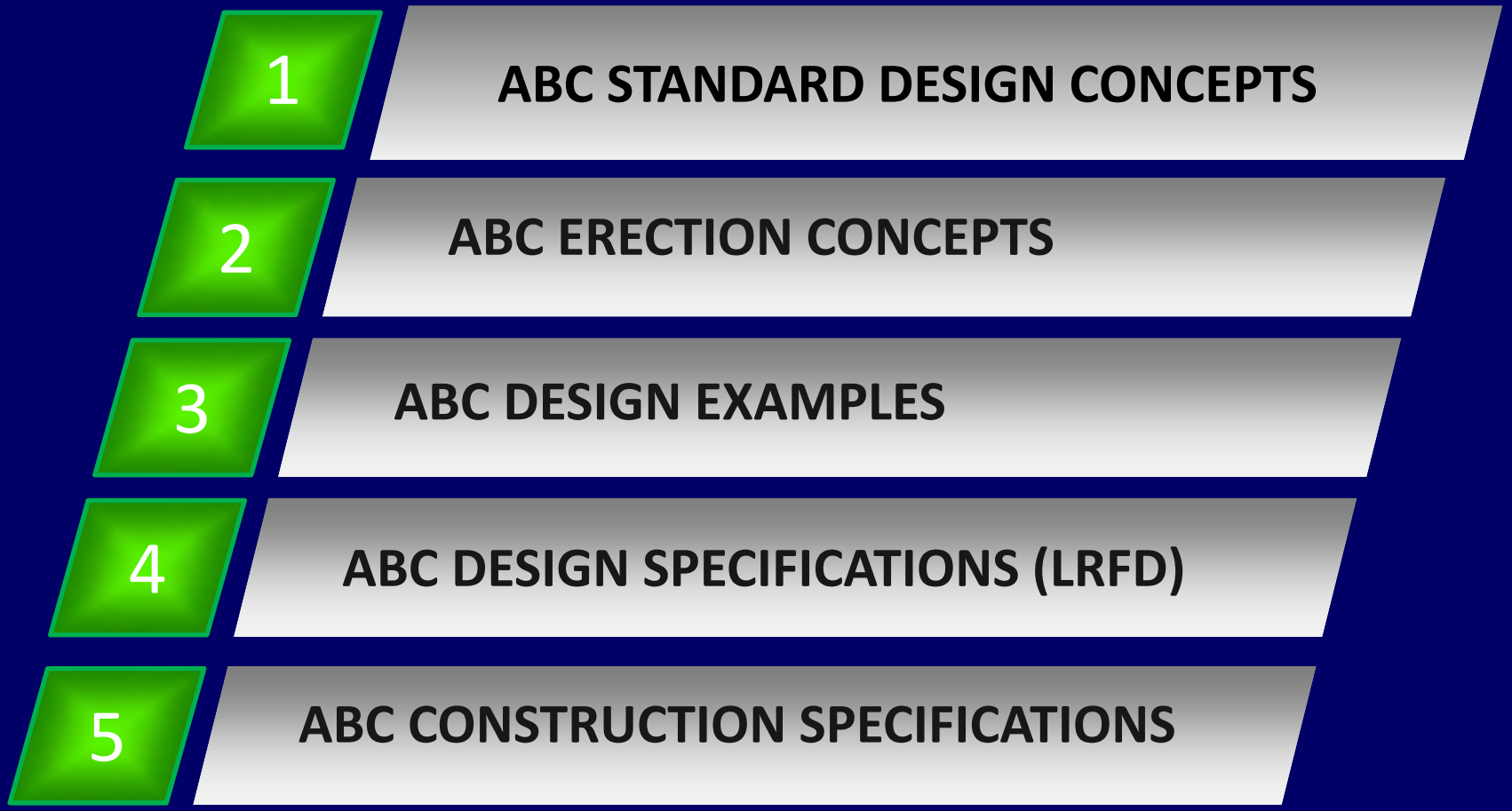
In June 2013, SHRP 2 produced a Project Brief on the project that developed the ABC Toolkit.

Project: Project Information
Project Number: R04

E-Newsletter Type: Recently Released TRB Publications
TRB Publication Type: SHRP 2 Research Reports

This Summary Last Modified On: 11/11/2014

SHRP2 R04 ABC Toolkit



Expected Outcome: The designer, guided by the sample drawings, and ABC design examples will be able to easily complete an ABC design.

