


SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Innovative Bridge Designs for Rapid Renewal ABC & State Experiences

2017, ABC Conference, Miami

Finn Hubbard, Fickett Structural Solutions
SHRP2 ABC/PBES
Subject Matter Expert

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

SHRP2 at a Glance

- **SHRP2 Solutions** – 63 products
- **Solution Development** – processes, software, testing procedures, and specifications
- **Field Testing** – refined in the field
- **Implementation** – 430 transportation projects; adopt as standard practice
- **SHRP2 Education Connection** – connecting next-generation professionals with next-generation innovations

What is SHRP2 R04?

- Provides state and local DOTs with a design toolkit for prefabricated bridge projects.
- Standardized approaches streamline the activities required to get bridge replacement systems designed, fabricated, and erected in less time, and **installed in hours or weeks, rather than months**.
- Standard design plans for foundation systems, substructure and superstructure systems, subsystems, and components that can be installed quickly with minimal traffic disruptions.

R04 Implementation Projects

- Through the Implementation Assistance Program, 8 states received funding and technical assistance to use the R04 product.
- SHRP2 Implementation Assistance Projects included:
  - Arizona: Gila River Indian Reservation
  - California: Fort Goff Creek
  - Kentucky: Stewarts Creek
  - Maine: Kittery Overpass
  - Missouri: Boone County
  - Rhode Island: Warren Avenue
  - Wisconsin: I-39/94
  - Michigan: Seney Wildlife Refuge

Next Step, R04 Training

- A one day training class was assembled to introduce frontline employees at DOT's to ABC in general and the SHRP2 R04 Toolkit in particular.
- This training was offered to the State DOT's through the FHWA and AASHTO.
- A total of 16 states received the training last winter
- The R04 team is currently delivering 19 more training sessions

The 16 States Who Received the ABC Training

- Arkansas Delaware Florida Illinois
- Iowa Louisiana Michigan Montana
- Nebraska New Jersey New Mexico Pennsylvania
- South Carolina South Dakota Wisconsin
- Puerto Rico

- As can be seen here, states with larger populations along with states with large areas were interested in ABC

What the States Learned from the Training Class

- Overall introduction to the concept and practice of ABC
  - Why consider ABC?
  - What has changed that makes us interested in building bridges faster?
- Bridge movement technologies
  - PBES
  - Slide-in
  - SPMT

What the States Learned from the Training Class (Continued)

- What does the R04 Toolkit contain? How can it help?
- Lessons learned
  - Two demonstration projects
  - Eight implementation projects
- Costs and savings by implementing ABC
- Contractor interactions
- Tour of ABC projects from around the country
  - Information gathered from the three R04 Peer to Peer exchanges (42 states attended)

What the SHRP2 R04 Team Learned from the States

- Most states have tried an ABC project
- Only a few states have a fully developed ABC program
- States are working to develop a statewide ABC program
- States are interested in what others have done to develop their ABC program
- What is the level of effort to start up an ABC program?
- How do you “sell” ABC to upper management?

What the SHRP2 R04 Team Learned from the States

- What criteria should be used to evaluate ABC opportunities?
  - Safety aspects
  - Restricted construction window
  - Environmental issues
  - Mainline or local road

- What does ABC cost? Save?
- Traffic is a BIG ABC driver in some states
- Detour length is the main factor in some states
- How do I convince contractors that ABC is a good thing?

What the SHRP2 R04 Team Learned from the States

- What have been some of the “pit falls” on past ABC projects?
  - Survey
    - Measure twice, cut once comes to mind
  - Joints are critical
  - Pay attention during shop plan reviews
  - When using bar couplers, template, template, templates!

Global Observations on State Experiences with ABC

- Generally most states have had a good experience with their ABC projects
- Most states are in the same boat and we are all moving up the ABC learning curve together
- Costs continue to be a challenge to ABC
  - First projects are expensive
  - Cost do come down with experience and repetition
  - Look at the total project cost, not just bid prices
    - Traffic control
    - Project management
    - User costs

Questions?

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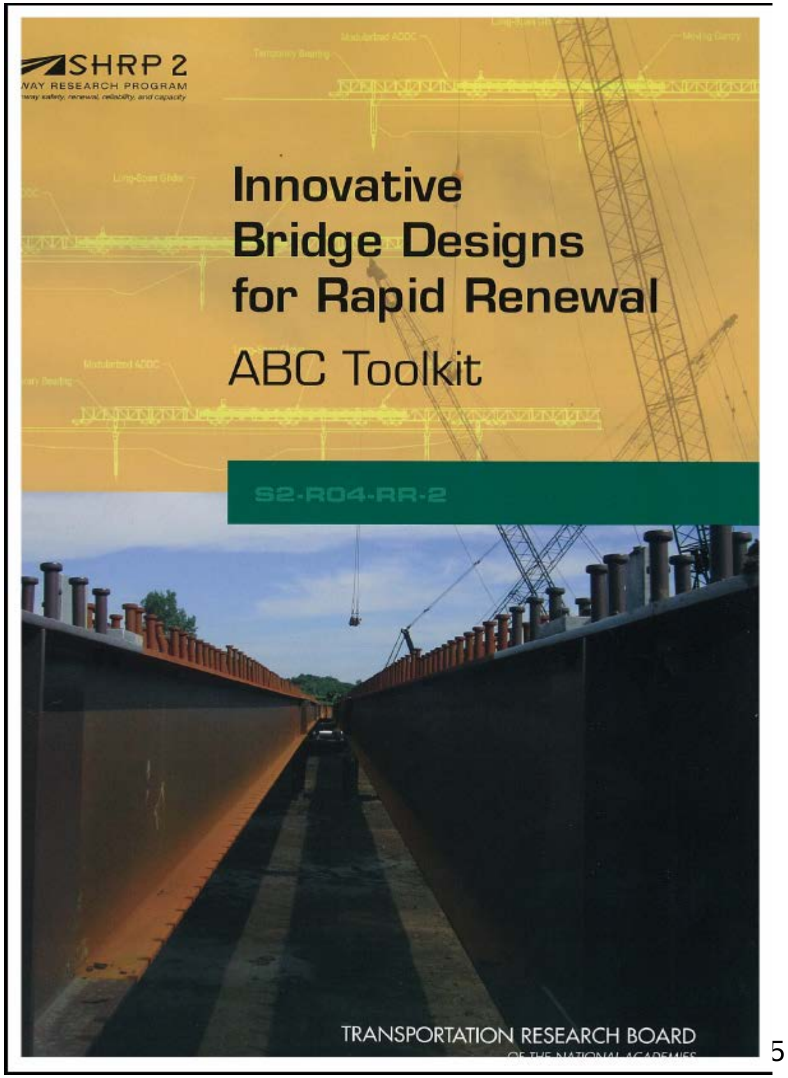

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SHRP2 Overview
Innovative Bridge Designs for Rapid Renewal (R04) Using ABC/PBES

Finn Hubbard, Fickett Structural Solutions
SHRP2 ABC/PBES
Subject Matter Expert

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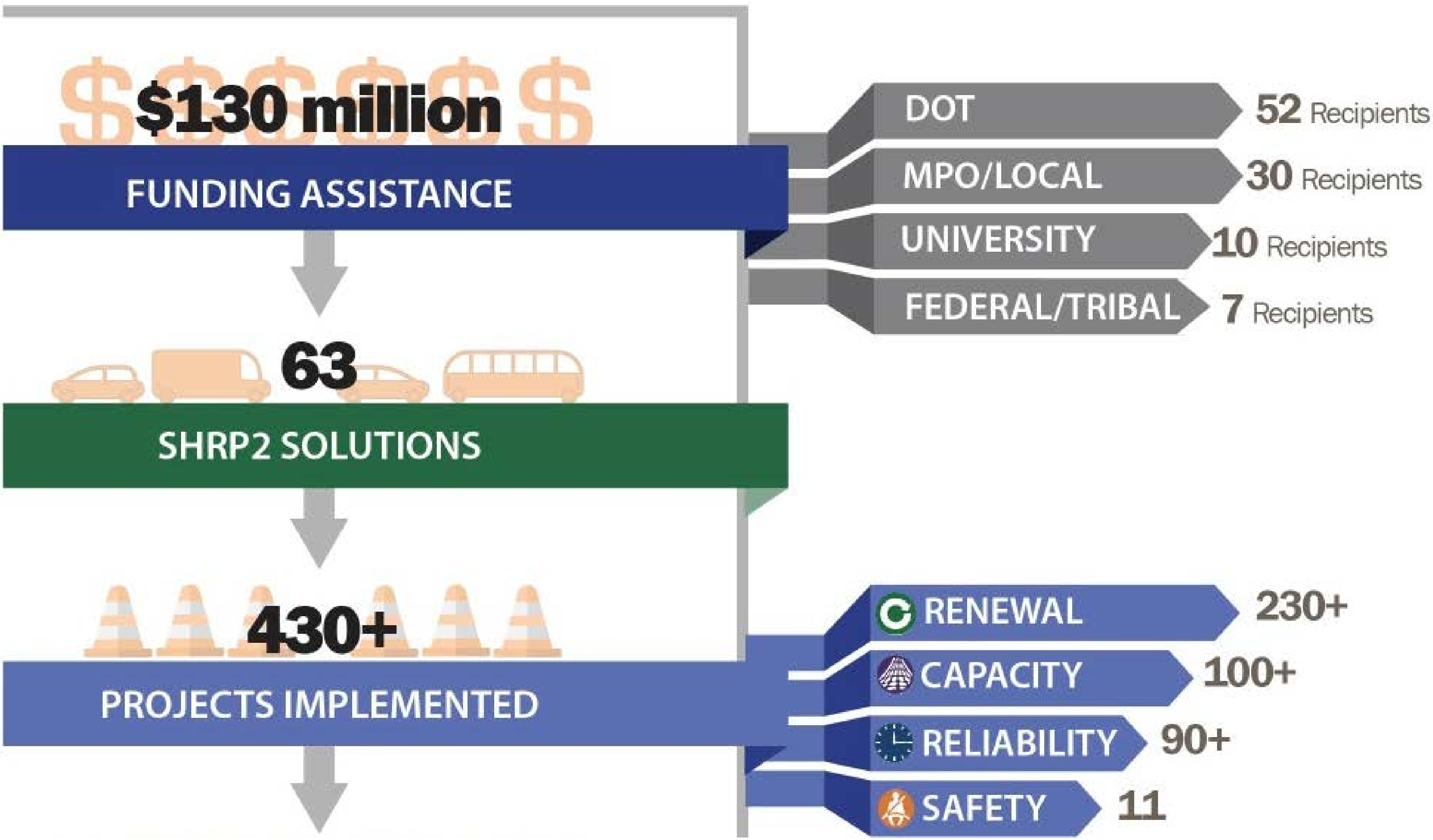
SHRP2 Implementation:
INNOVATE.IMPLEMENT.IMPROVE.



SHRP2 Implementation:
INNOVATE.IMPLEMENT.IMPROVE.

Focus Areas

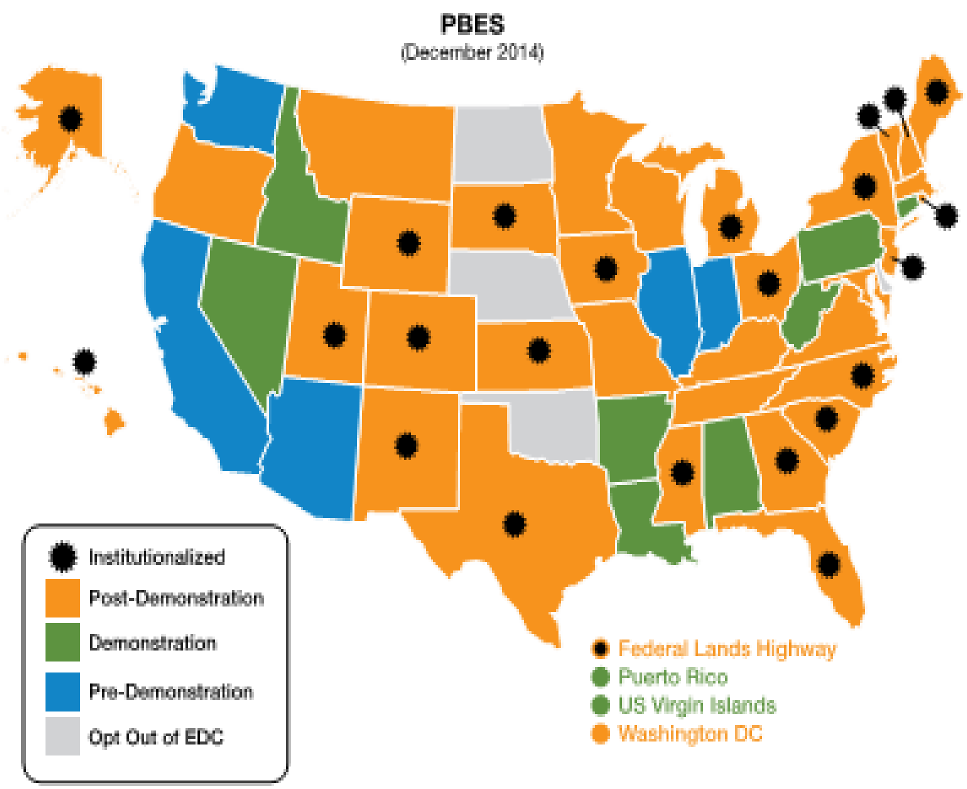
Safety: Fostering safer driving through analysis of driver, roadway, and vehicle factors in crashes, near crashes, and ordinary driving

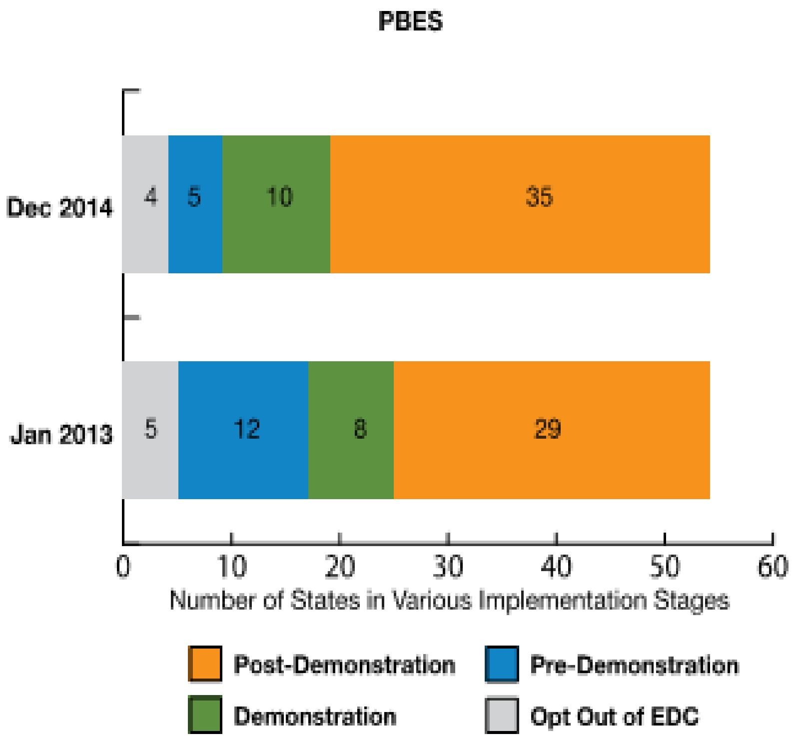
Reliability: Reducing congestion and creating more predictable travel times through better operations

Capacity: Planning and designing a highway system that offers minimum disruption and meets the environmental and economic needs of the community

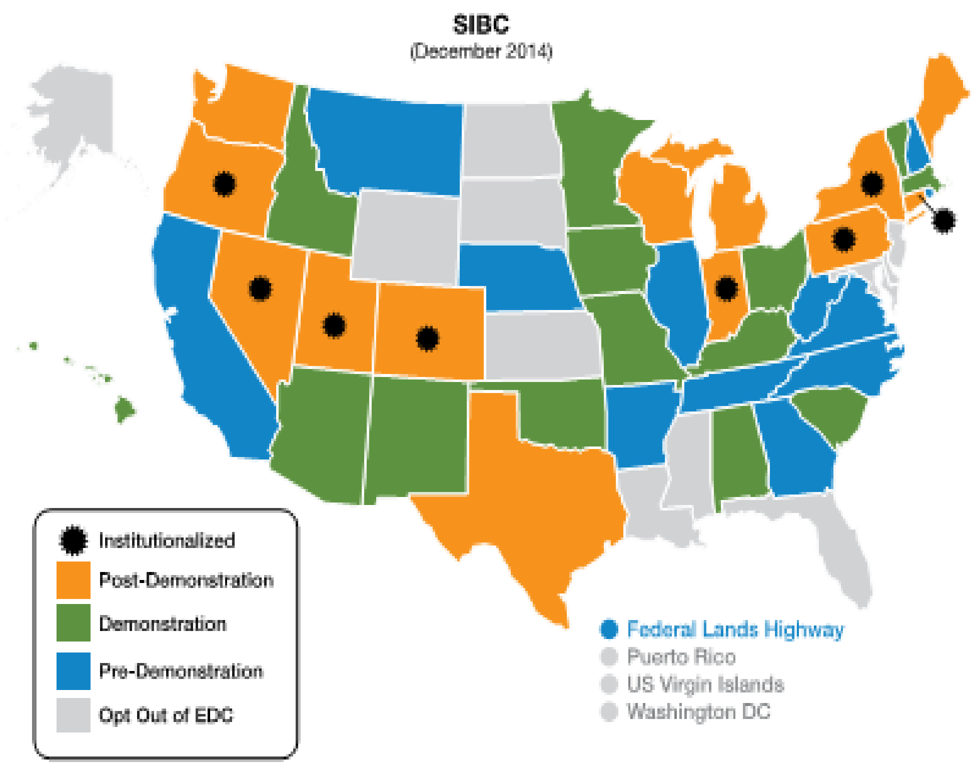
Renewal: Rapid maintenance and repair of the deteriorating infrastructure using already-available resources, innovations, and technologies

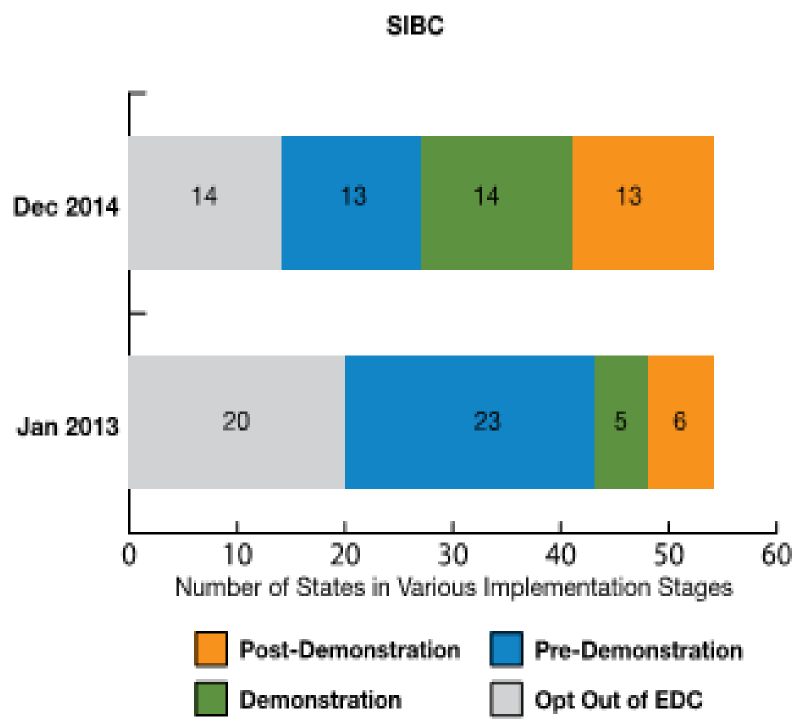
EDC-2, Prefabricated Bridge Elements and Systems



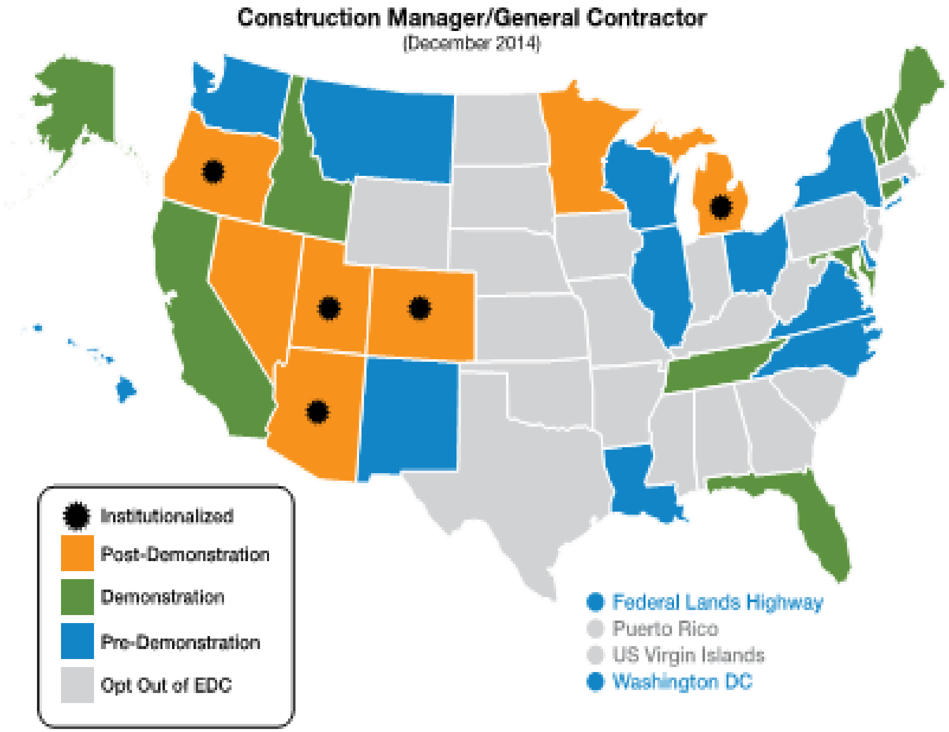


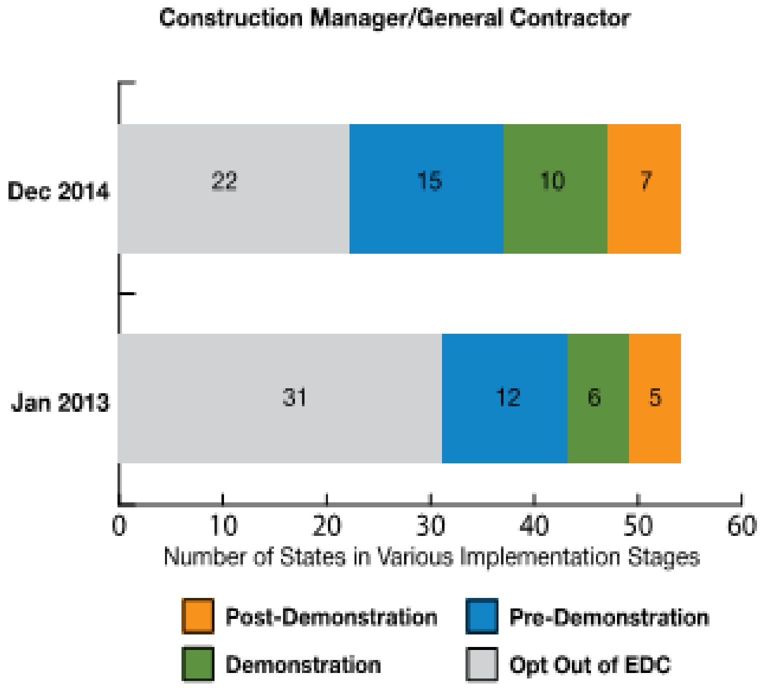
EDC-2, Slide-in Bridge Construction





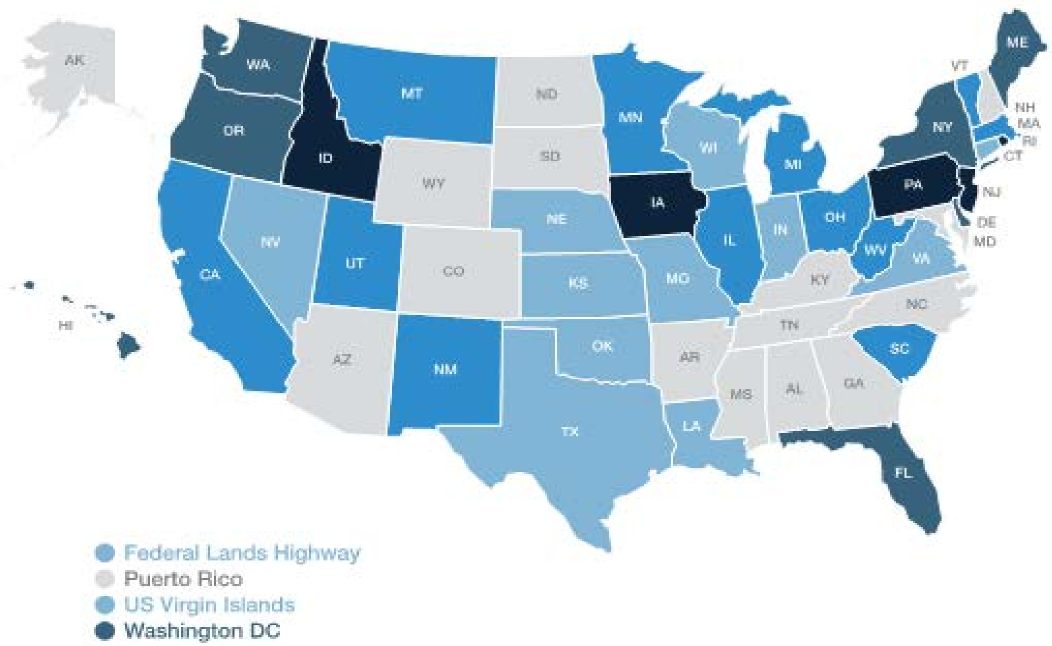
EDC-2, Construction Manager/ General Contractor



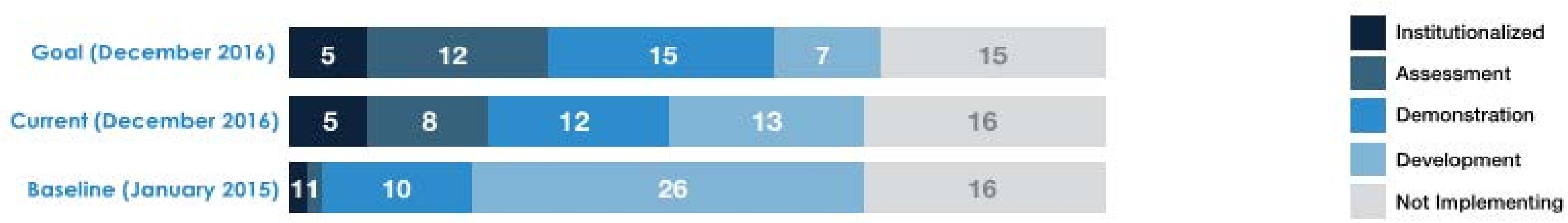


EDC-3, Ultra High Performance Connections

Current (December 2016)



Number of States in Various Implementation Stages



Workshop Learning Outcomes

- **Understanding ABC**
  - What does it mean?
  - Why do we care?
  - How do we implement?
- **Knowledge of the SHRP2 R04 Toolkit**
  - How can it assist me?
  - What guidance does it contain?

Accelerated Bridge Construction (ABC)

ABC – refers to technologies, contract mechanisms, design templates, and rapid-time savings in bridge construction

- Reduces construction time and minimizes traffic impacts
- Decreases safety risks by minimizing contractor exposure to traffic
- Increases local contractor involvement through standardized approaches
- Reduces environmental impacts
- Saves money and time

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- Provides standard design plans for foundation systems, substructure and superstructure systems, subsystems, and components that can be installed quickly with minimal traffic disruptions

R04 Pilot Projects

- Research phase of R04 product included two pilot projects built using the SHRP2 R04 ABC Toolkit:
  - Keg Creek Bridge, Iowa Department of Transportation
  - I-84 EB & WB Bridges over Dingle Road, New York Department of Transportation

R04 Implementation Projects

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Questions?




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SHRP2 *Innovative Bridge Designs for Rapid Renewal*

Introduction to ABC

ABC "Toolkit" for Designers

Finn Hubbard, Fickett Structural Solutions
SHRP2 ABC/PBES Implementation
Technical Lead

U.S. Department of Transportation
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AASHTO

ABC is bridge construction that uses innovative, non-conventional approaches in 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.

ABC Construction Methods

- Elements Assembled Onsite
- Slide In Bridge Construction (SIBC)
- Entire Super Structure moved in from a remote location (SPMT)
- Other methods?

Advantages of ABC

- Enhanced mobility - Reduces disruption to traffic and avoids congestion.
- Increased safety - Reduces exposure of workers and public to construction activities. Most of the construction is done at ground level.
- Reduced costs – Reduces owner costs, contractor risks, user delays, over time.
- Better quality control of precast elements
- Reduced environmental impacts

When to Use ABC

Planned Replacement

Emergency Replacement

At right, I-10 spans on Lake Pontchartrain after Hurricane Katrina

Process for Choosing ABC

- Successful use of ABC requires:
  - Careful evaluation of the requirements for the bridge,
  - Evaluation of site constraints, and
  - Review of total costs and benefits.

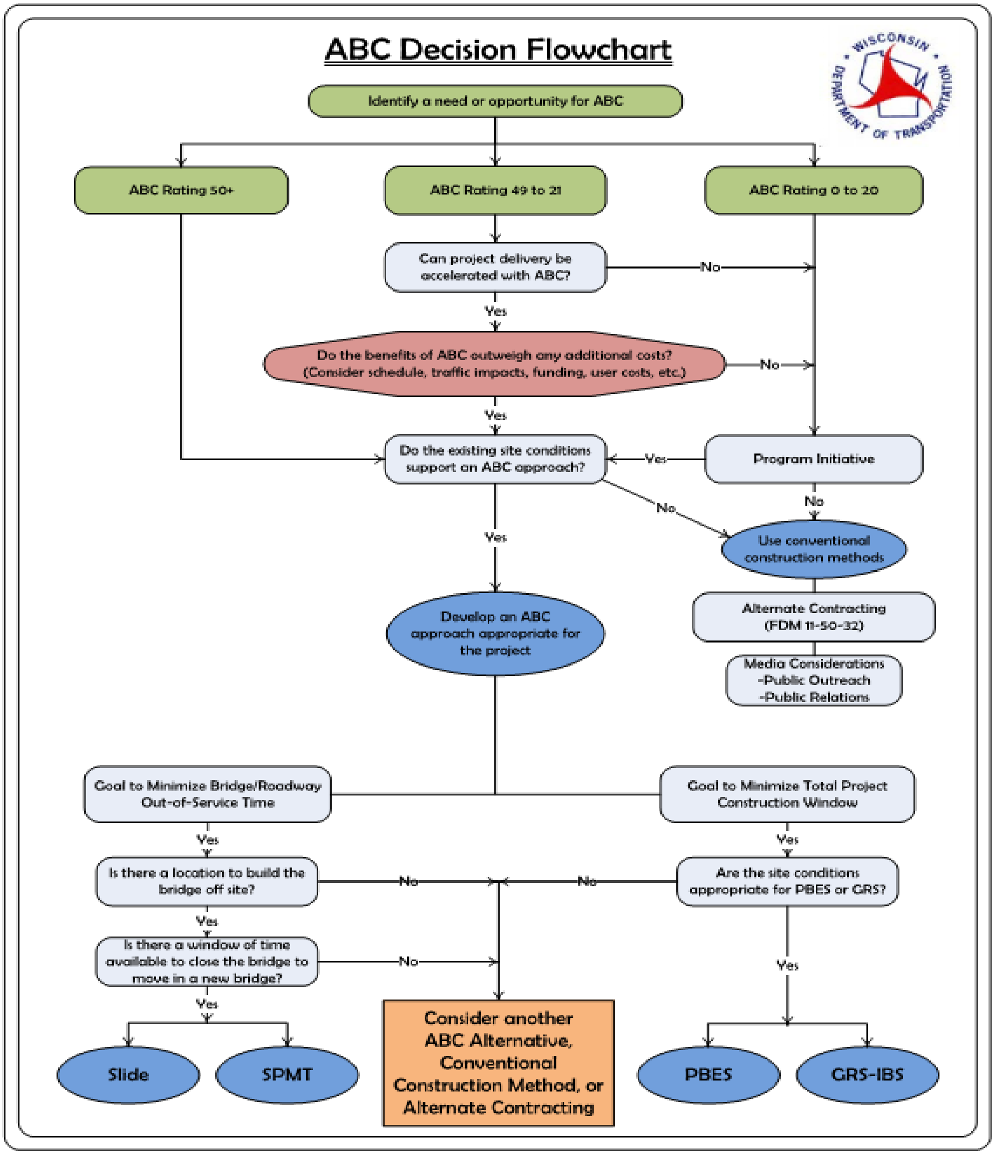
Gila River – Arizona

Good Locations for ABC???

Test Case for ABC Selection

% Weight	Category	Decision-Making Item	Possible Points	Points Allocated	Scoring Guidance
17%	Disruptions (on/under Bridge)	**Railroad on Bridge?**	8		0 No railroad track on bridge 4 Minor railroad track on bridge 8 Major railroad track on bridge
		Railroad under Bridge?	3		0 No railroad track under bridge 1 Minor railroad track under bridge 3 Major railroad track(s) under Bridge
		Over Navigation Channel that needs to remain open?	6		0 No navigation channel that needs to remain open 3 Minor navigation channel that needs to remain open 6 Major navigation channel that needs to remain open
8%	Urgency	**Emergency Replacement?**	8		0 Not emergency replacement 4 Emergency replacement on minor roadway 8 Emergency replacement on major roadway
23%	User Costs and Delays	**ADT and/or ADTT** (Combined Construction Year ADT on and under bridge)	6		0 No traffic impacts 1 ADT under 10,000 2 ADT 10,000 to 25,000 3 ADT 25,000 to 50,000 4 ADT 50,000 to 75,000 5 ADT 75,000 to 100,000 6 ADT 100,000+
		Required Lane Closures/Detours? (Length of Delay to Traveling Public)	6		0 Delay 0-5 minutes 1 Delay 5-15 minutes 2 Delay 15-25 minutes 3 Delay 25-35 minutes 4 Delay 35-45 minutes 5 Delay 45-55 minutes 6 Delay 55+ minutes
		Are only Short Term Closures Allowable?	5		0 Alternatives available for staged construction 3 Alternatives available for staged construction, but undesirable 5 No alternatives available for staged construction
		Impact to Economy (Local business access, impact to manufacturing etc.)	6		0 Minor or no impact to economy 3 Moderate impact to economy 6 Major impact to economy
14%	Construction Time	**Impacts Critical Path of the Total Project?**	6		0 Minor or no impact to critical path of the total project 3 Moderate impact to critical path of the total project 6 Major impact to critical path of the total project
		Restricted Construction Time (Environmental schedules, Economic Impact – e.g. local business access, Holiday schedules, special events, etc.)	8		0 No construction time restrictions 3 Minor construction time restrictions 6 Moderate construction time restrictions 8 Major construction time restrictions
5%	Environment	**Does ABC mitigate a critical environmental impact or sensitive environmental issue?**	5		0 ABC does not mitigate an environmental issue 2 ABC mitigates a minor environmental issue 3 ABC mitigates several minor environmental issues 4 ABC mitigates a major environmental issue 5 ABC mitigates several major environmental issues
3%	Cost	**Compare *Comprehensive* Construction Costs** (Compare conventional vs. prefabrication)	3		0 ABC costs are 25%+ higher than conventional costs 1 ABC costs are 1% to 25% higher than conventional costs 2 ABC costs are equal to conventional costs 3 ABC costs are lower than conventional costs
18%	Risk Management	**Does ABC allow management of a particular risk?**	6		0 - 6 Use judgment to determine if risks can be managed through ABC that aren't covered in other topics
		Safety (Worker Concerns)	6		0 Short duration impact with TMP Type 1 3 Normal duration impact with TMP Type 2 6 Extended duration impact with TMP Type 3-4
		Safety (Traveling Public Concerns)	6		0 Short duration impact with TMP Type 1 3 Normal duration impact with TMP Type 2 6 Extended duration impact with TMP Type 3-4
12%	Other	**Economy of Scale** (repetition of components in a bridge or bridges in a project) (Total spans = sum of all spans on all bridges on the project)	5		0 1 total span 1 2 total spans 2 3 total spans 3 4 total spans 4 5 total spans 5 6+ total spans
		Weather Limitations for conventional construction?	2		0 No weather limitations for conventional construction 1 Moderate limitations for conventional construction 2 Severe limitations for conventional construction
		Use of Typical Standard Details (Complexity)	5		0 No typical standard details will be used 3 Some typical standard details will be used 5 All typical standard details will be used
		Sum of Points:		0	(100 Possible Points)

Test Case for ABC Method



ABC Project Coordination

- Starts in planning
- Project Manager, Designer and Construction Engineer need to be on the same page
- Discuss the site constraints
- What is the best method?
  - PBES
  - Slide-in
  - SPMT
  - Other?
  - None

Other Factors: ABC Significantly Decreases Construction Impacts

- During peak construction season:
  - ✓ 20% of highways are under construction
  - ✓ More than 3,000 work zones.
  - ✓ Active work zone in 1 out of every 100 miles

- More than 40,000 people are injured each year in crashes in work zones.
- One work zone fatality every 8 hours – 3 per day
- One work zone injury every 9 minutes – 160 per day

Traffic and ABC

- We live in a different world from the one the interstate system was built in
- User delays are a real cost to society
- User delays include detour lengths
- ABC can dramatically help

Challenges of ABC

- Higher initial construction cost
- Considering user costs can be difficult/need standards
- Joint durability
- Connections approved for seismic regions
- Engineers need ABC standards/specifications/training
- ABC projects are perceived as more risky/less profitable
- Industry reluctance
- CIP culture/ contractors want to self-perform

ABC Example – Massachusetts

I-93 Fast 14 Project

Massachusetts DOT replaced 14 bridges in 12 weekends!

- Used Prefabricated Bridge Elements and Systems (PBES)

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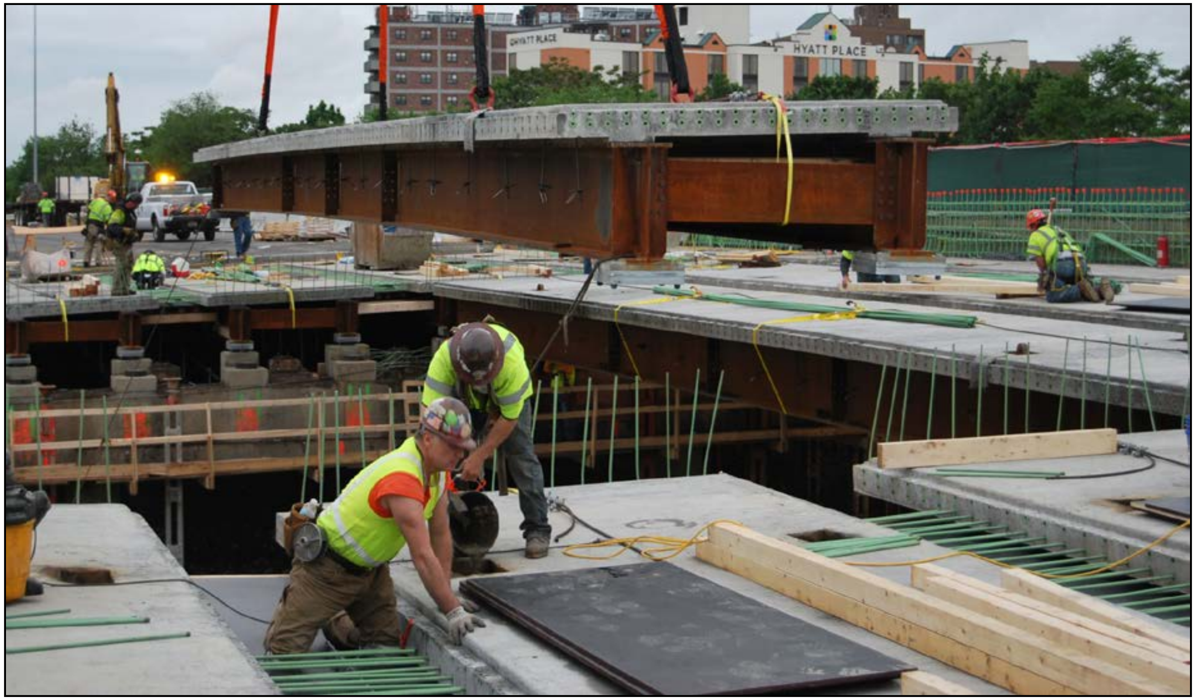


I-93 Fast 14 Project

Massachusetts DOT replaced 14 bridges in 12 weekends!