14 Day Bridge Replacement

PBES Demonstration Project

Keg Creek Bridge, Iowa

Total prefabricated bridge

- 14 day ABC period
- Opened Nov 1, 2011

Oct. 17 2001

Oct. 21st

Oct. 22nd

Oct. 24th

Oct. 28th

ABC Current Projects Nationwide

ABC Design of the Franklin Avenue Arch Rehabilitation

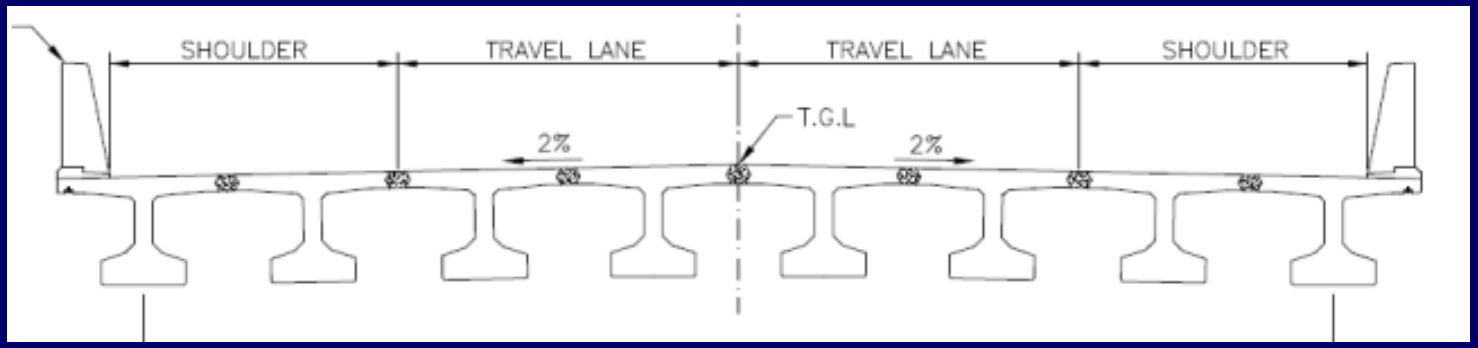
Minneapolis, MN

Pennsylvania DOT, State Route 30

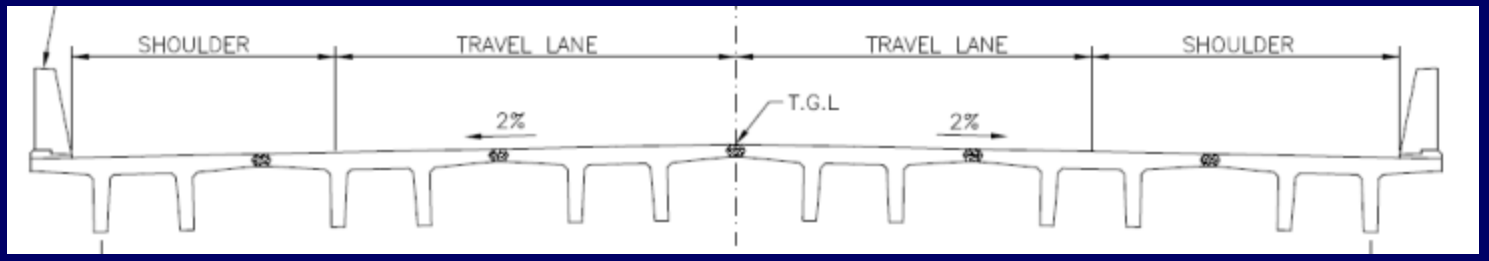
Standard Design Concepts For PBES

- DECKED STEEL GIRDERS
- DECKED CONCRETE GIRDERS
- PRECAST ABUTMENTS & WINGWALS
- PRECAST PIERS
- PRECAST FOOTINGS
- PRECAST APPROACH SLABS
- ABC CONNECTIONS