- This is what caused the need to push hard and fast!

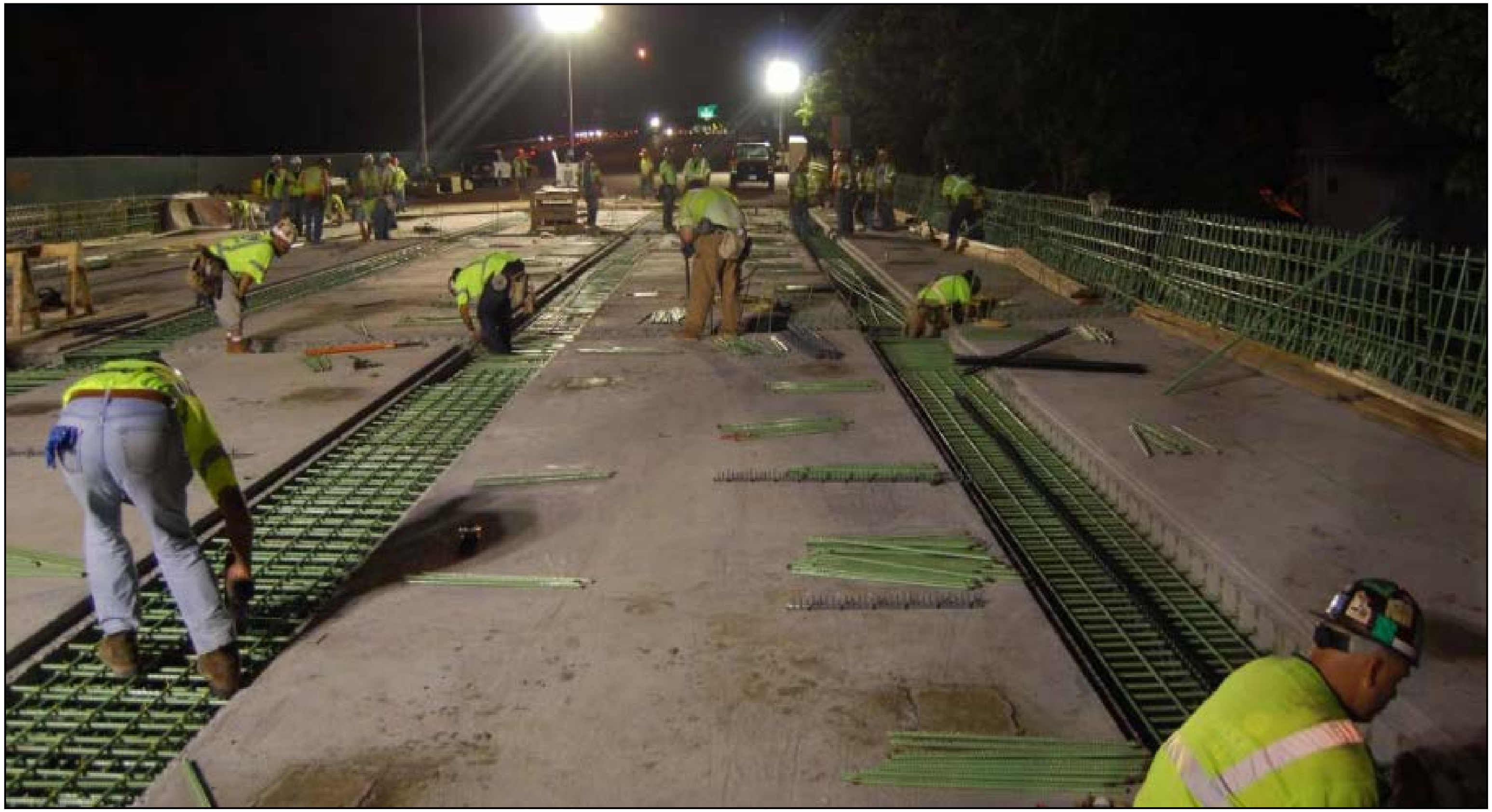
Fast 14 - Module Shipping

- Modules delivered in mass to stay on schedule

Fast 14 - Doing It Fast Means Lots of Equipment On Site

Fast 14 – Work Around the Clock

- Ten: 55-hour closures (each bridge was completed in less than 48 hours!)



ABC “Toolkit” for Designers

The Toolkit contains the philosophy of ABC, movement technologies, and several completely worked out design examples in steel and concrete super structures and concrete substructures.

Elements vs. Systems

What are Prefabricated Elements?

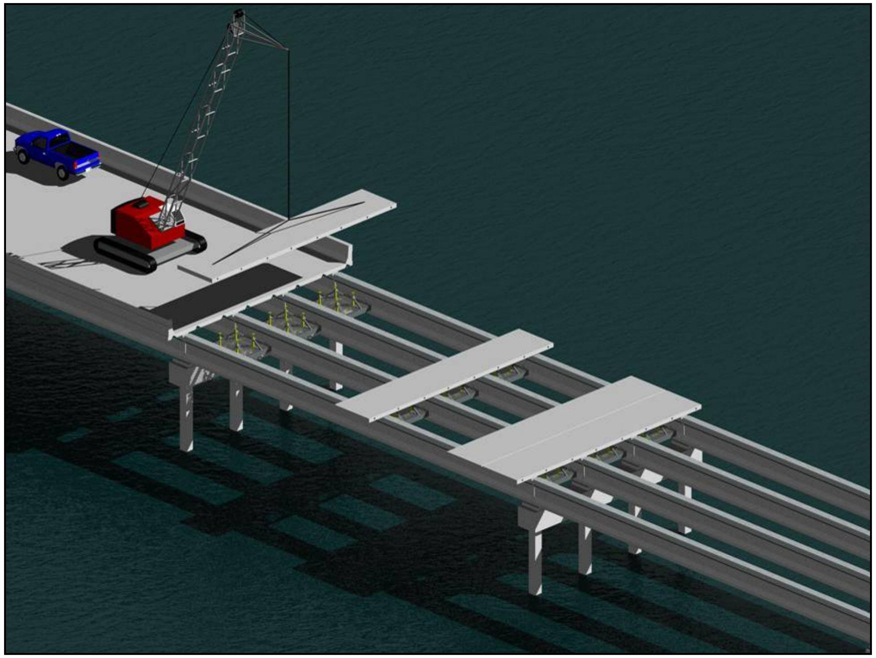
- Element: Single structural component of a bridge:
  - Deck Element
  - Beam Element
  - Pier Element
  - Abutment and Wall Element

Prefabricated Elements

Deck Elements

- Precast Deck Slab Panels:
  - Partial Depth
  - Full Depth
- Level of Compression
  - Post-Tensioning
- Ultra High Performance Concrete
  - Simplified Joints without Compression

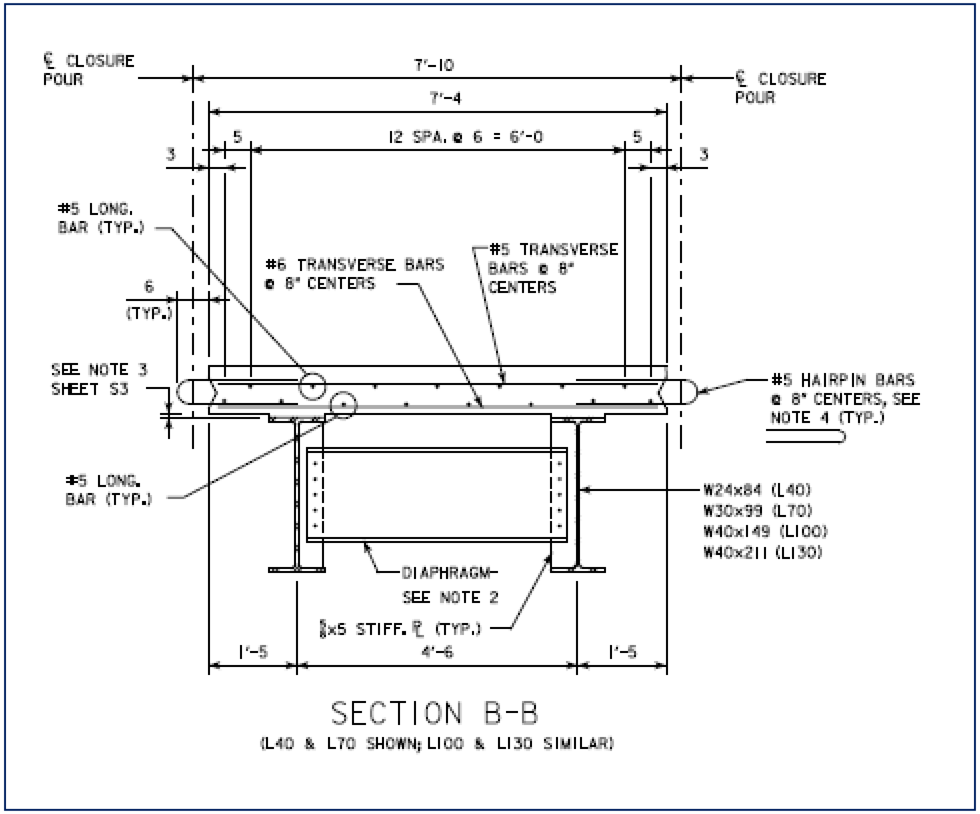
Full Depth Precast Deck Panels

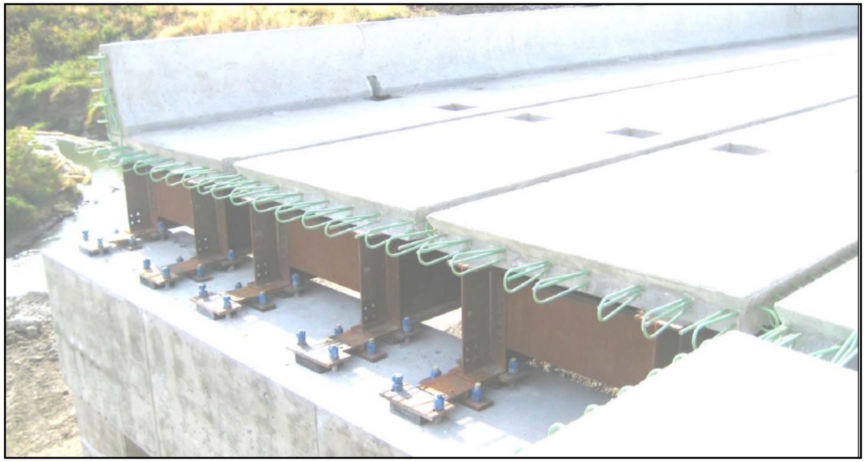


Precast Bridge Decks with Quality Riding Surfaces

- Diamond grinding is used to smooth deck after installation of the elements.
- Concrete cover in the elements needs to be thick enough to accommodate the grinding operation.
- Thin concrete overlays or asphalt can eliminate the need for grinding..
  - Dependent of the amount of differential alignment of the precast pieces.

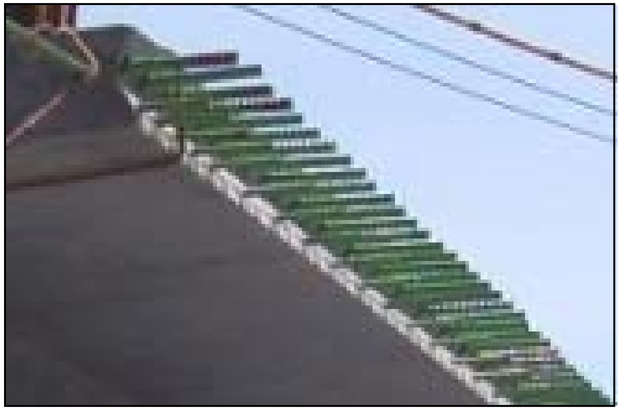
Typical Decked Steel Girders





- Not proprietary
- Contractor can self-perform precasting of deck onsite
- Lightweight system for ABC

Deck Bulb Tee Superstructure



85 foot span; 15 degree skew

NY Route 31

UHPC Prestressed/ Post Tensioned Beams

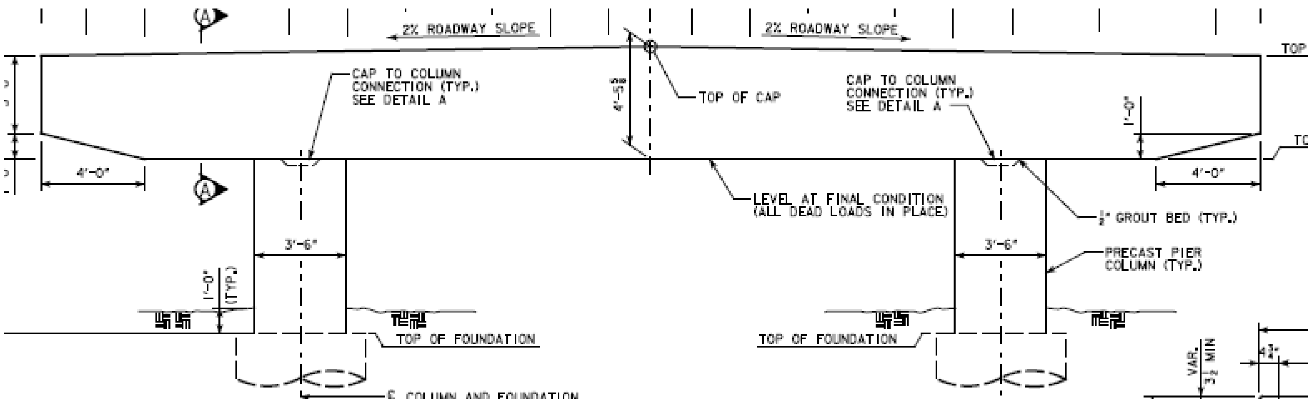
Iowa???

Substructures and ABC

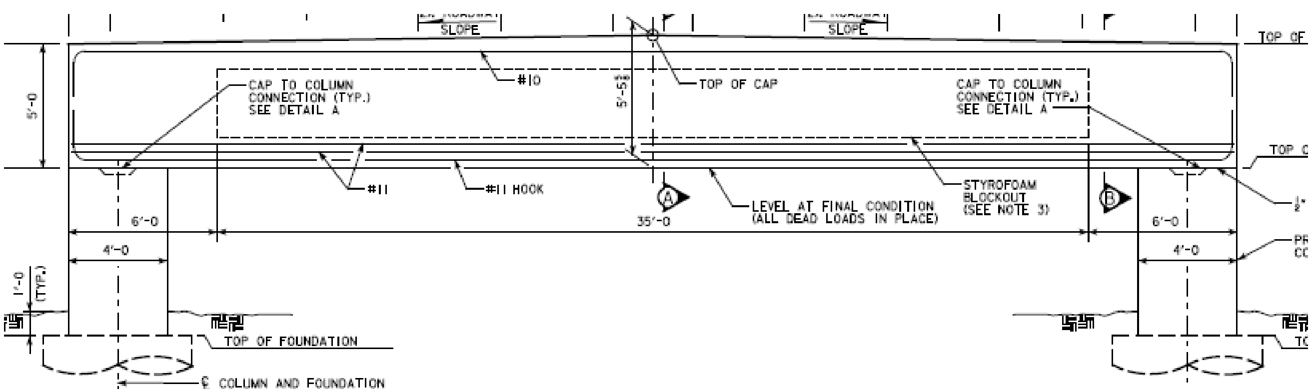
- May control the ABC schedule
- If possible do before ABC closure
- Precast abutments/footings
- Drilled shafts
- Precast piers

Drilled Shaft Outside Footprint

Complete Precast Piers



Conventional Pier



Straddle Bent

Precast Piers

Segmental Columns

Prefabricated Foundations

- Prefabricated footings
  - Size and weight issues
  - Precast sections with closure pours
- Prefabricated pile caps
  - Corrugated pipe pile pockets
- Prefabricated box caissons
  - Dewater for footing construction

Abutments on H Piles

Prefabricated Footings & Walls

Prefabricated Systems

Importance of Connections in ABC

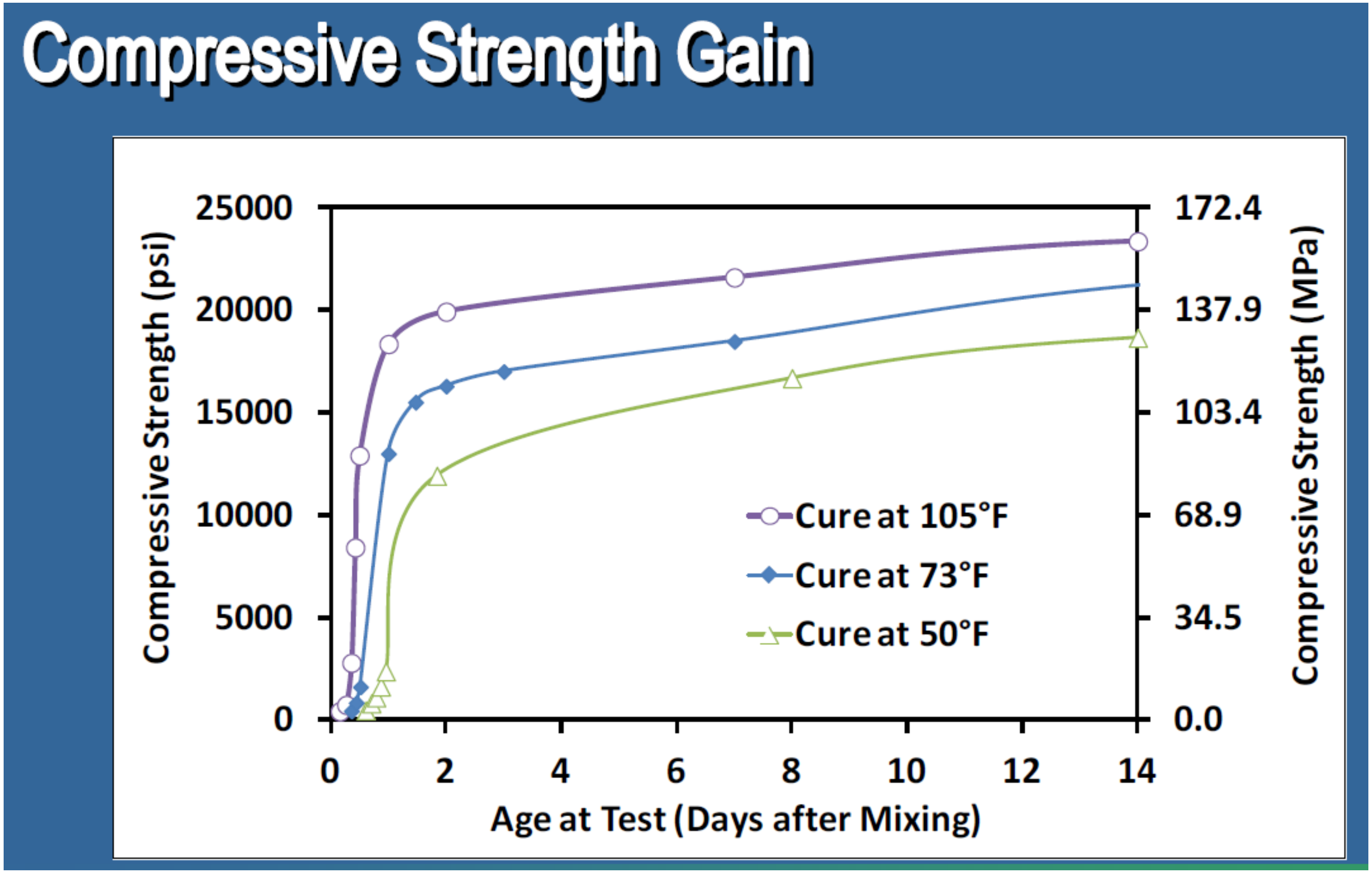
Important Design Characteristics of PBES Connections

- Engineering characteristics for design:
  - Strong, Durable Material
  - Good Bond to Concrete
  - Good Bond to Rebar
  - Self Consolidating
  - Sustained Tensile Strength
  - Short Development Length

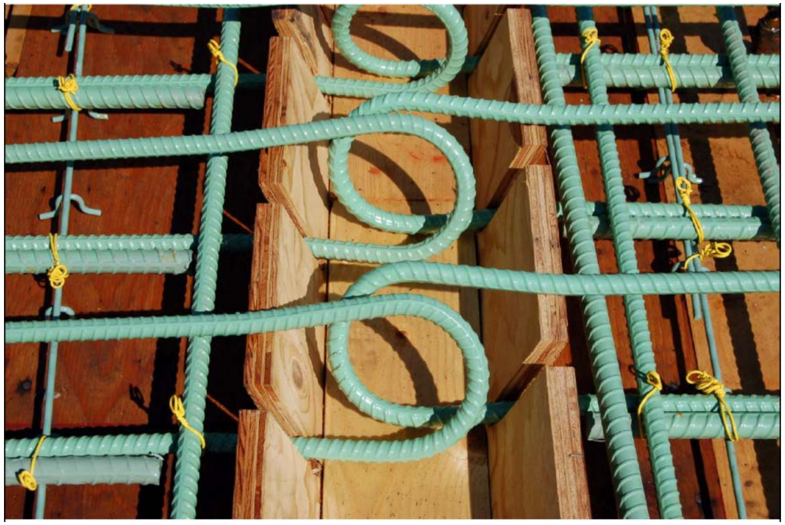
How UHPC Fits into ABC

- Benefits
  - Strong joint, short lap lengths of rebar
  - Watertight
  - Chloride resistant
- Drawbacks
  - Expensive material
  - Specialty sub contractor?
  - Non-familiarity of contractor/owner

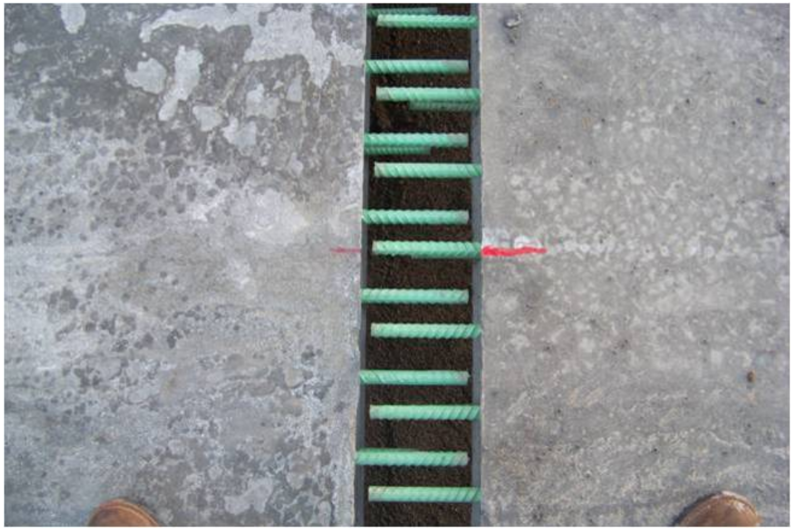
UHPC Strength Gain



UHPC Longitudinal Joints



6-inch joint using hairpin bars

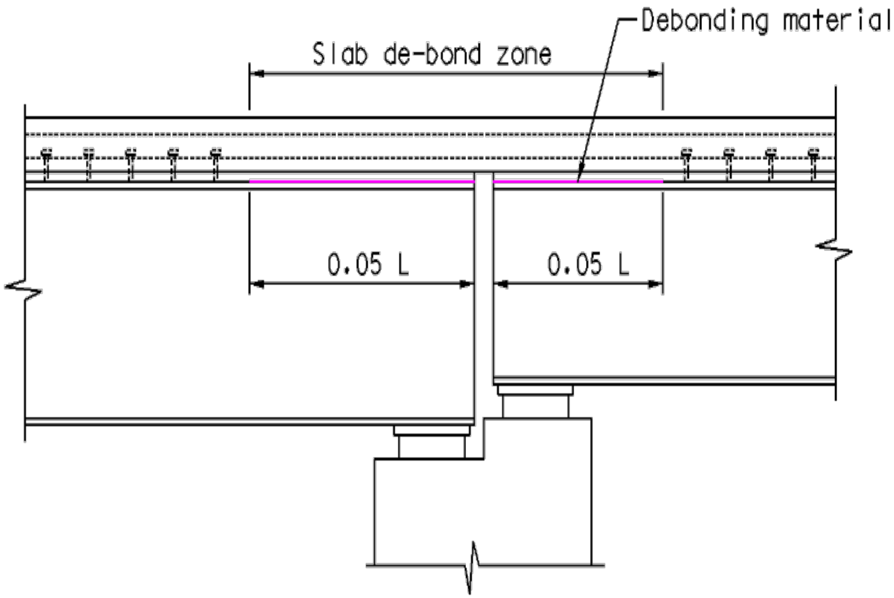


6-inch joint using straight bars

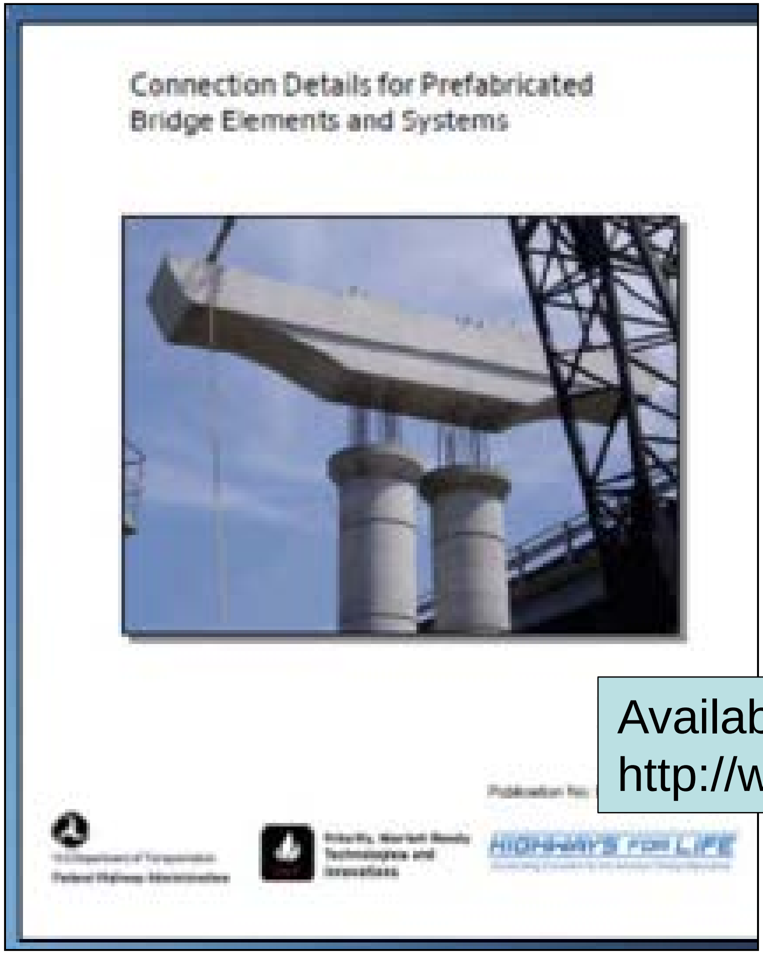
UHPC Mixing and Placement – NYSDOT Example

Link Slabs

- Another option for multi-span bridges
- Jointless, not continuous
  - Less complicated
  - Less Expensive
  - Great for prefabricated beam elements
- Used to accommodate the end rotations in the beams

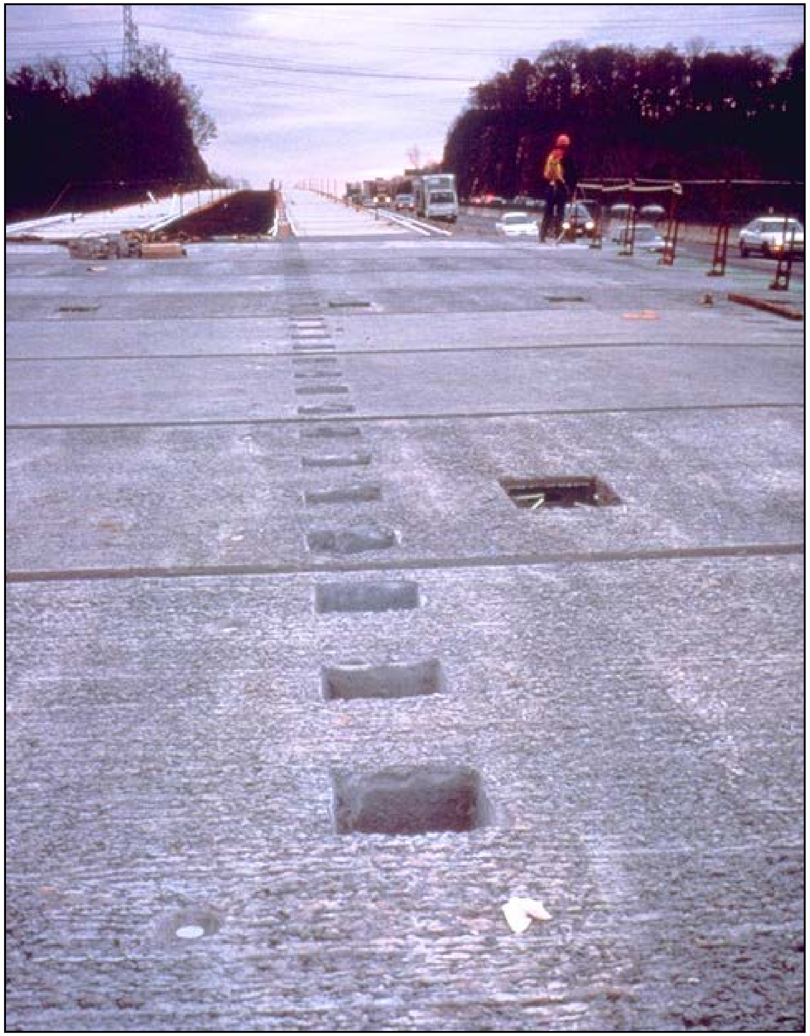


Excellent Resource: FHWA ABC Connections Manual



Available at:
http://www.fhwa.dot.gov/bridge/prefab/if09010/

Precast Concrete Deck Panels
Open Shear Connector Pockets



Options for Connecting Deck Elements

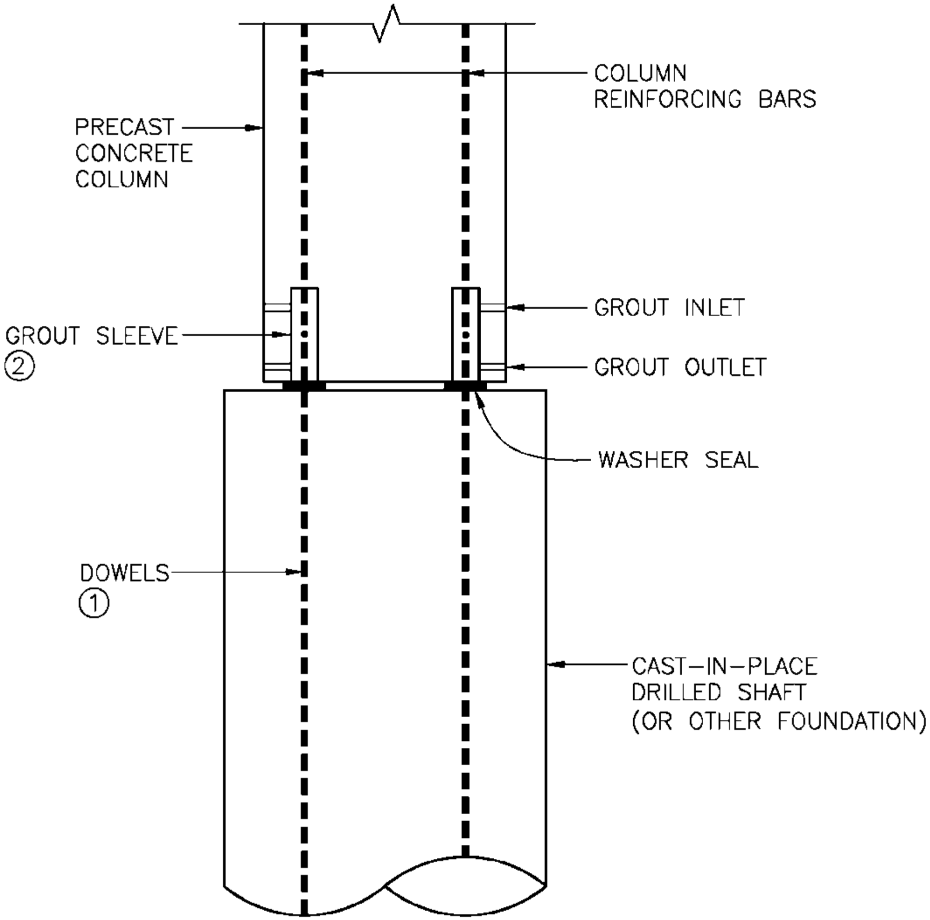
- Closure pour with lapped reinforcement and rapid set concrete
- Small closure pour with UHPC
- Small closure pour with headed reinforcing bars and non-shrink grout
- Grouted shear key with transverse post-tensioning
- Match cast epoxied edges with transverse post-tensioning

ABC Substructure Connections

Connections for Precast Systems:

- Grouted Splice Sleeve
- Grouted Post Tensioning ducts
- Grouted Cap Pockets (seismic)

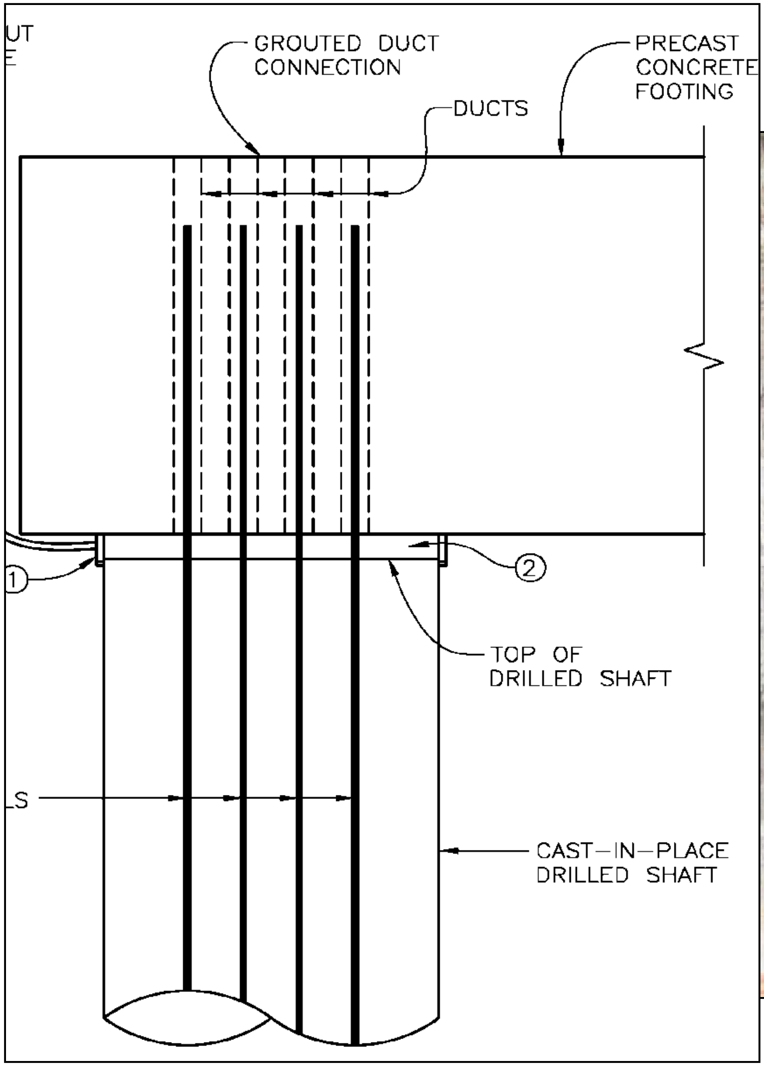
Grouted Splice Sleeve Couplers

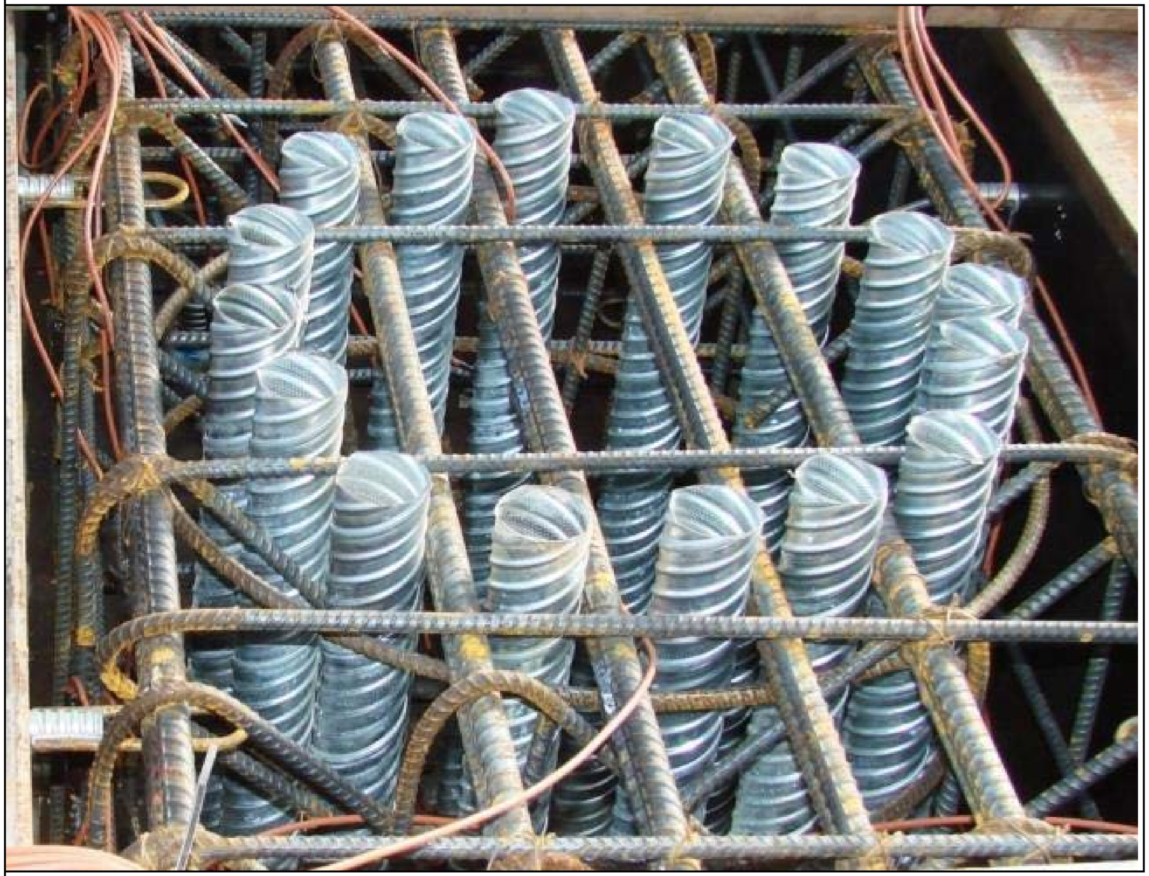


Grouted Splice Sleeve Couplers

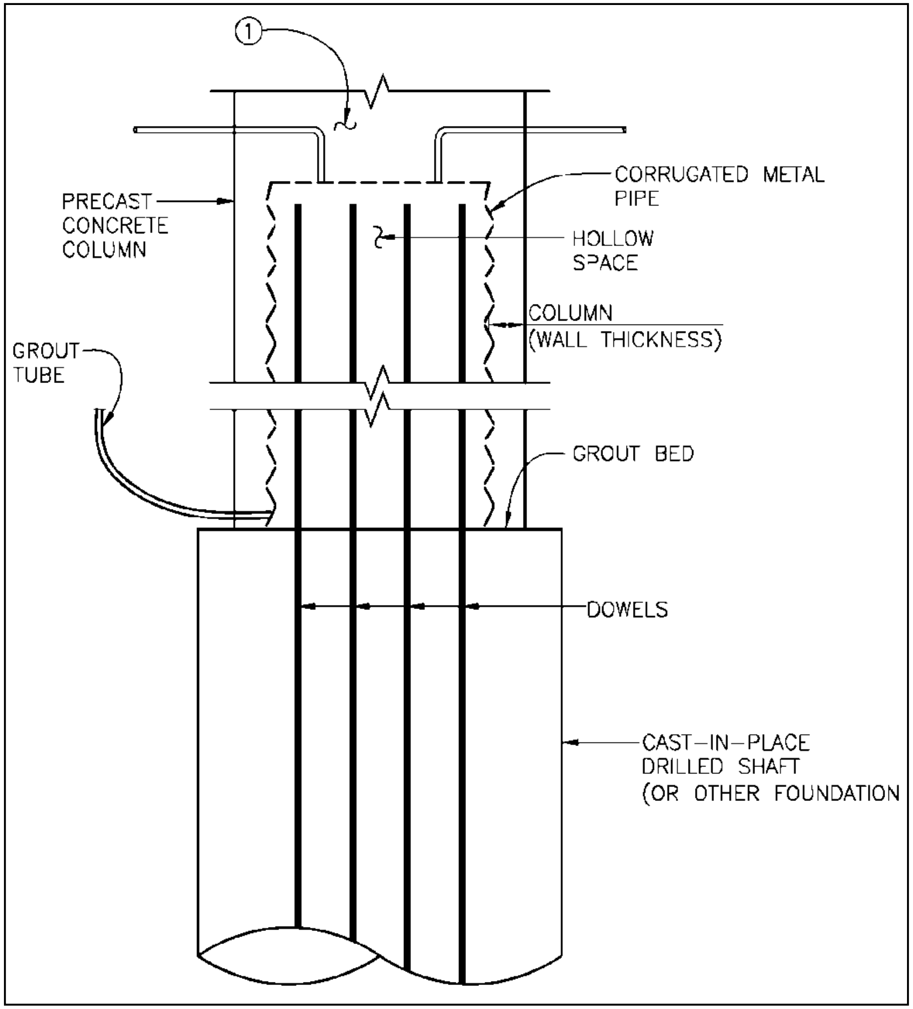
Grouted Splice Sleeve Couplers

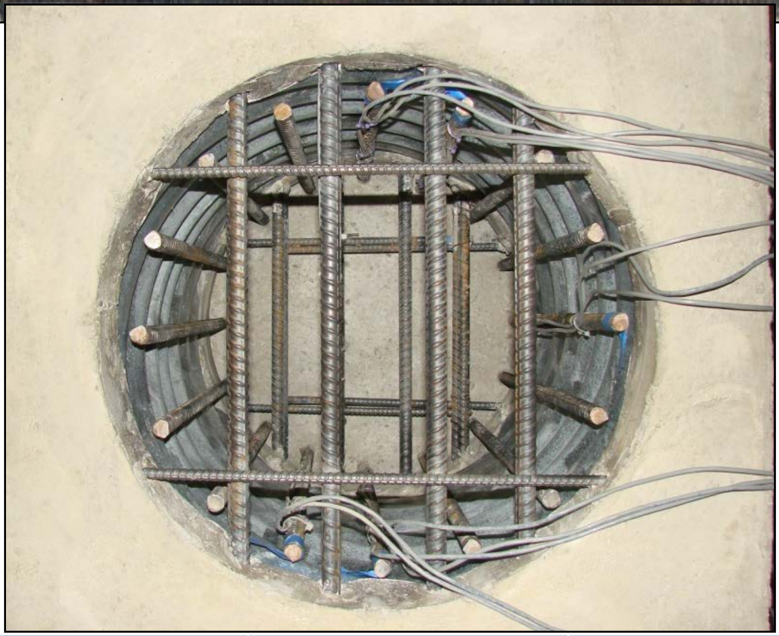
Grouted Ducts for Dowels in Caps/Foundations





For Seismic Regions: Precast Bent Cap, Grouted Cap Pocket





Bridge Movement Technologies

The concept of building all the bridge elements offline (where ROW is available) and then moving them into place in a few hours is a powerful ABC method to minimize traffic disruption.