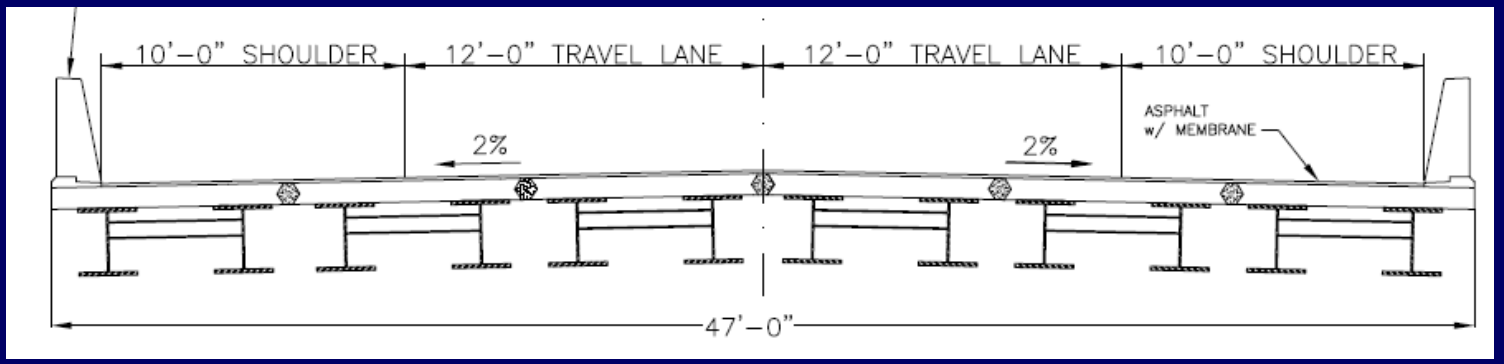
Prefabricated Decked Beam Elements



Deck Bulb Tees

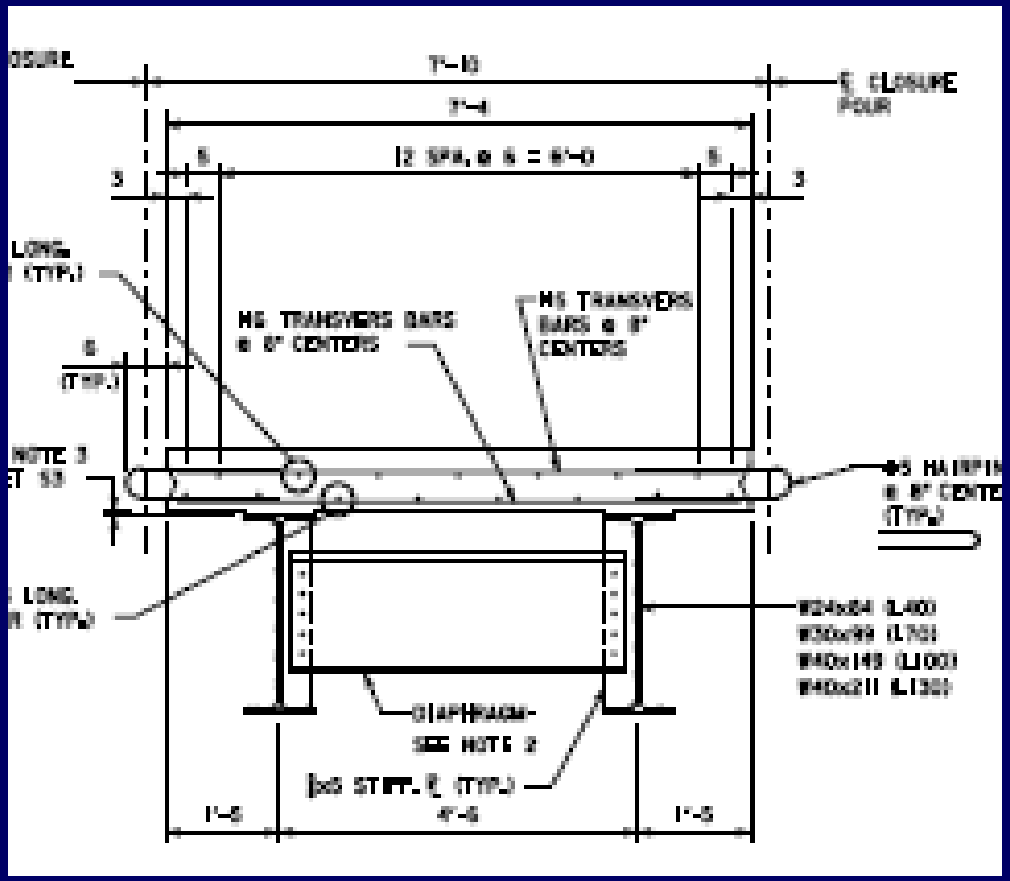


Double Tees



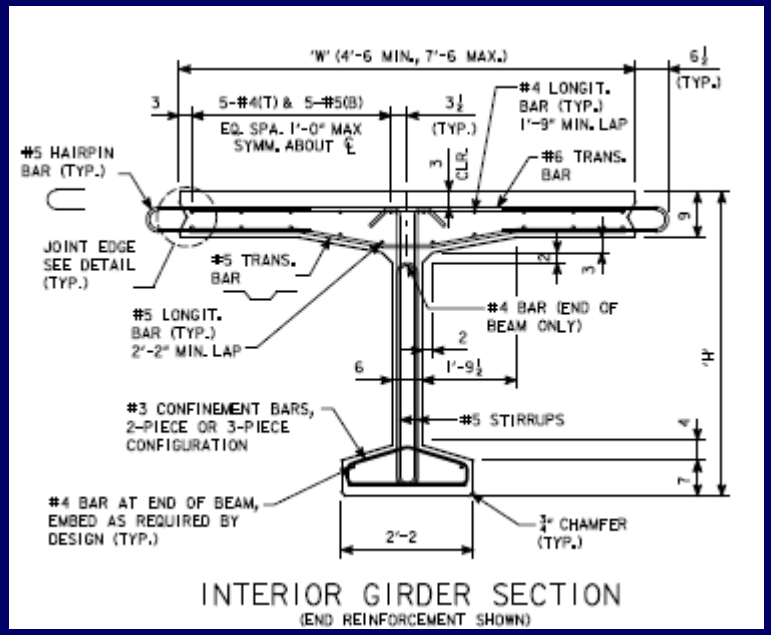
Composite Steel System

Pre-decked Modular Steel Beams

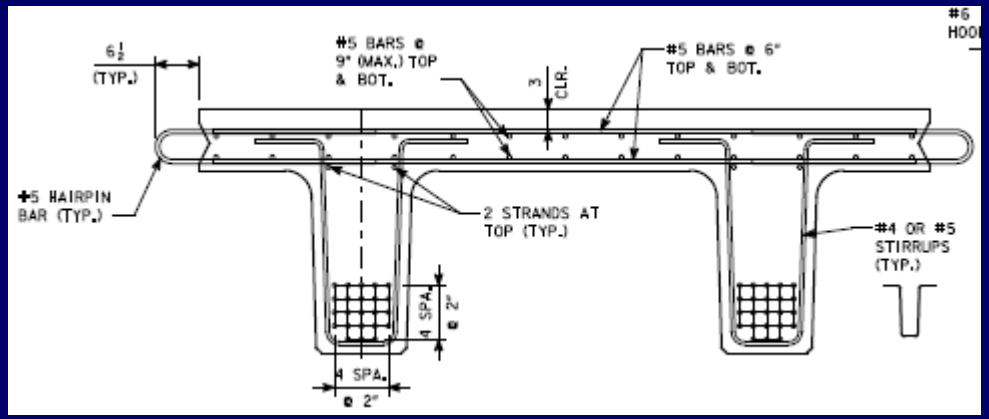


- Not proprietary
- Contractor can self-perform precasting of deck onsite
- Adaptable to any geometry

Precast Decked Girders



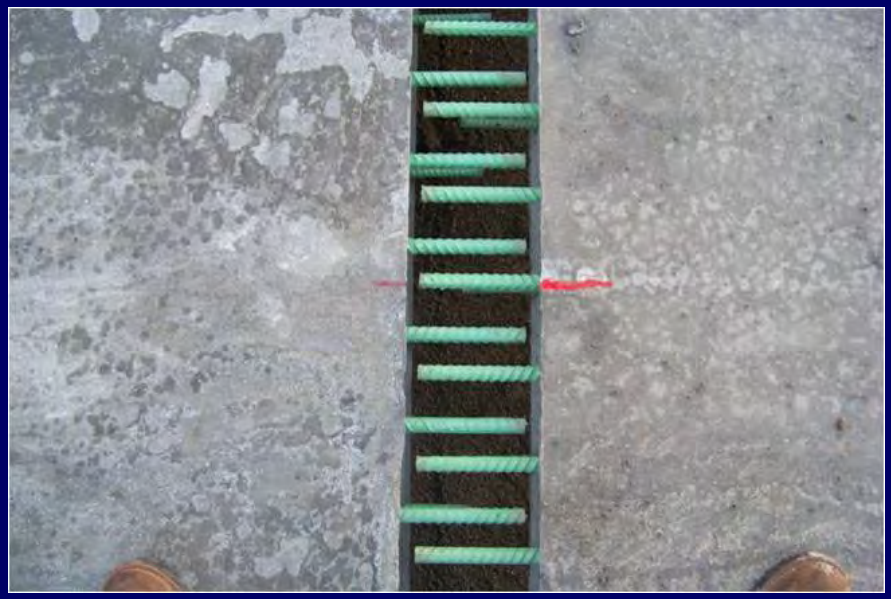
- Deck Bulb Tee
- Span lengths from 40 ft to 130 ft
- UT, WA, ID among states with DBT standards