Rapid Demolition Using Conventional Equipment

Rapid Demolition Using SPMTs

4500 South over I-215 (2007) Utah.
Existing bridge spans removed using SPMT.

ABC Methods, What to Choose?

- The construction site will lead you to the best ABC solution
- What are the constraints?
  - Interstate over local road
  - Local road over an Interstate
  - Bridge over a river
  - Open area around bridge site
  - Tight urban area

Bridge Moves with Self Propelled Modular Transporter (SPMTs)

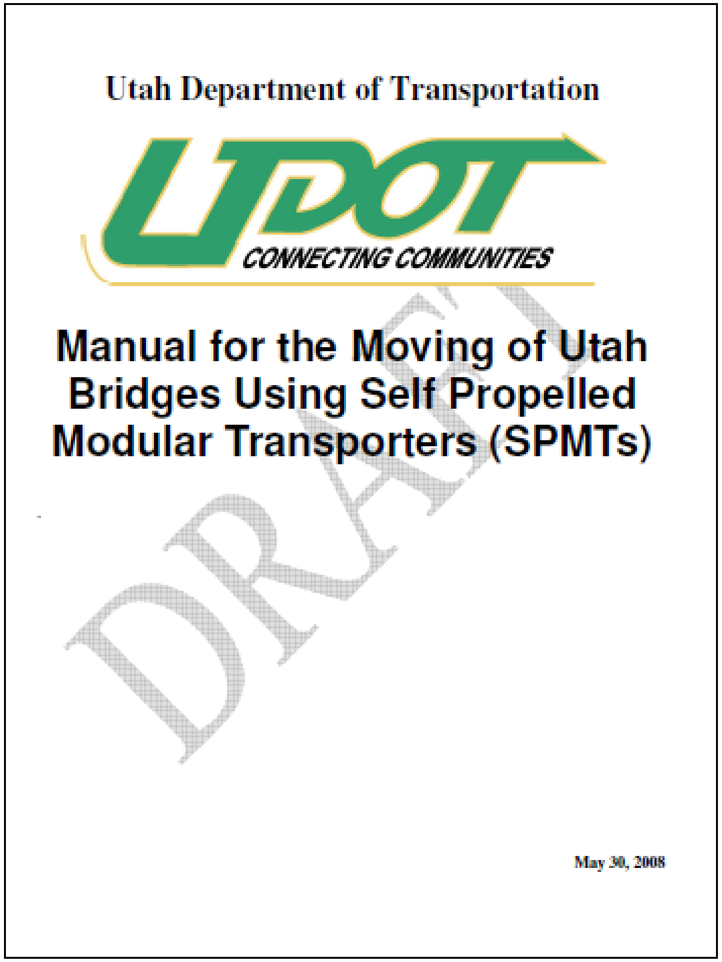
Example: Barge-Mounted SPMTs

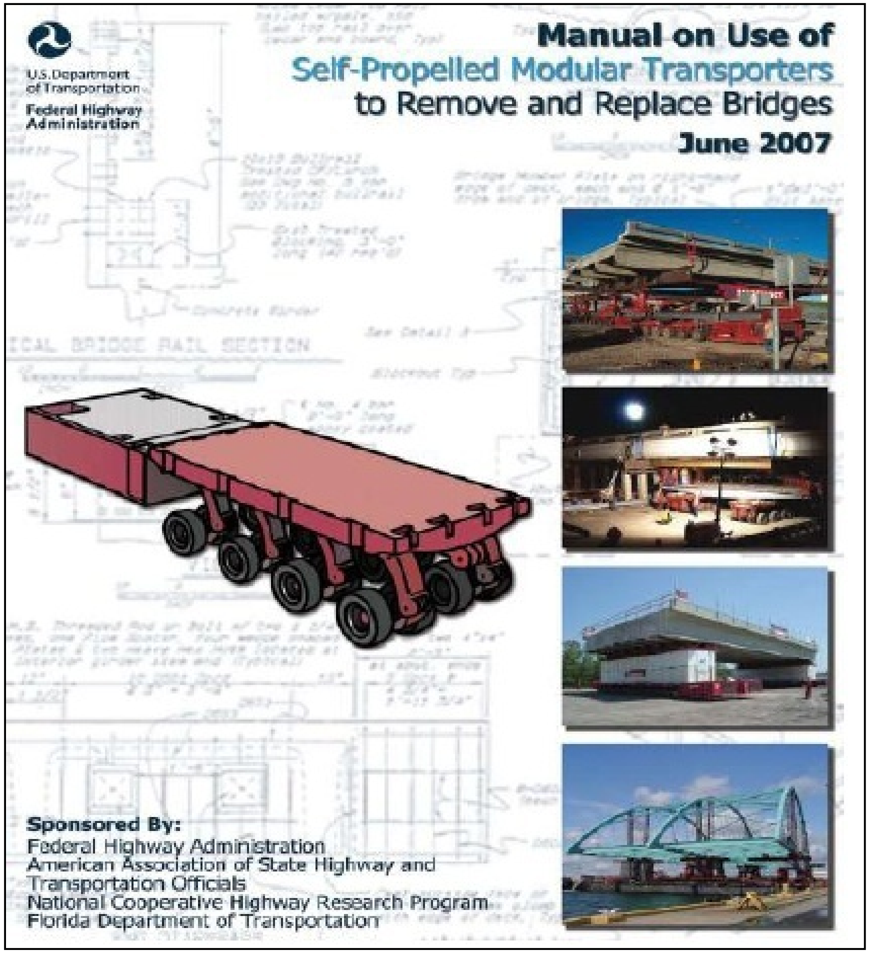
- Category 4 Hurricane Ivan struck the Pensacola area on September 16, 2004, damaging nearly a ¼ mile of the double span, I-10 concrete bridge over Escambia Bay.
- SPMTs on barges were used to transport 24 good spans from the east-bound lane to the west-bound lane.

Example: Utah Bridge Farm

Utah I–80 Bridges,
State to 1300 East

SPMT Manuals





SPMT Resource Documents available here:
https://www.fhwa.dot.gov/bridge/abc/spmts.cfm

Erection Concepts For Bridge Replacement Using Cranes

Factors to Consider

- Weight of Module
- Pick Radius
- Crane Set Up Locations
- Ground Access/Barge/ Causeway/Work Trestle
- Truck Access for Delivery

Crane Placement for Erection

Lateral Sliding of Bridges

- Sliding technique allows the projects to be built while minimizing disruption to traffic, accelerating construction, and reducing costs considerably.
- It can be used to slide the old bridge superstructure onto temporary supports to become the construction detour, leaving the old alignment open for new construction.
- Moving the bridge can be done by pushing, using pairs of hydraulic jacks pulled with strand jacks, or by cranes.
- The bridge is usually moved along a steel track.

Slide Track and Jacks

Lateral Slide Example: Nevada

I–15 West Mesquite Interchange, Mesquite, Nevada

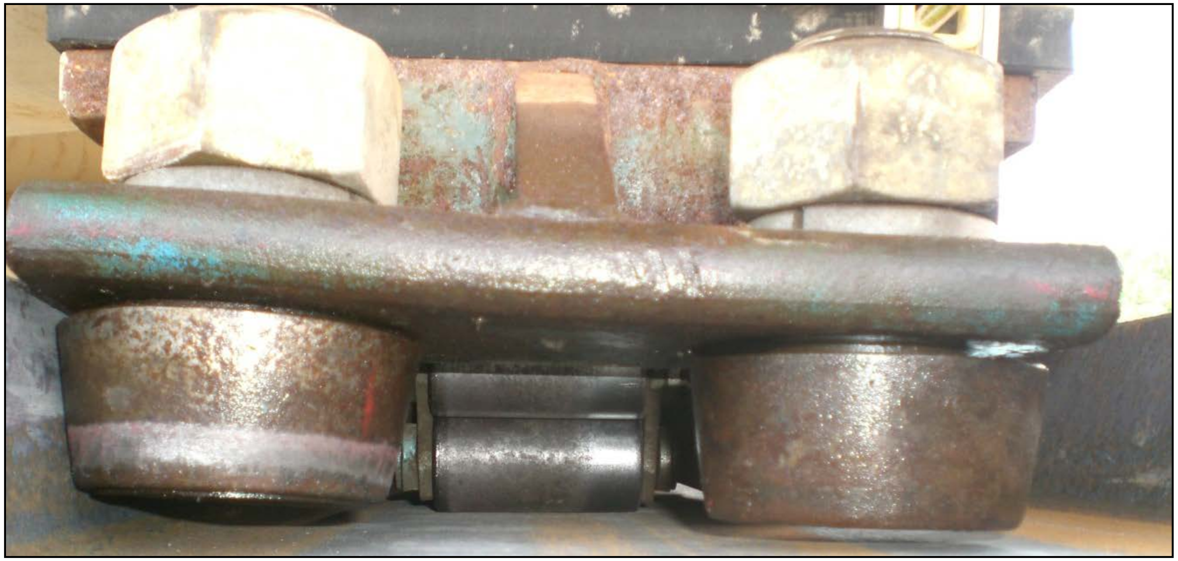
Saved 2 million by NOT having to realign the interstate

Lateral Slide by Pulling With a Crane – Example

Green Bay, Wisconsin

Lateral Slide By Pulling with a Crane

Example: Slide Bearings



Example: Jacking After Roll-In

What's in the R04 Toolkit for Designers?

Reminder:

- Focus on "workhorse" bridges.
- Complete bridges using prefabricated elements and modular systems.
- Contractor could self-perform much of the work.
- Simple to fabricate on site or in a plant and easy to erect using conventional cranes.
- Fast assembly in the field in 1 to 2 weeks.
- Durable connections/durable bridges.

Design Considerations for ABC Standards

- Eliminate deck joints at piers and abutments.
- Consider modular systems that do not require post-tensioning for assembly.
- Consider modular systems with integral wearing surfaces so that an overlay is not required.
- **Provide extra ½ inch for grinding for smooth riding surface and skid resistance.**
- Consider modules that can be used in simple spans and in continuous spans.

Using the ABC Toolkit

- Review the ABC Standard Plans and Design Examples.
- General Information Sheets introduce the intent and scope of the ABC standard plans and details.
- Engineer of Record (EOR) should perform own ABC design calculations for the site using the examples as a guide.
- EOR to customize the standard plans for the site—span lengths/bridge width/module size/skew/foundations/etc.

General Information Sheet

- Lifting and Handling Stresses
- Shop Drawings and Assembly Plan
- Fabrication Tolerances
- Site Casting Requirements
- Geometry Control
- Mechanical Grouted Splices
- Element Sizes
- General Procedure for Installation of Modules

General Information Sheet

GENERAL INFORMATION: SUPERSTRUCTURE

PREFABRICATED COMPONENTS PRODUCED OFF-SITE CAN BE QUICKLY ASSEMBLED, AND CAN REDUCE CONSTRUCTION TIME, COST, MINIMIZE LANE CLOSURE TIME AND/THE NEED FOR A TEMPORARY BRIDGE. THE INTENT OF THESE DESIGN STANDARDS IS TO PROVIDE INFORMATION THAT APPLIES TO THE DESIGN, DETAILING, FABRICATION, HANDLING AND ASSEMBLY OF PREFABRICATED COMPONENTS USED IN ACCELERATED BRIDGE CONSTRUCTION, ACCORDING TO AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS.

THE SYSTEMS PRESENTED IN THESE DESIGN STANDARDS CONSIST OF A PRESTRESSED CONCRETE GIRDER WITH AN INTEGRALLY CAST DECK AND A COMPOSITE DECKED STEEL STRINGER MODULE. BOTH SYSTEMS INCLUDE A FULL DEPTH FLANGE THAT SERVES AS THE RIDING SURFACE TO ELIMINATE THE NEED FOR A CAST-IN-PLACE DECK.

THE PREFABRICATED SUPERSTRUCTURE SYSTEMS (SUPERSTRUCTURE MODULES) PRESENTED IN THESE PLANS MAY BE USED WITH THE PREFABRICATED SUBSTRUCTURE SYSTEMS THAT ARE A PART OF THESE DESIGN STANDARDS, OR THEY MAY BE USED WITH OTHER NEW OR EXISTING SUBSTRUCTURES THAT HAVE BEEN ADAPTED TO SUPPORT THE LOAD REQUIREMENTS FOR THESE SUPERSTRUCTURE MODULES.

TYPICAL DESIGNS FOR SUPERSTRUCTURE MODULES HAVE BEEN GROUPED INTO THE FOLLOWING SPAN RANGES:

20 FT < SPAN < 40 FT
40 FT < SPAN < 70 FT
70 FT < SPAN < 100 FT
100 FT < SPAN < 130 FT

THE SUPERSTRUCTURE CROSS-SECTION AND MODULE WIDTHS HAVE BEEN SHOWN FOR A TYPICAL TWO LANE BRIDGE WITH SHOULDERS HAVING AN OUT-TO-OUT WIDTH OF 47'-2". WHILE THE BRIDGE CROSS-SECTION WAS CHOSEN TO REPRESENT A ROUTINE BRIDGE STRUCTURE, THE DESIGN CONCEPTS, DETAILS, FABRICATION AND ASSEMBLY ARE EQUALLY APPLICABLE TO OTHER BRIDGE WIDTHS.

THE DETAILS PRESENTED IN THESE PLANS ARE INTENDED TO SERVE AS GENERAL GUIDANCE IN THE DEVELOPMENT OF DESIGNS SUITABLE FOR ACCELERATED BRIDGE CONSTRUCTION. THESE DETAILS SHALL NOT BE PERCEIVED AS STANDARDS THAT ARE READY TO BE INSERTED INTO CONTRACT PLANS. THEIR IMPLEMENTATION SHALL WARRANT A COMPLETE DESIGN BY THE ENGINEER OF RECORD (EOR) IN ACCORDANCE WITH THE REQUIREMENTS FOR THE PROJECT SITE AND DOT STANDARDS AND SPECIFICATIONS. THE DESIGNER SHALL VERIFY THAT ALL REQUIREMENTS OF THE LATEST AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, INCLUDING INTERIM PROVISIONS, ARE SATISFIED AND PROPERLY DETAILED IN ANY DOCUMENTS INTENDED OR PROVIDED FOR CONSTRUCTION.

ALL CONSTRUCTION AND ASSEMBLY PLANS, INCLUDING THE DESIGN OF LIFTING POINT, HARDWARE, AND RIGGING, SHALL BE SIGNED AND SEALED BY A LICENSED PROFESSIONAL ENGINEER.

ALL FORMWORK FOR THE DECK SHALL BE SUPPORTED FROM THE LONGITUDINAL GIRDERS SIMILAR TO CONVENTIONAL CONSTRUCTION METHODS. SHORED CONSTRUCTION SHALL NOT BE ASSUMED. DECKED GIRDER SYSTEMS SHALL ALLOW FUTURE DECK REPLACEMENT WITHOUT THE USE OF SHORING.

SKEWED STRUCTURES:

THESE PLANS PRESENT A CONCEPT WELL-SUITED TO BRIDGES SUPPORTED ON BEARING LINES NORMAL TO THE CENTERLINE OF THE STRUCTURE. LOW TO MODERATE SKEWS CAN BE ACCOMMODATED WITH DUE CONSIDERATION GIVEN TO DESIGN, FABRICATION, AND ERECTION. LARGER SKEWS REQUIRE DUE CONSIDERATION OF DESIGN AND DETAILING REQUIREMENTS. THE ENGINEER OF RECORD SHALL BE RESPONSIBLE FOR COMPLETELY INCORPORATING THE EFFECTS OF ANY DEGREE OF SKEWED SUPPORTS IN ACCORDANCE WITH ALL APPLICABLE DESIGN SPECIFICATIONS.

DESIGN SPECIFICATIONS:

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 5TH EDITION

DESIGN LIVE LOAD: HL-93
FUTURE WEARING SURFACE = 25 PSF

THESE CONCEPT DESIGNS DO NOT CONSIDER PERMIT OR OVERLOAD VEHICLES AT THE STRENGTH LIMIT STATE THAT MAY BE REQUIRED BY THE GOVERNING AGENCY.

FABRICATION TOLERANCES:

FABRICATION TOLERANCES SHALL BE DETAILED IN THE PROJECT PLANS AND SPECIFICATIONS. UNLESS OTHERWISE SHOWN ELSEWHERE IN THE PLANS OR SPECIFICATIONS, LIMIT VARIATIONS FROM DIMENSIONS SHOWN IN THE CONTRACT DOCUMENTS TO NO MORE THAN 1/4 INCH.

SITE CASTING:

IF THE CONTRACTOR ELECTS TO FABRICATE THE NON-PRESTRESSED BRIDGE COMPONENTS AT A TEMPORARY CASTING FACILITY, THE CASTING SHALL COMPLY WITH THE PROVISIONS OF THE PROJECT SPECIFICATIONS.