- Double Tee -- PCI NEXT beam
- Spans to 90 ft
- Low depth alternative

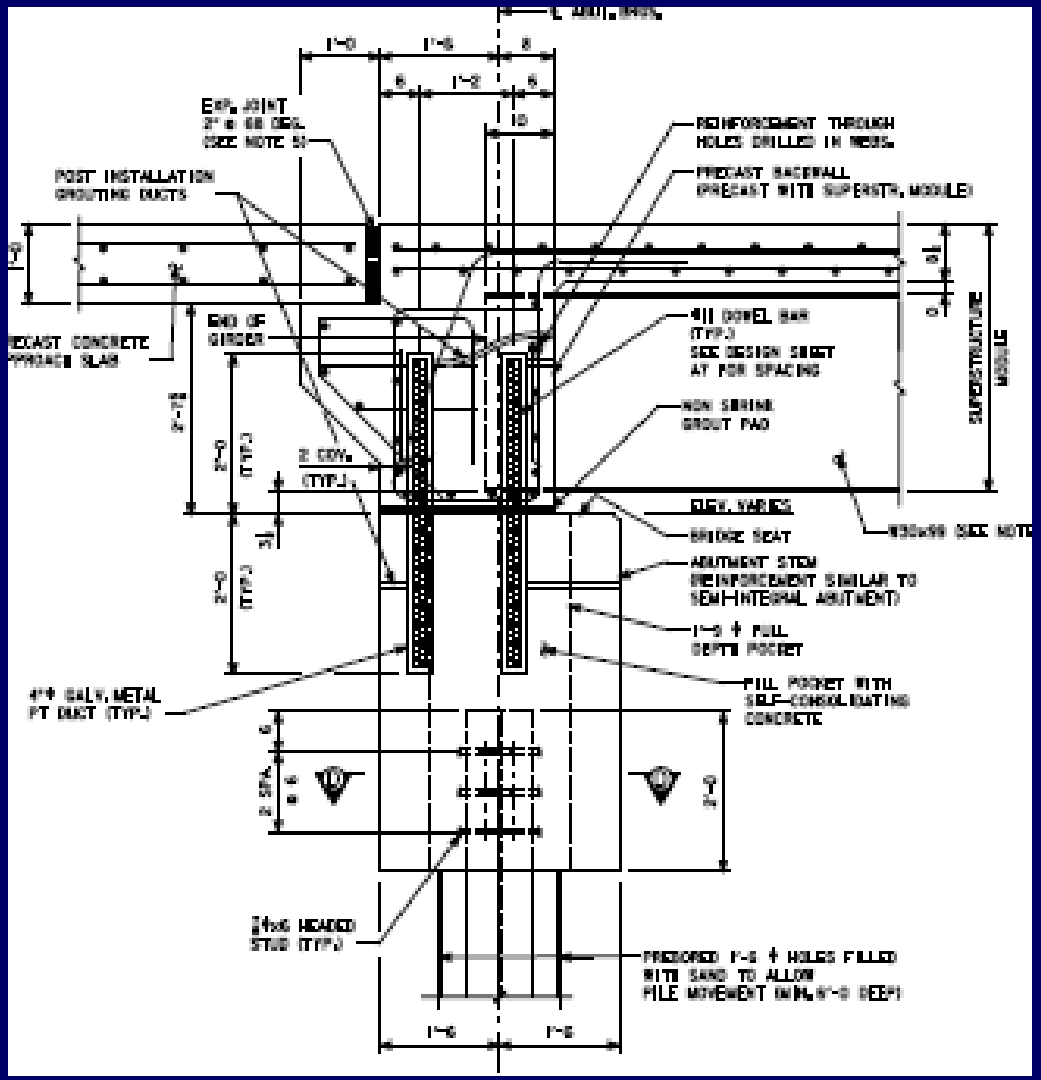
UHPC Joints in Bridge Deck

- Full moment transfer. No post tensioning required
- Only 6 in wide. High strength; low permeability



Longitudinal Joint

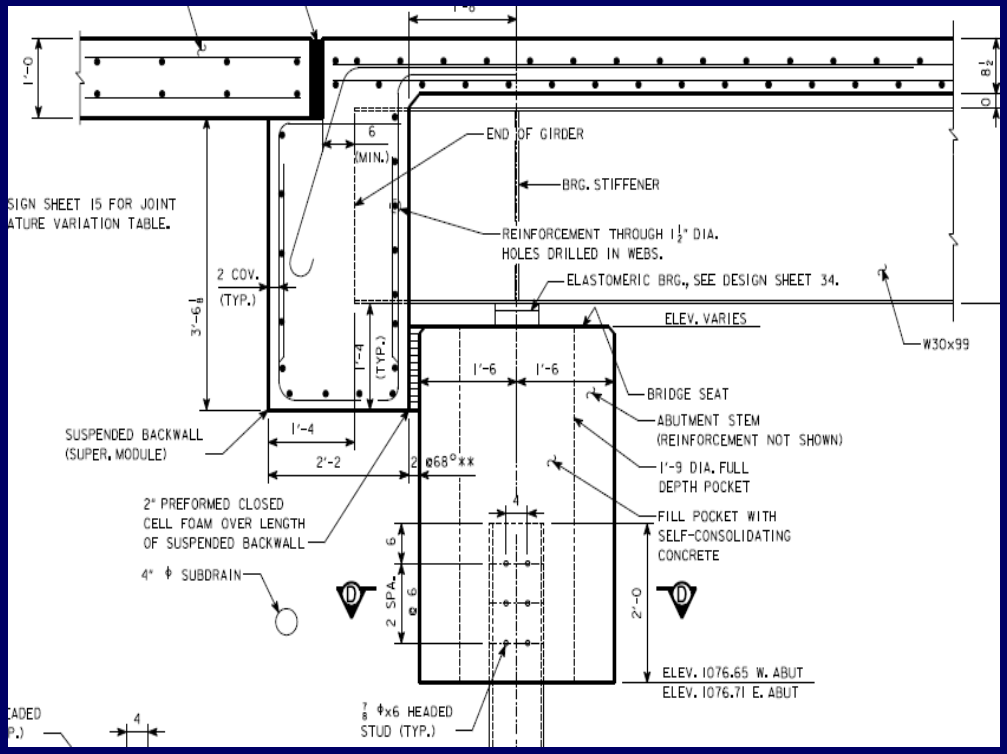
Integral Abutment



- Only one row of vertical piles
- Precast backwall - dowelled
- Fast construction

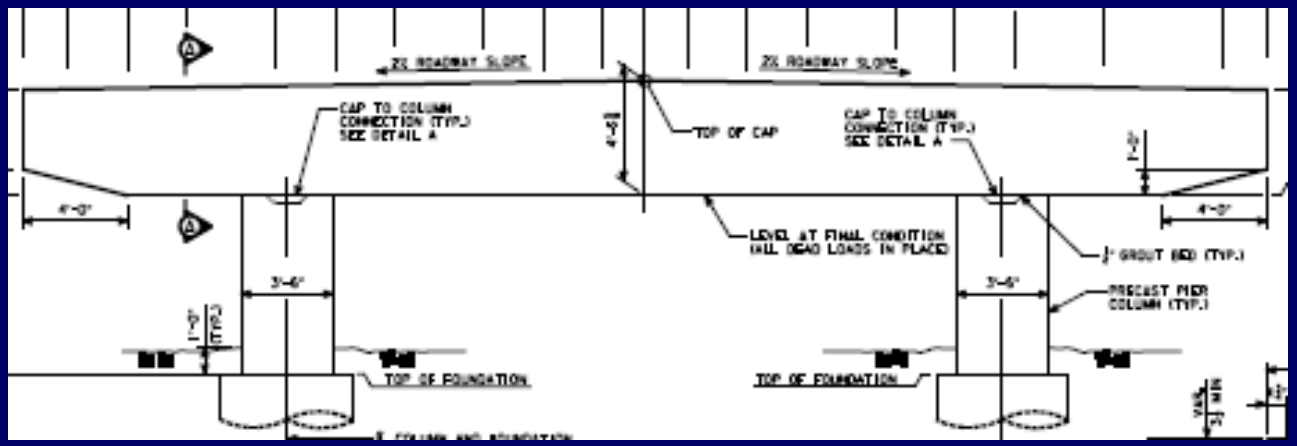
Semi-Integral Abutment

Suspended Backwall

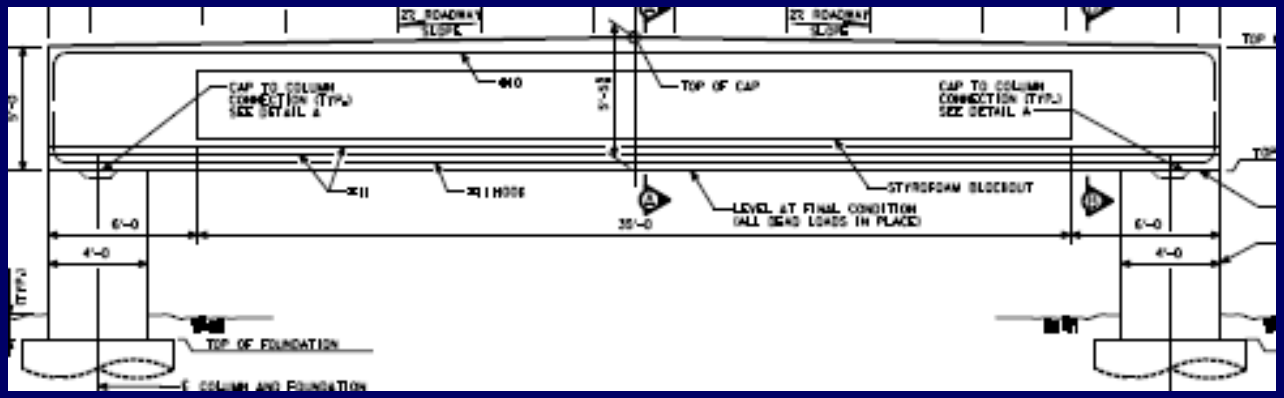


- H piles or spread footings
- Fill pile pockets with SCC
- Easy fit-up in the field

Precast Piers



Conventional Pier



Straddle Bent

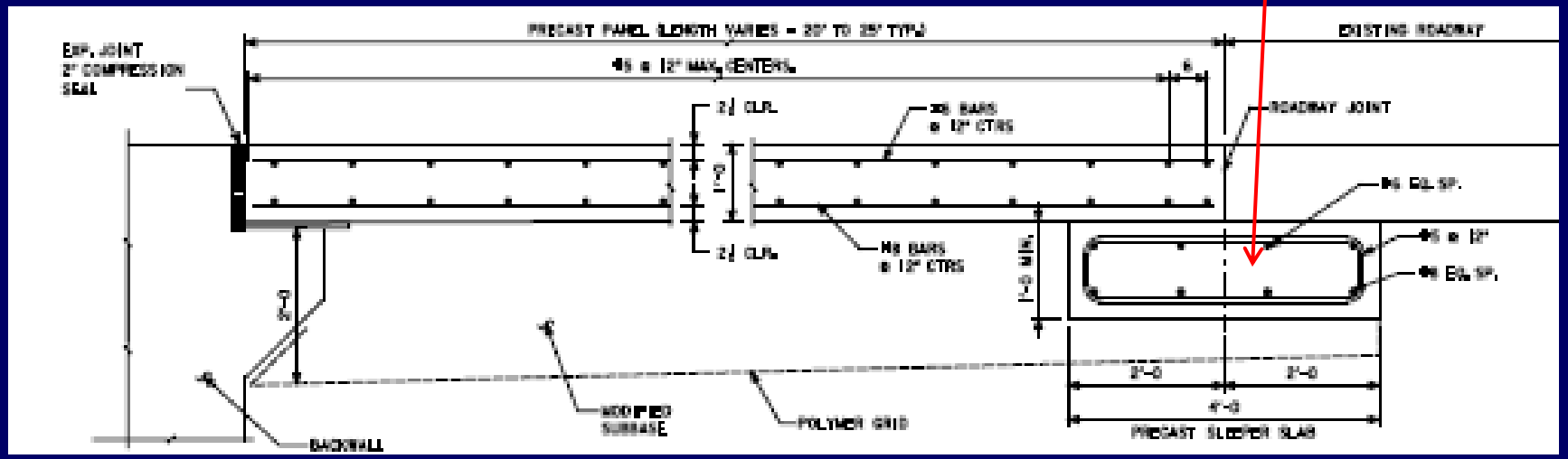
- Non-prestressed so contractor can self-perform precasting
- Fast erection using grouted splice couplers