GENERAL INSTALLATION PROCEDURE:

1. DRY FIT ADJACENT PRECAST ELEMENTS IN THE YARD PRIOR TO SHIPPING TO THE SITE.
2. DO NOT PLACE MODULES ON PRECAST SUBSTRUCTURE UNTIL THE COMPRESSIVE TEST RESULTS OF FOR THE PRECAST SUBSTRUCTURE CONNECTION CONCRETE HAS REACHED THE SPECIFIED MINIMUM VALUES.
3. SURVEY THE TOP ELEVATION OF THE SUBSTRUCTURES. ESTABLISH WORKING POINTS, WORKING LINES, AND BENCHMARK ELEVATIONS PRIOR TO PLACEMENT OF ALL MODULES.
4. LIFT AND ERECT MODULES USING LIFTING DEVICES AS SHOWN ON THE SHOP DRAWINGS IN CONFORMANCE WITH THE ASSEMBLY PLANS.
5. SET MODULE IN THE PROPER LOCATION. SURVEY THE TOP ELEVATION OF THE MODULES. VERIFY PROPER LINE AND GRADE WITHIN SPECIFIED TOLERANCES. APPROVED STEEL SHIMS SHALL BE USED BETWEEN THE BEARING AND THE GIRDER TO COMPENSATE FOR MINOR DIFFERENCES IN ELEVATION BETWEEN MODULES AND APPROACH ELEVATIONS. FOLLOW MATCH-MARKS.
6. TEMPORARILY SUPPORT, ANCHOR, AND BRACE ALL ERECTED MODULES AS NECESSARY FOR STABILITY AND TO RESIST WIND OR OTHER LOADS UNTIL THEY ARE PERMANENTLY SECURED TO THE STRUCTURE. SUPPORT, ANCHOR, AND BRACE ALL MODULES AS DETAILED IN THE ASSEMBLY PLAN.
7. DIFFERENCES IN CAMBER BETWEEN ADJACENT MODULES SHIPPED TO THE SITE SHALL NOT EXCEED THE PRESCRIBED LIMITS. IF THERE IS A DIFFERENTIAL CAMBER, THE CONTRACTOR SHALL APPLY DEAD LOAD AS NEEDED TO BRING ADJACENT BEAMS WITHIN THE CONNECTION TOLERANCE. A LEVELING BEAM CAN ALSO BE USED TO EQUALIZE CAMBER. THE LEVELING PROCEDURE SHALL BE DEMONSTRATED DURING THE PRE-ASSEMBLY PROCESS PRIOR TO SHIPPING TO THE SITE. THE ASSEMBLY PLAN SHALL INDICATE THE LEVELING PROCESS TO BE APPLIED IN THE FIELD. IF A LEVELING BEAM IS TO BE USED, HAVE AVAILABLE A LEVELING BEAM AND SUITABLE JACKING ASSEMBLIES FOR ATTACHMENT TO THE LEVELING INSERTS OF ADJACENT MODULES. EQUIP ALL MODULES WITH LEVELING INSERTS FOR FIELD ADJUSTMENT OR EQUALIZING OF DIFFERENTIAL CAMBER. THE INSERTS WITH THREADED FERRULES SHALL BE CAST IN THE DECK, CENTERED OVER THE BEAM WEB(S). A MINIMUM TENSION CAPACITY OF 5,500 LBS IS REQUIRED FOR THE INSERTS.
8. FORM, CAST AND CURE UHPC CLOSURE POURS AS DETAILED IN THE PLANS AND SPECIFICATION.
9. DIAMOND GRIND THE DECK TO ACHIEVE A SMOOTH PROFILE. DIAMOND GRINDING OF THE BRIDGE DECK SHALL NOT BEGIN UNTIL THE UHPC CLOSURE POUR CONCRETE HAS REACHED THE SPECIFIED MINIMUM COMPRESSIVE STRENGTH OF 10 KSI.

REQUIREMENTS FOR UHPC JOINTS:

PRIOR TO CONCRETE PLACEMENT DURING FABRICATION, THOROUGHLY COAT THE BEVELED FACES OF THE FORMWORK AT ALL CLOSURE JOINTS WITH AN APPROVED CONCRETE RETARDING ADMIXTURE.

AFTER FORMS ARE STIPPED DURING FABRICATION, USE A HIGH-PRESSURE STREAM OF WATER TO ROUGHEN THE BEVELED FACES AT ALL CLOSURE JOINTS TO AN AMPLITUDE OF 1/4 INCH WITHOUT DISPLACING COARSE AGGREGATE.

EDGES OF CLOSURE POUR SHALL BE SATURATED SURFACE DRY PRIOR TO PLACING UHPC. ALL CONCRETE FACES TO BE IN CONTACT WITH UHPC SHALL BE CLEANED AND COATED WITH AN APPROVED EPOXY BONDING AGENT PRIOR TO PLACING UHPC.

MOCKUPS OF EACH UHPC POUR SHALL BE PERFORMED PRIOR TO ACTUAL UHPC CONSTRUCTION.

ALL THE FORMS FOR UHPC SHALL BE CONSTRUCTED FROM PLYWOOD. USE CONTINUOUS TOP AND BOTTOM FORMS FOR UHPC JOINTS.

TWO PORTABLE BATCHING UNITS SHOULD BE USED FOR MIXING OF THE UHPC.

EACH UHPC PLACEMENT SHALL BE CAST USING ONE CONTINUOUS POUR. COLD JOINTS ARE PERMITTED ONLY AS APPROVED BY THE ENGINEER. UHPC SHALL BE PRODUCED TO FILL ANY ONE CONNECTION AREA WITHIN 30 MINUTES.

THE UHPC SHALL BE CURED ACCORDING TO MATERIALS SUPPLIER RECOMMENDATIONS.

WEATHER CONDITION DURING UHPC PLACEMENT, INCLUDING TEMPERATURE AND WIND, SHOULD BE TAKEN INTO CONSIDERATION INACCORDANCE WITH SUPPLIER RECOMMENDATIONS.

DIAMOND GRIND BRIDGE DECK:

AN ADDITIONAL THICKNESS OF 1/4 INCH HAS BEEN INCORPORATED IN THE DECK TO PERMIT CORRECTION OF THE DECK PROFILE BY DIAMOND GRINDING.

SAW CUT GROOVE TEXTURE FINISH:

SAW CUT LONGITUDINAL GROOVES INTO TOP OF BRIDGE DECK USING A MECHANICAL CUTTING DEVICE AFTER DIAMOND GRINDING.

GEOMETRY CONTROL:

CONSTRUCTION GEOMETRY CONTROL FOR DIFFERENTIAL CAMBER, SKEWNESS, AND CROSS-SLOPE ARE KEY TO ENSURING PROPER FIT UP OF PREFABRICATED SYSTEMS.

THE CONTRACTOR SHALL CHECK THE ELEVATIONS AND ALIGNMENT OF THE STRUCTURE AT EVERY STAGE OF CONSTRUCTION TO ASSURE PROPER ERECTION OF THE STRUCTURE TO THE FINAL GRADE SHOWN ON THE DESIGN PLANS. USE VERTICAL ADJUSTMENT DEVICES TO PROVIDE GRADE ADJUSTMENT TO MEET THE ELEVATION TOLERANCES SHOWN ON THE PLANS.

BRIDGE CROSS SLOPES UP TO 4 PERCENT CAN BE ACCOMMODATED BY ERECTING THE SUPERSTRUCTURE MODULES OUT OF PLUMB. THE SLOPE OF THE BRIDGE SEAT SHALL CONFORM TO THE BRIDGE CROSS SLOPE. CORRECTIONS FOR GRADE BY SHIMMING OR NEOPRENE PADS CAN BE DONE WHEN APPROVED BY THE ENGINEER.

CAMBER CONTROL:

DIFFERENTIAL CAMBER CAN CAUSE DIMENSIONAL PROBLEMS WITH THE CONNECTIONS. CONTROL OF CAMBER DURING FABRICATION IS REQUIRED TO ACHIEVE RIDE QUALITY. CAMBER DIFFERENCES BETWEEN ADJACENT DECK SECTIONS AT THE TIME OF ERECTION SHALL NOT EXCEED THE LIMITS SHOWN ON THE PLANS.

THE PREFABRICATED SUPERSTRUCTURE SPAN SHALL BE PRE-ASSEMBLED TO ASSURE PROPER MATCH BETWEEN MODULES TO THE SATISFACTION OF THE ENGINEER BEFORE SHIPPING TO THE JOB SITE. THE PROCEDURE FOR LEVELING ANY DIFFERENTIAL CAMBER SHALL BE ESTABLISHED DURING THE PRE-ASSEMBLY AND APPROVED BY THE ENGINEER.

THE STRATEGIC HIGHWAY RESEARCH PROGRAM 2
PROJECT R04
INNOVATIVE BRIDGE DESIGNS FOR RAPID RENEWAL

STANDARD PREFABRICATED GIRDER SUPERSTRUCTURE

GENERAL INFORMATION

HNTB
SEA / ISU / GENESIS   OCTOBER 2011

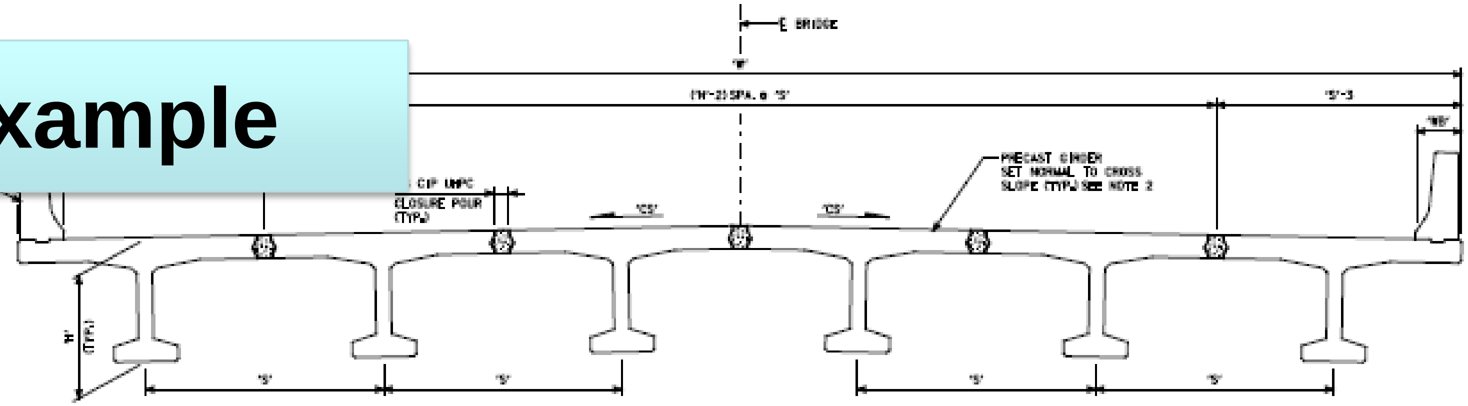
DESIGN TEAM   SHEET NUMBER 03

DGN$SYTIME01123456   slaw   \\nys00\dept\cadd\45737 TRB\Typical Detail\03-General Information.dgn

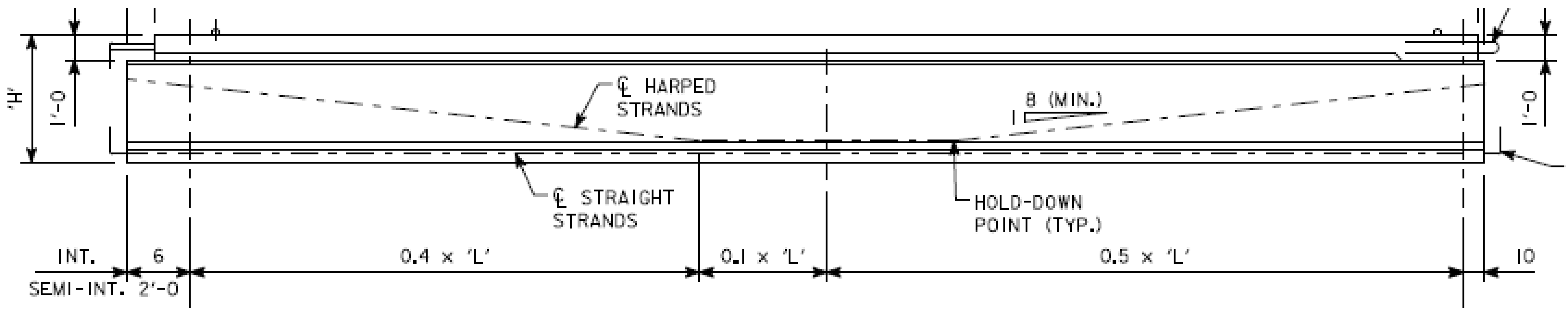
Sample Drawings from the ABC Toolkit

- Shows typical level of detail
- Plan sheets contain ABC specific details for routine bridges
- Guides the designer new to ABC on appropriate module configurations and connections
- Guidance on erection

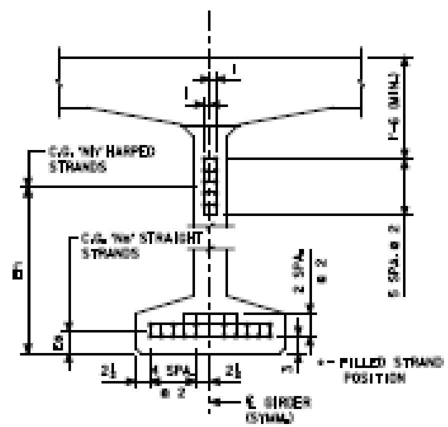
Example



TYPICAL SECTION

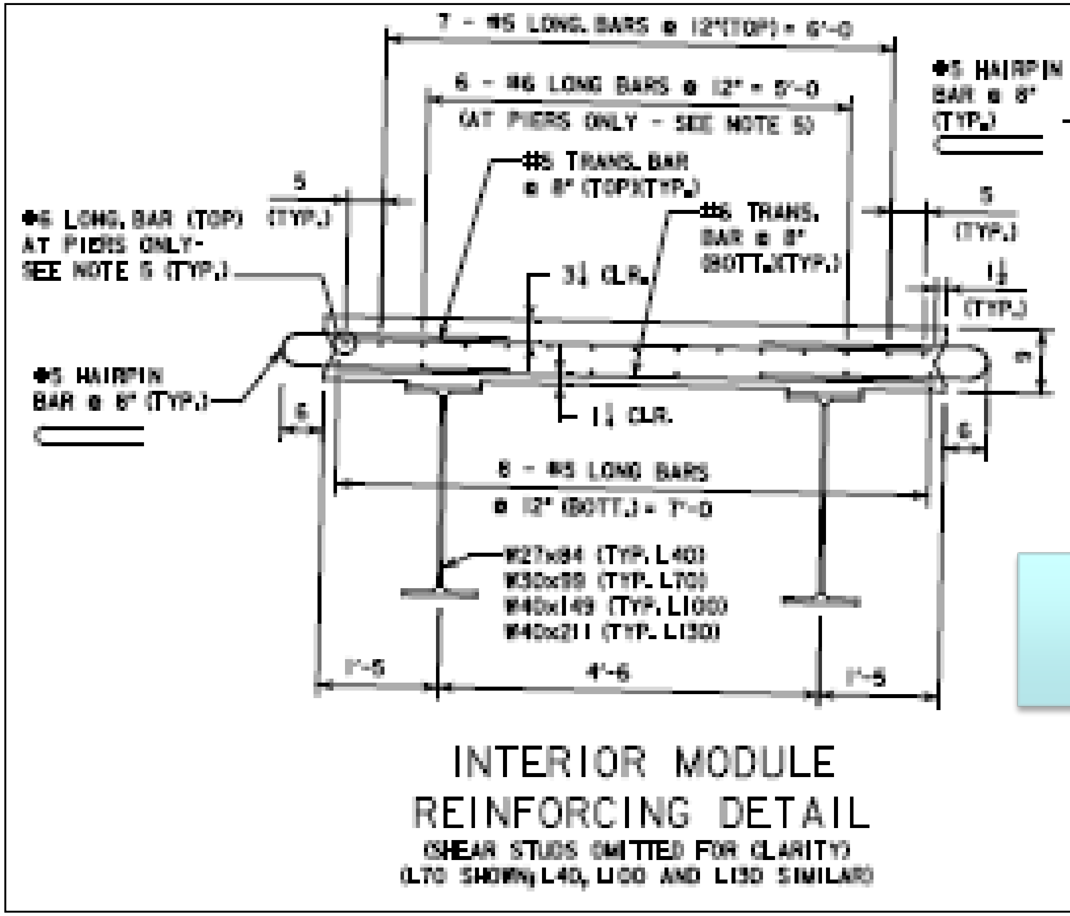


EXAMPLE STRAND LAYOUT - INTERIOR GIRDER											
BEAM TYPE	'L' (FT)	'S' (FT)	f'c (KSI)	STRAND SIZE (IN)	STRAIGHT		HARPED		TOTAL		
					'Ns'	'Es' (IN)	'Nh'	'Eh' (IN)	'N'	'E' (BRG.) (IN)	'E' (MID.) (IN)
DBT42	40	5	8	0.5	6	3.00	4	23.00	10	11.00	3.80
		8	8	0.5	6	3.00	6	22.00	12	12.50	4.00
	70	5	8	0.5	12	3.33	10	20.00	22	10.91	4.09
		8	8	0.5	16	3.75	14	18.00	30	10.40	4.33
DBT48	70	5	8	0.5	10	3.00	10	26.00	20	14.50	4.00
		8	8	0.5	14	3.57	14	24.00	28	13.79	4.29
	100	5	8	0.6	14	3.57	14	24.00	28	13.79	4.29
		7	8	0.6	16	3.75	16	23.00	32	13.38	4.38
DBT60	100	5	8	0.6	12	3.33	10	38.00	22	19.09	4.09
		8	8	0.6	14	3.57	14	36.00	28	19.79	4.29
	130	5	10	0.6	16	3.75	16	35.00	32	19.38	4.38
		7	10	0.6	24	4.50	16	35.00	40	16.70	4.70

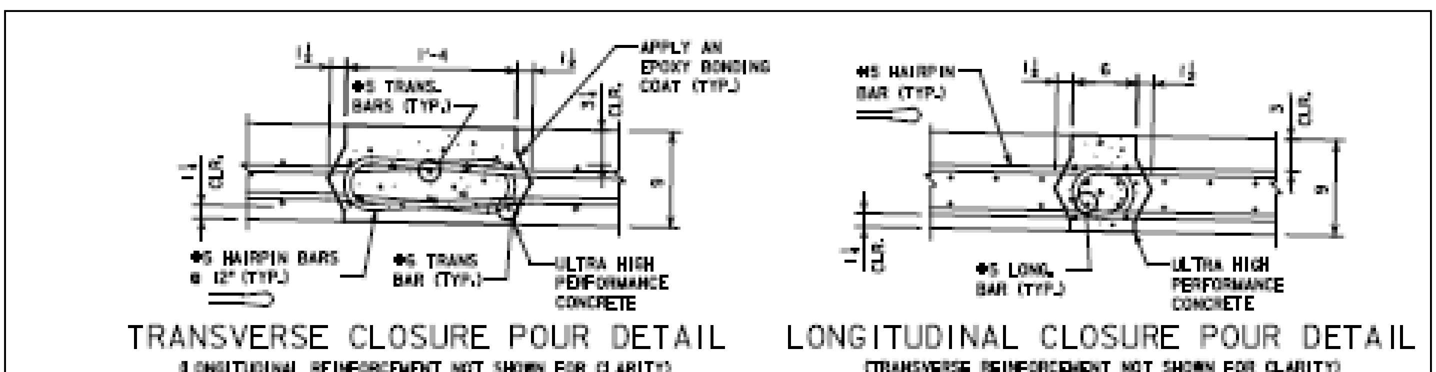


STRAND PATTERN AT ℄ BEARING

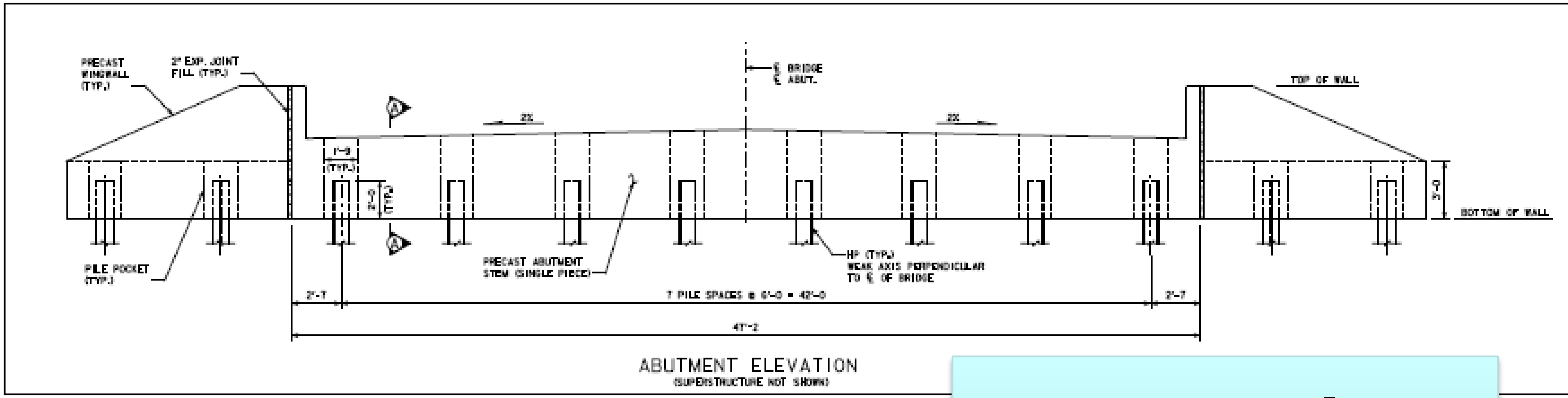
(EXAMPLE PATTERN SHOWN, SEE TABLE)