- Deep foundation may be outside existing footprint

Grouted Splice Sleeve Couplers

Precast Approach Slab

Precast Sleeper Slab

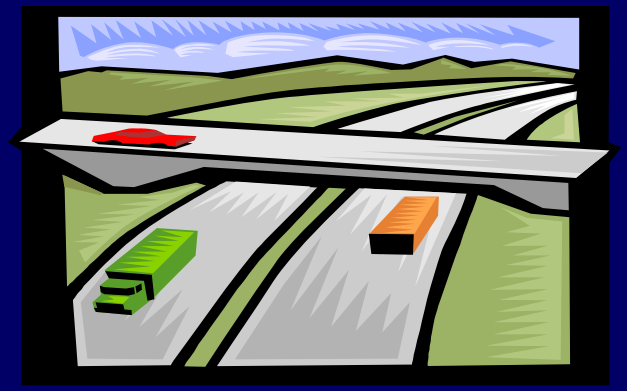


- Flooded backfill
- Flowable fill under slab
- Exp joint can be moved to sleeper slab

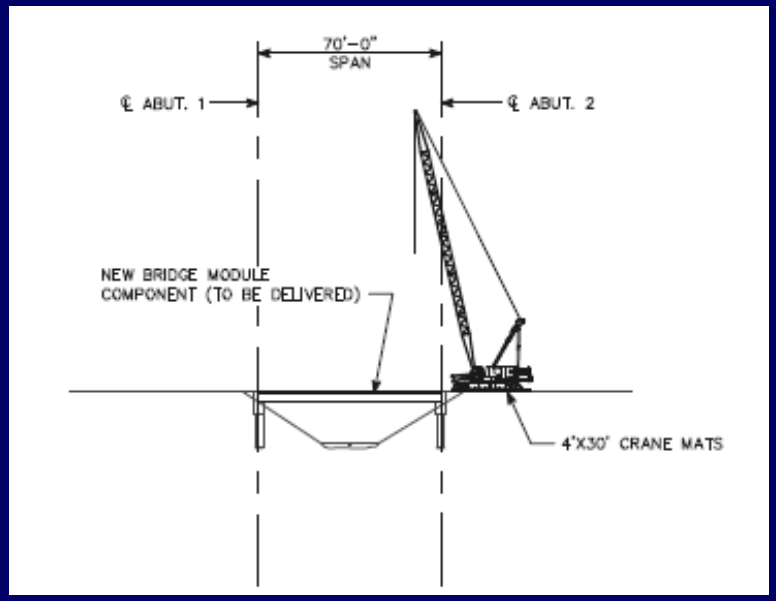
ABC Erection Concepts for PBE

Erection Concept Drawings

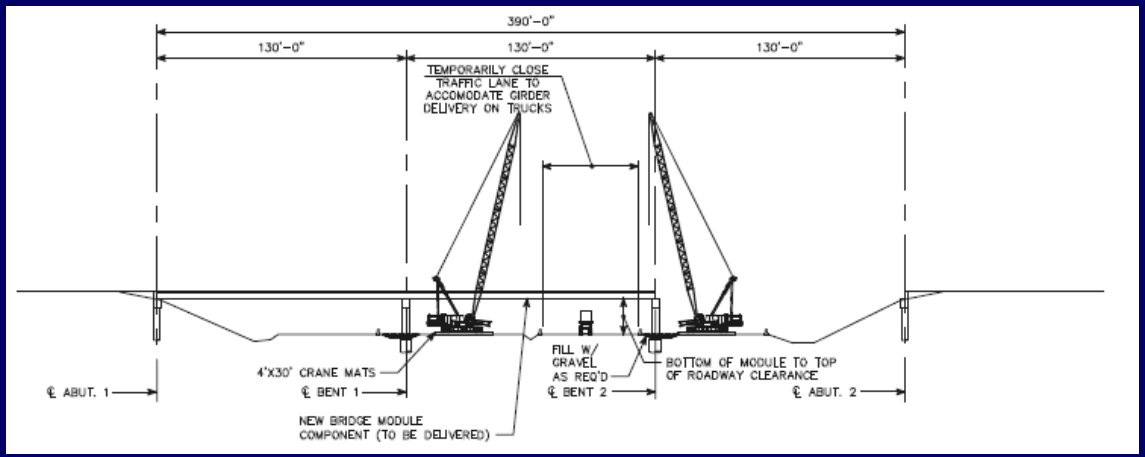
1. Erection using conventional cranes.
2. Erection using ABC construction technologies adapted from long span construction