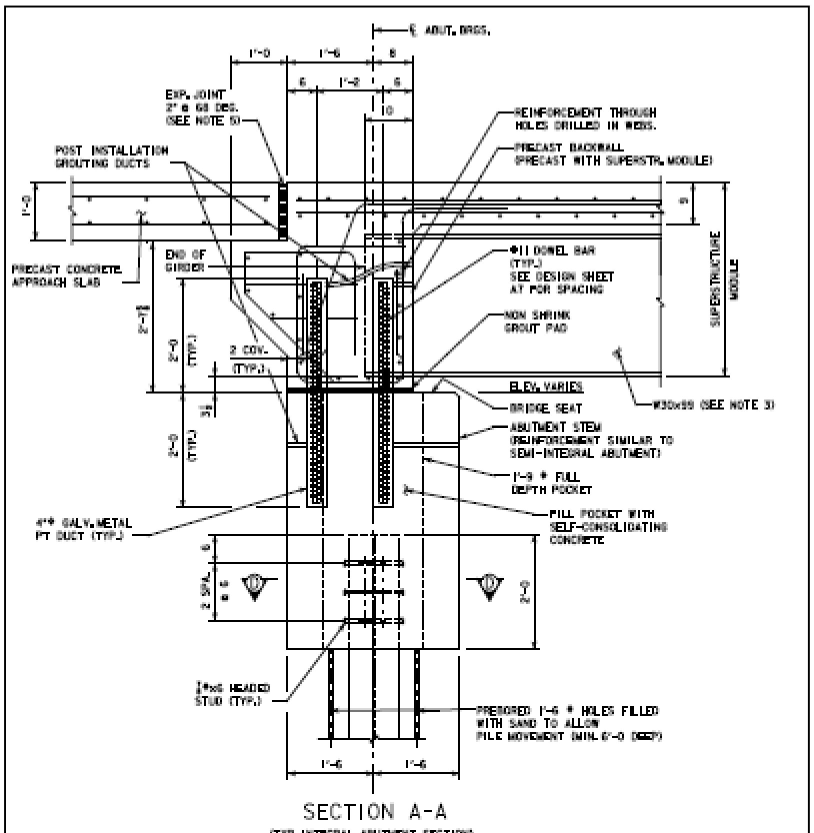

INTERIOR MODULE
REINFORCING DETAIL
(SHEAR STUDS OMITTED FOR CLARITY)
(L70 SHOWN; L40, L100 AND L130 SIMILAR)

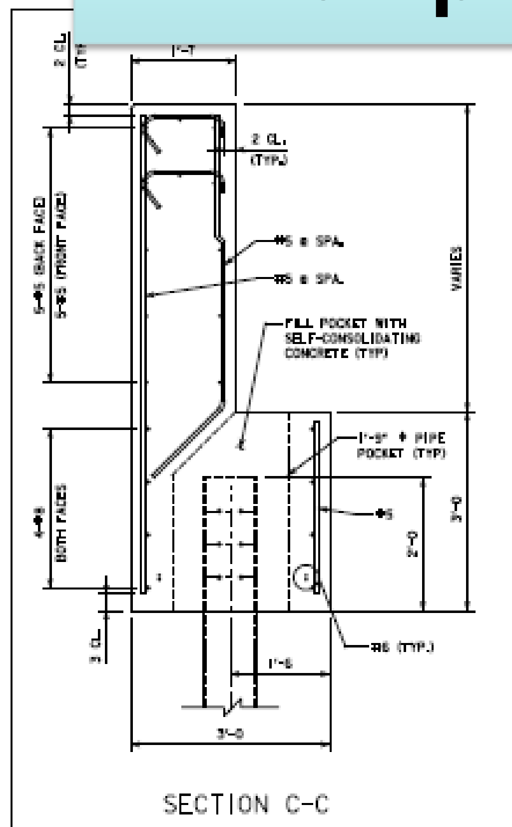
Example


TRANSVERSE CLOSURE POUR DETAIL
(LONGITUDINAL REINFORCEMENT NOT SHOWN FOR CLARITY)
LONGITUDINAL CLOSURE POUR DETAIL
(TRANSVERSE REINFORCEMENT NOT SHOWN FOR CLARITY)
APPLY AN EPOXY BONDING COAT (TYP.)
ULTRA HIGH PERFORMANCE CONCRETE

Example


PRECAST WINGWALL (TYP.)
2" EXP. JOINT FILL (TYP.)
℄ BRIDGE ℄ ABUT.
TOP OF WALL
2%
2%
1'-9 (TYP.)
2'-0 (TYP.)
3'-0
BOTTOM OF WALL
PILE POCKET (TYP.)
PRECAST ABUTMENT STEM (SINGLE PIECE)
HP (TYP.) WEAK AXIS PERPENDICULAR TO ℄ OF BRIDGE
2'-7
7 PILE SPACES @ 6'-0 = 42'-0
2'-7
47'-2
ABUTMENT ELEVATION
(SUPERSTRUCTURE NOT SHOWN)


℄ ABUT. BRGS.
EXP. JOINT 2" @ 68 DEG. (SEE NOTE 5)
POST INSTALLATION GROUTING DUCTS
REINFORCEMENT THROUGH HOLES DRILLED IN WEBS.
PRECAST BACKWALL (PRECAST WITH SUPERSTR. MODULE)
PRECAST CONCRETE APPROACH SLAB
END OF GIRDER
#11 DOWEL BAR (TYP.) SEE DESIGN SHEET AT POR SPACING
NON SHRINK GROUT PAD
SUPERSTRUCTURE MODULE
2 COV. (TYP.)
ELEV. VARIES
BRIDGE SEAT
W30x99 (SEE NOTE 3)
ABUTMENT STEM (REINFORCEMENT SIMILAR TO SEMI-INTEGRAL ABUTMENT)
1'-9 ⌀ FULL DEPTH POCKET
FILL POCKET WITH SELF-CONSOLIDATING CONCRETE
4"⌀ GALV. METAL PT DUCT (TYP.)
PREBORED 1'-6 ⌀ HOLES FILLED WITH SAND TO ALLOW PILE MOVEMENT (MIN. 6'-0 DEEP)
1'-6
1'-6
SECTION A-A
(TYP. INTEGRAL ABUTMENT SECTION)


1'-7
2 CL. (TYP.)
5-#5 (BACK FACE)
5-#5 (FRONT FACE)
#5 @ SPA.
#5 @ SPA.
VARIES
FILL POCKET WITH SELF-CONSOLIDATING CONCRETE (TYP)
1'-9" ⌀ PIPE POCKET (TYP)
4-#8 BOTH FACES
#5
2'-0
3'-0
#6 (TYP.)
3 CL.
1'-6
3'-0
SECTION C-C

ABC Standards for Modular Superstructures

- **Decked Steel Girders**
  - Decked Steel Girder Interior Module
  - Decked Steel Girder Exterior Module
  - Bearing and Connection Details
- **Decked Concrete Girders**
  - Prestressed Deck Bulb-Tee Interior Module
  - Prestressed Deck Bulb-Tee Exterior Module
  - Prestressed Double-Tee module
  - Bearing and Connection Details

ABC Standards for Modular Substructures

- **Abutments & Wing Walls**
  - Semi Integral Abutments
  - Integral Abutments
  - Wing walls
  - Pile Foundations and Spread Footings
- **Piers**
  - Precast Conventional Pier
  - Precast Straddle Bent
  - Drilled Shaft and Spread Footing Option

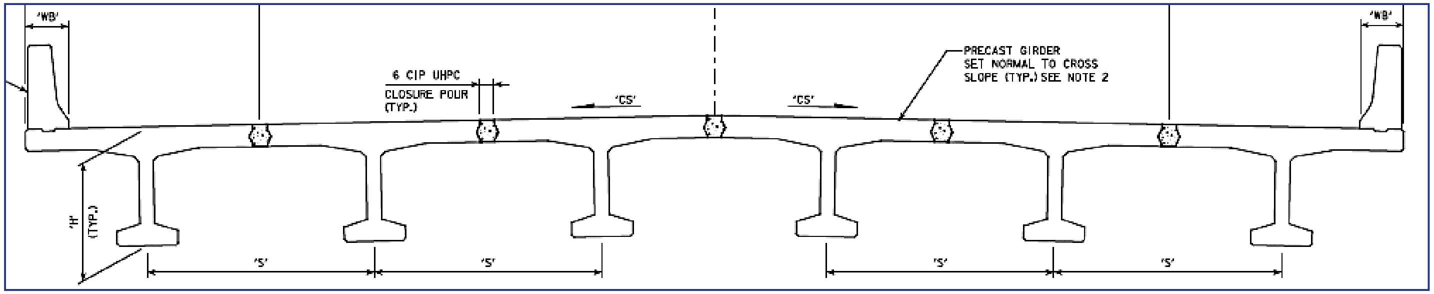
Outline of ABC Standard Plans

Standard Sheet Sets	Contents
G1 – G3	General Information Sheets
A1 – A12	Precast Abutments, Wing Walls, & Approach Slabs
P1 – P9	Precast Complete Pier Systems
S1 – S8	Decked Steel Girder Superstructures
C1 – C12	Decked Concrete Girder Superstructures
CC1 – CC32	ABC Erection Concepts

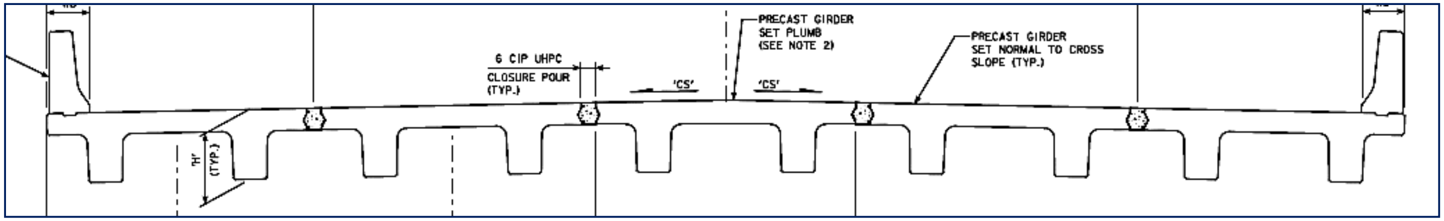
Span Ranges for Superstructures

- Simple/continuous spans from 40 ft. to 130 ft.
- Simple for DL; Continuous for LL; No Open Joints.
- Plans are grouped in the following span ranges:
  - 40 ft. to 70 ft.
  - 70 ft. to 100 ft.
  - 100 ft. to 130 ft.
- Spans to 130 ft. can usually be transported and erected in one piece at many sites.
- Weight < 200 Kips for erection

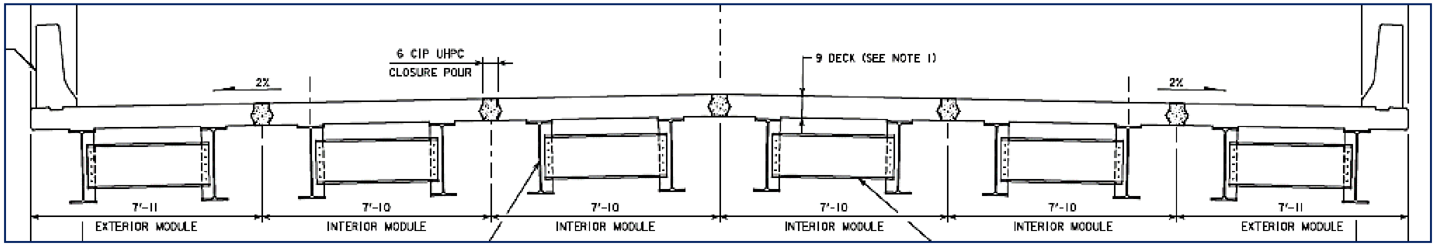
Modular Superstructure Systems



Deck Bulb Tees

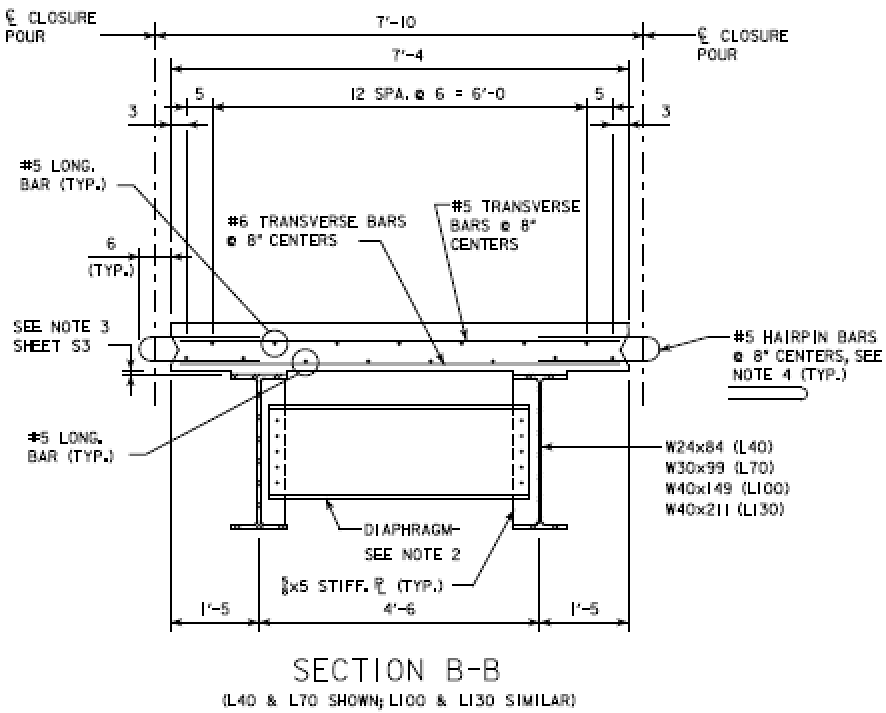


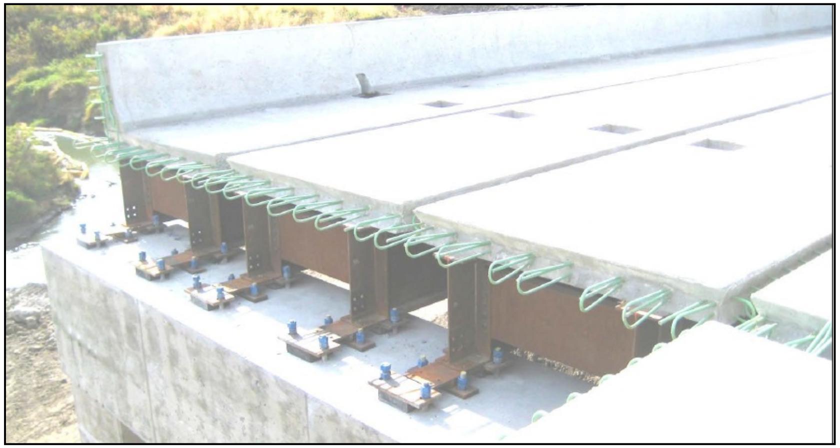
Double Tees



Composite Steel System

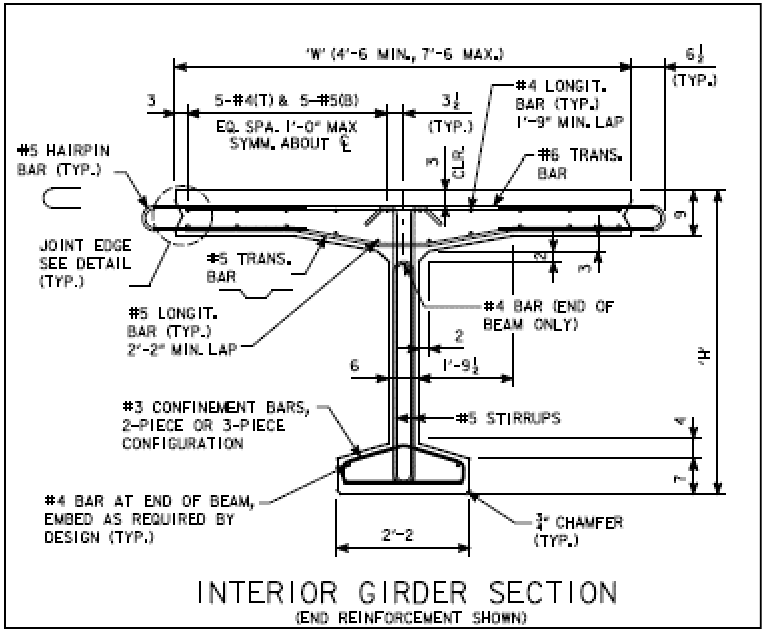
Typical Decked Steel Girder Module Interior



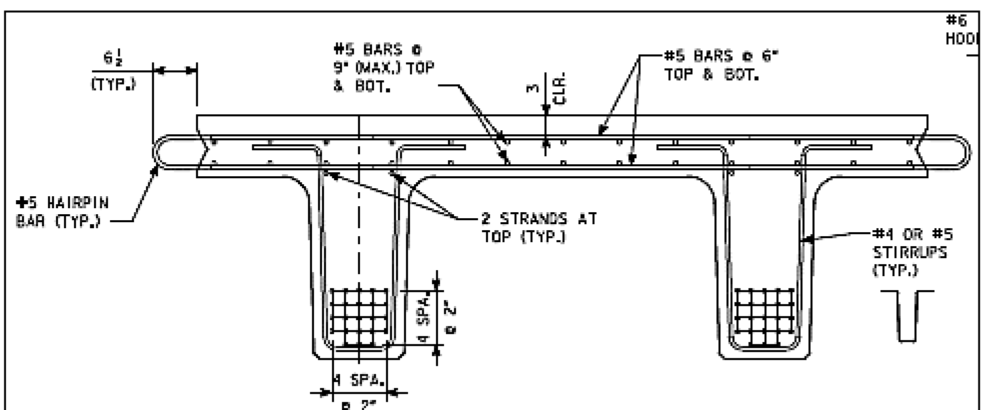


- Not proprietary
- Contractor can self-perform precasting of deck onsite
- Lightweight system for ABC