Erection Using Mobile Cranes

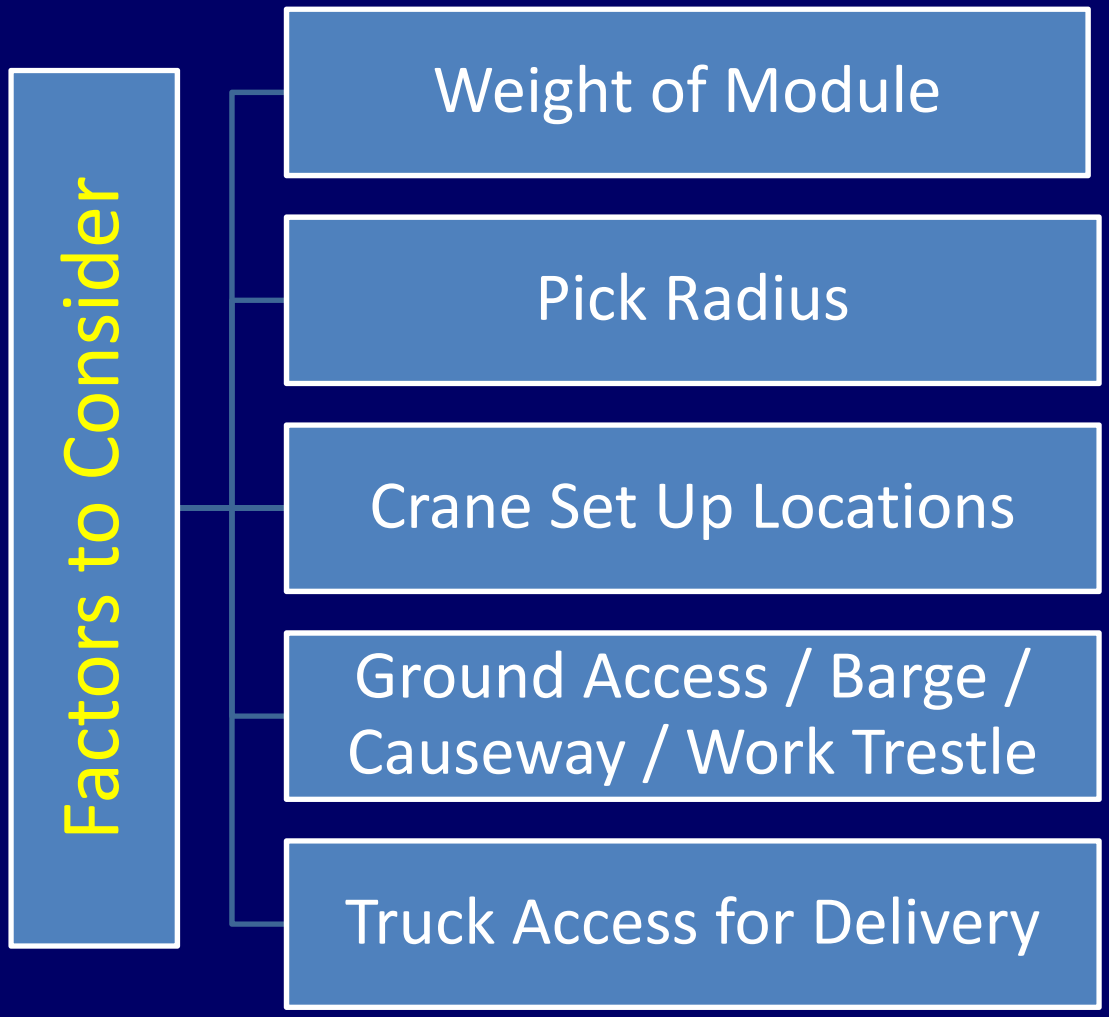


Short Single Span over Stream
Cranes selected for 90 Kip pick



Longer Span over Roadway
Weight up to 200 kips

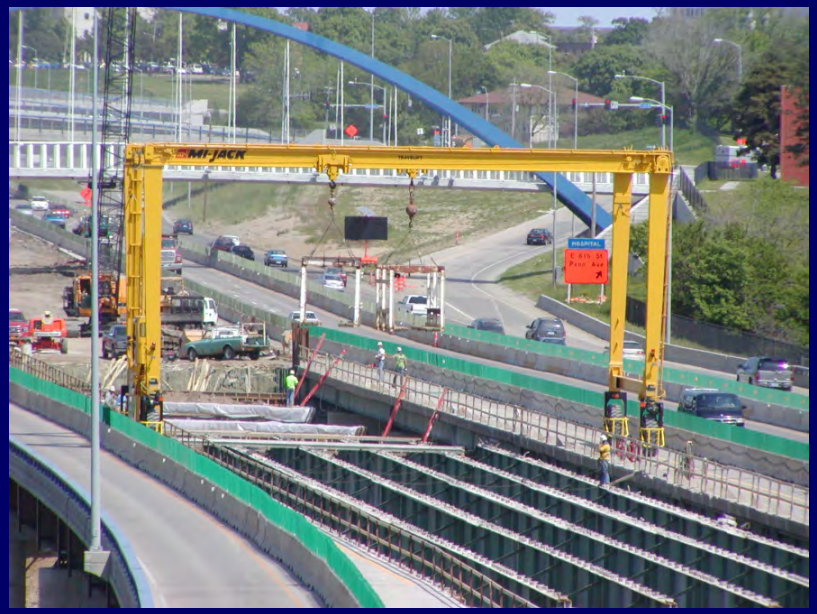
Erection Using Mobile Cranes

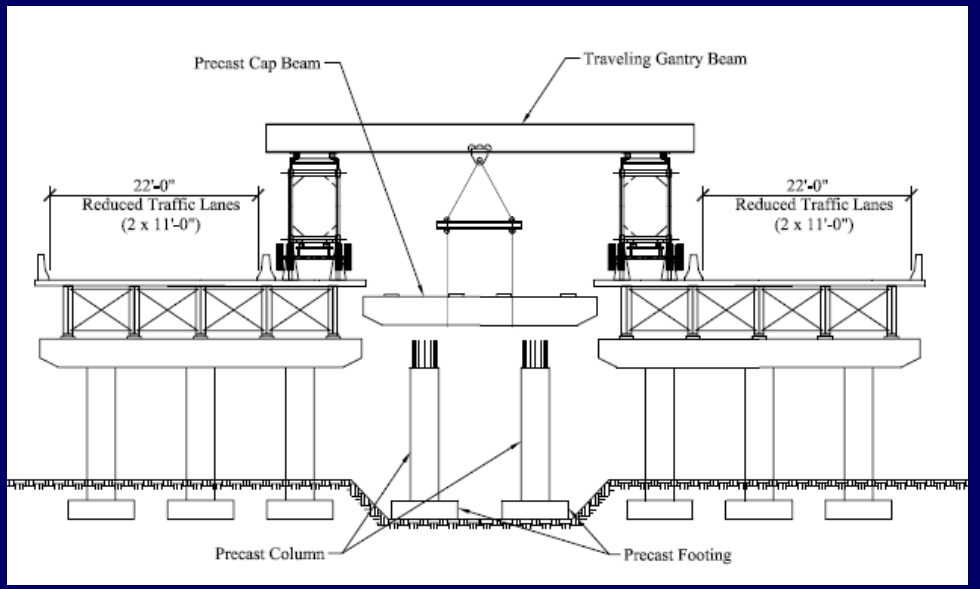


Erection with ABC Construction Technologies

- Use ABC construction technologies where ground access for cranes below the bridge may be limited.
- ABC technologies that allow construction from above:
  - Above Deck Driven Carriers
  - Launched Temporary Bridge
  - Transverse Gantry Frames
  - Longitudinal Gantry Frames

Above Deck Driven Carriers





- Allows fast rate of erection
- Rides on existing bridge or new bridge
- Ideal for bridges with many spans. long viaducts

Launched Temporary Bridge

- Sites with limited ground access or long spans
- Launched across to act as a “temporary bridge”
- Used to deliver the heavier modules without inducing large erection stresses.

Sample ABC Design Calculations

- Three design examples for prefabricated systems
  - Modular Decked Beams
  - Decked Precast Prestressed Girder
  - Precast Pier
- Stages for design are demonstrated
  - Prefabrication Stage (many support options)
  - Erection Stage (many lift options)
  - Final Stage (Modules are assembled on site)

Proposed LRFD Specs for ABC

- LRFD formatted design and construction specifications
- Address impediments in LRFD Specs to ABC implementation:
  - Loads and Load combinations
  - Construction load cases, Erection stresses
  - Design of connections
  - Design responsibility --- EOR / Contractor's engineer
  - Prefabrication tolerances, quality, rideability
  - Assembly plans

Slide-In Bridge Construction

ABC Toolkit: *Components of Slide-In Construction Bridge Design*

1. Permanent Bridge Design
2. Temporary Support System
3. Push / Pull System
4. Sliding Bearings
5. Sliding Forces

1. Permanent Bridge Design

- Permanent bridge design must consider how the new bridge will be slid into place.
- Strengthen local areas where the push/pull system will be attached (end diaphragms)
- Consider flexural, shear effects on substructure from moving vertical load

2. Temp Support System (falsework)

- Design must consider anticipated load effects applied by the sliding system.
- Relative stiffness of permanent support structures (likely relatively stiff) versus stiffness of temporary support structures (likely relatively flexible).
- Anticipated deflection / settlement of the temporary system & provisions for vertical adjustment
- Attach the temp support to the permanent structure


GROVE

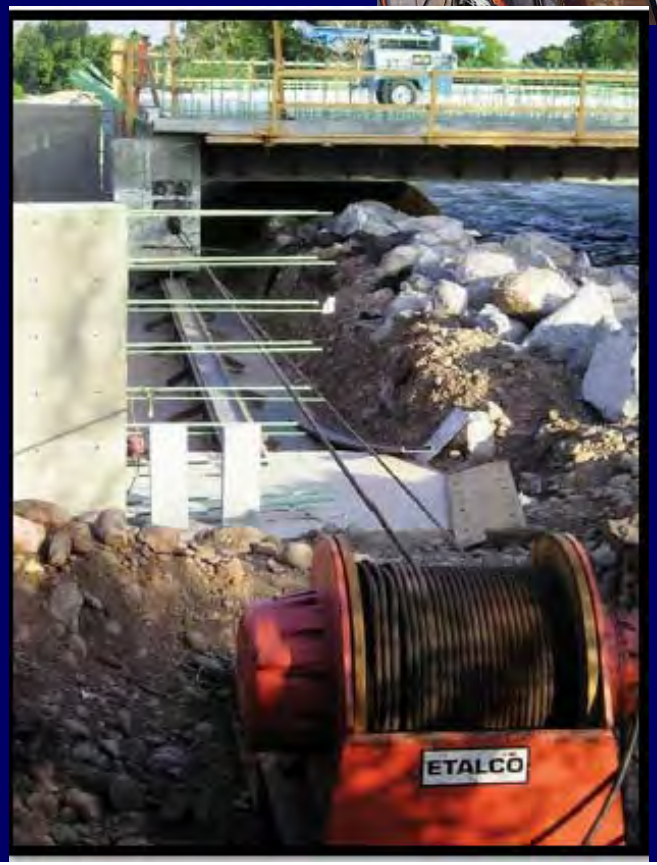
3. Push / Pull System

- Adequate force to overcome frictional forces
- Hydraulic jacks can either push or pull the system.
- Pairs of opposing strand jacks or winches can be used
- System controls to ensure all components work together
- Displacement control during the slide to ensure that the ends of the superstructure move at the same rate
- Contingency planning in the event of equipment failure

Movement Systems

Push/Pull hydraulic jacks

Pulling with strand jacks / Power winch



4. Sliding Bearings

- Steel rollers or PTFE (teflon) sliding bearings can be used.
- PTFE bearings could be designed to remain as part of the permanent structure.
- PTFE also allows the use of an unguided system.
- Rollers are more costly than PTFE pads and are often used on bridge projects with larger load requirements.

Slide Bearings

Roller Bearings

PTFE Pads

5. Sliding Forces

- Coefficients of friction for PTFE bearings are given in the *AASHTO LRFD Specifications*.
- Static and dynamic coefficients of friction.
- Use a **trial slide** to verify friction values
- Rollers have lower friction values
- Jacks with capacity well in excess of friction.

Slide Mechanism	Coefficient of Friction
Teflon coated neoprene bearing pads	10% of Vertical Load
Hillman Rollers	5% of Vertical Load

Lateral Slide Demonstration Project

NY I-84 Twin Bridges

- 20 Hr closure
- Two weekend nights
- Sept 21, 2013
- Oct 19, 2013

20 Hr Lateral Slide

NY I-84 Twin Bridges

Substantial completion in 10 months