Precast Decked Girders



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

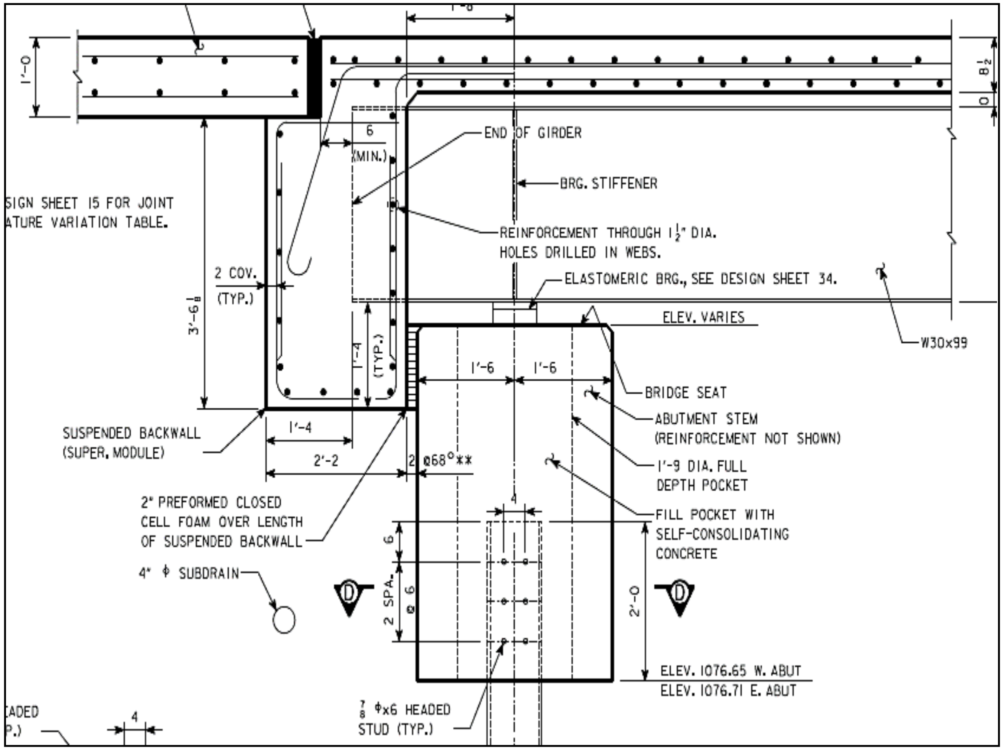


- Based on the PCI NEXT beam
- Spans to 90 ft
- Low depth alternative

Integral and Semi-Integral Bridges for Rapid Renewal

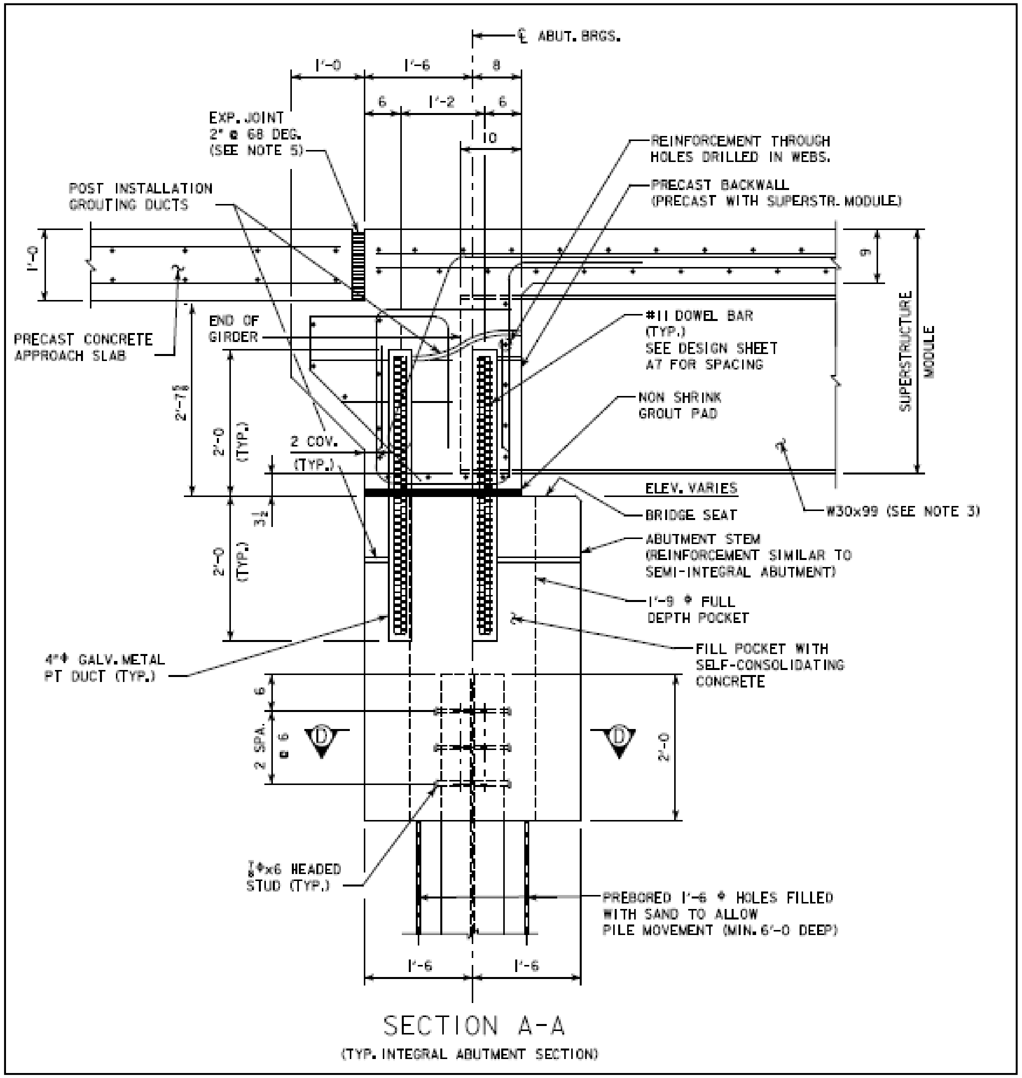
- They allow the joints to be moved beyond the bridge.
- Well suited for ABC.
- Close tolerances required when using expansion bearings, and joints are eliminated.
- The backwall is precast with the deck.
- Fast erection in 1 to 2 days.
- Economical.

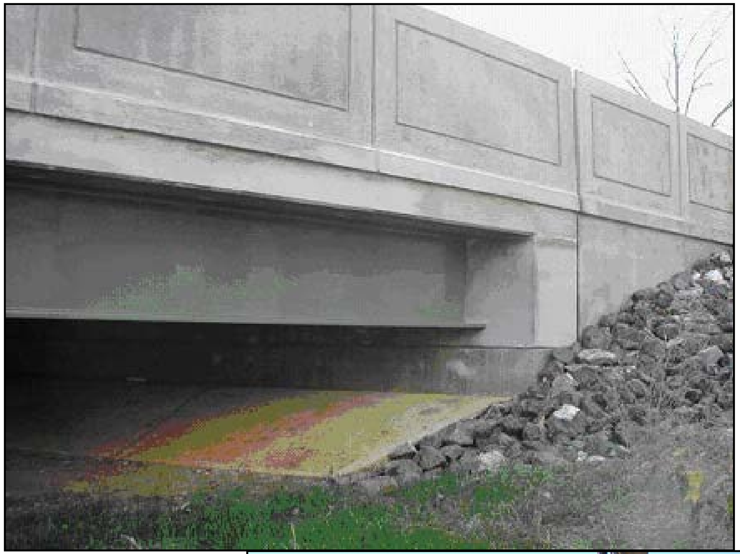
Example: Iowa – Semi-Integral Abutment Suspended Backwall



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

Integral Abutment





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

Questions




SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Procurement, Costs, Savings and ABC

“Total” Project Costs
Contractors and ABC

Finn Hubbard, Fickett Structural Solutions
SHRP2 ABC/PBES Implementation
Technical Lead

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
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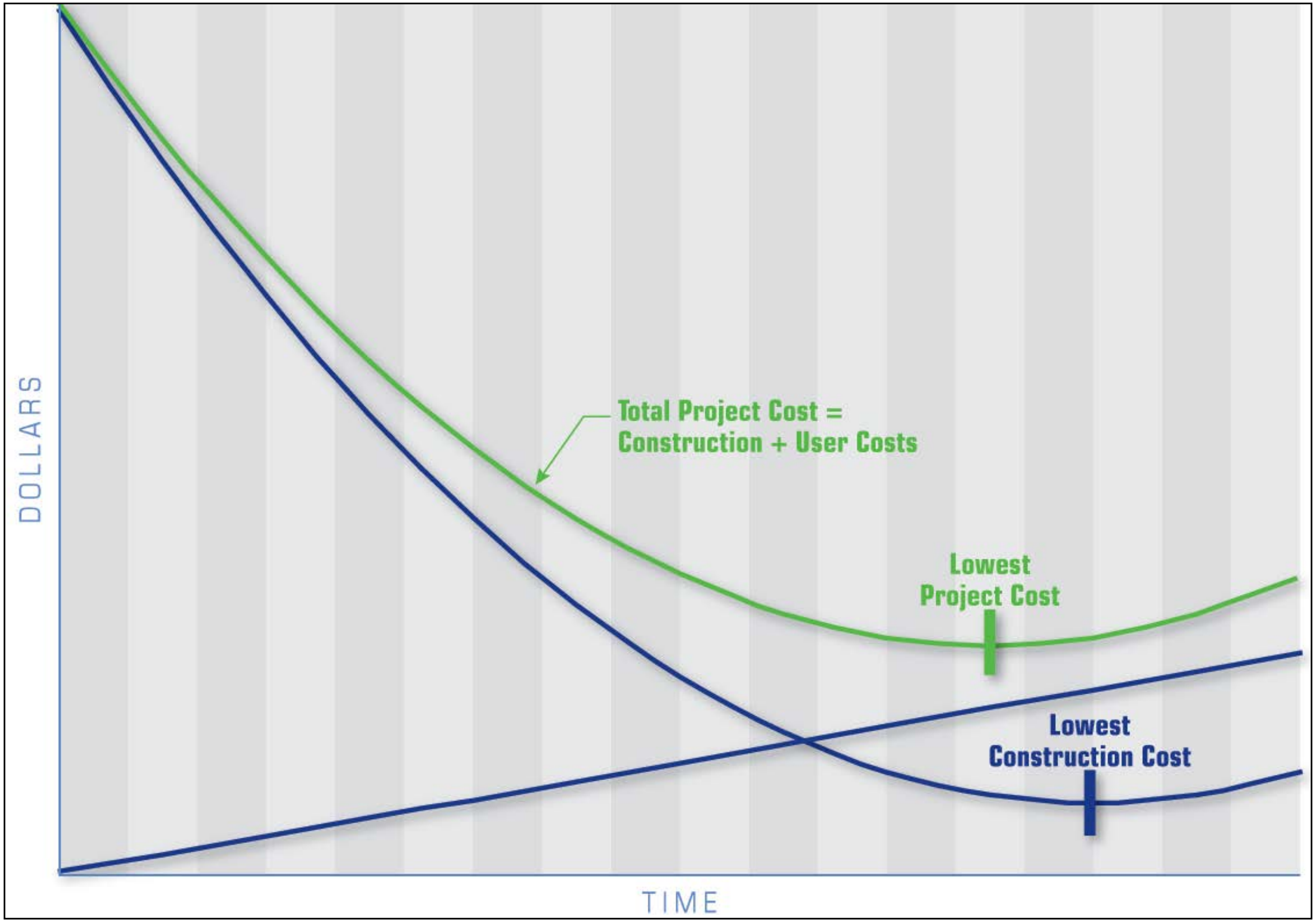
Total Project Cost = Construction Cost + User Cost



Understanding ABC Costs

- In general, bid prices for ABC are higher than conventional construction
- Bid prices are not the only cost parameter
- Owners need to be persuaded thru Cost-Benefit Analysis

Evaluating ABC Costs

Σ(Project Cost) =

$$\sum_{t=0}^{Serive\ Life} (planning, design, procurement, construction, maintenance)_{cost}$$

ABC Cost Impact?

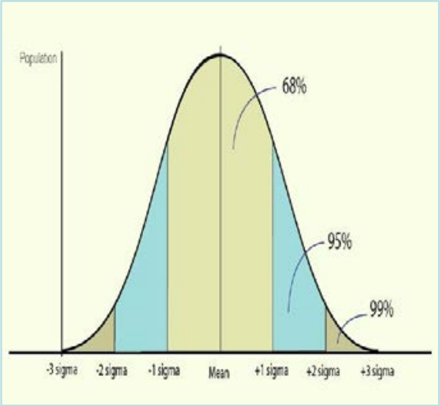
How Much Does ABC Cost?

It depends…..

- *How fast is fast*
  - Build a bridge in a weekend: Very expensive
  - Build a bridge in two weeks: Not too expensive
  - Build a bridge in a month: Can be the same price
- *Overtime pay*
  - Weekends, nights
- *Details*
  - Complex details tend to be more expensive
- *Site conditions*
  - Difficult sites can lead to higher costs
- *Equipment*
  - Specialized equipment is pricey

Risk Analysis

- Risk cost = Cost of failure * Probability of Occurrence
  - Known probabilities can be managed
  - Unknown probabilities are difficult to estimate
  - Probabilities will vary between different contractors
    - Size and experience of staff
    - Back-up equipment
    - This makes it hard to estimate during design
  - Example
    - Weekend Disincentive Clause = $100K
    - Probability of not finishing bridge = 10%
    - Risk factor = $100k * 0.10 = $10,000



How Can Owners Address Risk?

- Understand that incentives and disincentives come at a price
  - Pick incentives and disincentives that are commensurate with the needs
- Tight schedules come at a price
  - Consider relaxing the schedule if appropriate
    - If a week is workable, do not try and do in a day

How Can Owners Address Risk?

- Risk Analysis?
  - Difficult for owners to estimate probabilities
  - Engage a specialty construction schedule consultant
- Allow for value engineering
- Consider Alternative Technical Concepts (ATC)
- CMGC
  - Risk management is a big part of this procurement process

Other Ways To Reduce Costs

- Bid a Series of Similar Projects
  - Builds up contractor experience = lower risk
  - Provides more efficient use of specialized equipment
    - If it is a “one of a kind” project, you may pay for the equipment in one project
    - Similar to precast girder forms

How Do You Justify ABC?

- If it costs more, why do we do it?
  - Reduces user costs
    - However, you can’t spend user costs
    - Good PR for the agency
  - Improves Safety
    - Workers and travelers
  - Provides Better Durability
    - Prefabricated Elements

Contractors Bid

- What do contractors price?
  - Materials, labor, **risk**
- Contractors profit by doing/building things
- Self performance is important
  - Who does what matters
  - Do not like to use subcontractors if possible
- Comfortable with conventional construction
  - Means and methods

Benefits and Risks of ABC

Benefits

- Complete more projects in one season
- Increase profits from additional work
- Less exposure to traveling public, safety
- Incentives to open early
- Better prepared for emergency ABC work

Risks

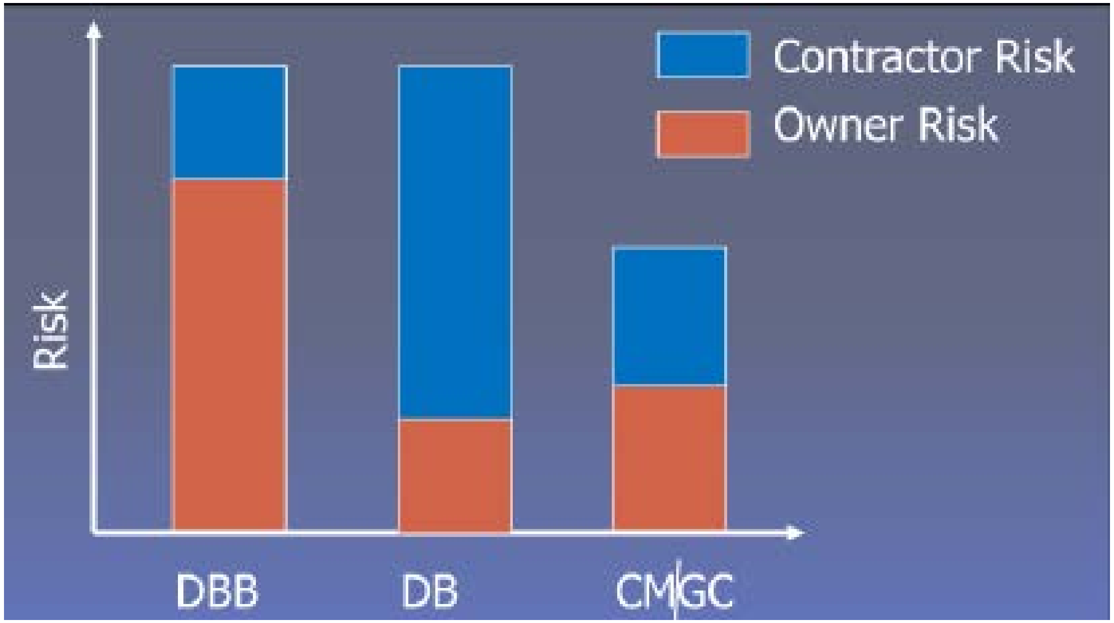
- Liquidated damages
- Tight schedule
- Weather
- Subcontractors
- Worker fatigue
- Equipment breakdown
- Unknown territory

Contractor Lessons Learned

- Allow contractors to self perform when possible.
- Use local equipment
  – "Keep it simple" really works
- Involve the contracting community as early and often as possible in the ABC process.
- Contractors have good ideas – work with them
- **A good team is the best solution!**

Risk Mitigation Between Procurement Methods

- CM/GC Basics
- Risk Allocation
- Difference between D-B-B, D-B, and CM/CG
- CM/GC Shared Risk Approach



Owners, Designers, Contractors, and CMGC

- Why do owners like CMGC?
- Why do designers like CMGC?
- Why (most) contractors like CMGC?
- What happens if the total cost of the project is not agreed to by the team?
  - There is a simple solution
  - Rarely needed

Do Bid Prices Tell The Whole Story?

- The simple answer is **NO**
- We need to look at **TOTAL PROJECT COSTS**
  - This is the total cost to the agency to complete a project
    - Engineering costs
    - Right of way
    - Environmental permitting
    - Traffic management
    - Construction management
    - Maintenance
    - Safety costs: police, flaggers, etc.

Factoring Non-bid Costs In Decision Making

- Decision makers should use both bid costs and agency costs in decision making
- There is no one ABC decision-making solution
  - Some agencies need a simple process
  - Some need detailed processes
- Oregon Analytical Hierarchy Process
  - Sophisticated analysis approach
  - Includes agency costs and indirect costs
- Connecticut DOT process
  - Simplified approach to total project cost

Conclusion

- ABC Costs depend on many factors:
  - Speed of construction
  - Incentive/Disincentive Clauses
  - Local capabilities
  - Risk analysis
- Bid prices do not tell the whole story
  - Consider non-bid costs in ABC decision making

Questions




SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Innovative Bridge Designs for Rapid Renewal
SHRP2, R04
Case Studies and Lessons Learned

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AASHTO

Next Generation Innovative Bridge Design Projects

- Eight projects scattered around the county
  - Arizona, Gila River Indian Reservation
  - California, Fort Goff Creek
  - Kentucky, Stewarts Creek
  - Maine, Kittery Overpass
  - Missouri, Boone County
  - Rhode Island, Warren Avenue
  - Wisconsin, I-39/90
  - Michigan, Seney National Wildlife Refuge

Gila River - Arizona

- Project Delivery – CMGC
- Construction Manager/General Contractor
  - Team the GRIC DOT with the designer and contractor
  - Allows maximum use of contractor’s means and methods
  - Owner intimately involved in process
  - Bridge slide project (SIBC)
  - Wide open site, good for slide in ABC

Gila River - Arizona

Gila River - Arizona

Gila River - Arizona

Fort Goff Creek, California

- Built in a remote location in Northern California
  - 90 minutes to nearest ready mix plant
  - Precast answers this quality issue well
- Lessons Learned
  - Allow time for all needed pre-approvals
  - Entire team must be on board with ABC approach and available
  - ABC allowed construction in one short season

Fort Goff Creek, California

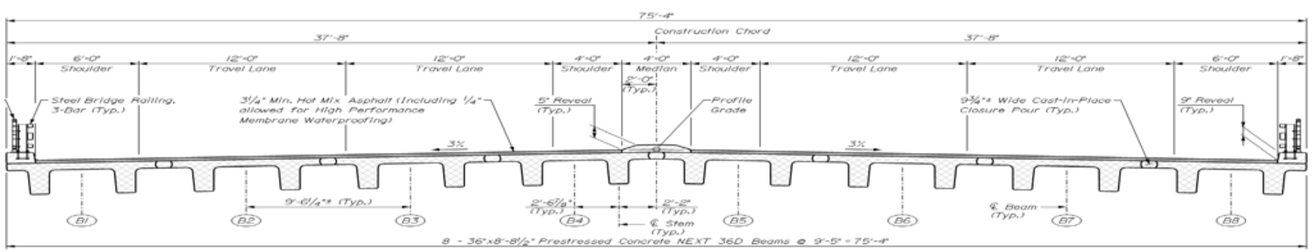
Stewarts Creek, Kentucky

- Replaced 2 bridges using R04 ABC techniques.
- A + B bidding, (Cost plus time)
  - Shorten closure time
  - Total project only 38 days
- Galvanized and painted steel superstructure
- Galvanized deck rebar
- Super in 2 longitudinal pieces
- Preassembly worked great

Stewarts Creek, Kentucky

Kittery Overpass, Maine

- Replaced aging concrete ridged frame bridge.
- Maximum closure time was 35 days, used 29
- Heavy tourist area
- Contractor redesigned precast abutment wall to footing connection, accepted by Maine DOT
- Northeast Extreme Tee Deck Beams (NEXT)
- Carbon fiber prestressing strands to be used
  - No corrosion issues with stand
  - Also used "Z" bar in beams



Kittery Overpass, Maine

Kittery Overpass, Maine

Lessons Learned, Kittery Overpass

- ABC works!
- Traffic interruptions was minimized
- The tourist season saw minimal effects
- Locals really got involved in the whole ABC process
- Local police suggested useful modifications to the traffic management plan
- Excellent local and state wide press
- A + B bidding was successfully used

Route B Bridge, Boone County, Missouri

- Replaced bridge on Route B over Loop 70 in Columbia, MO
- ABC and Geosynthetic Reinforced Soil Abutments (GRS)
- Lessons Learned:
  - Make sure modular block are available that meet the spec.
  - Anyone can build a GRS Abutment
  - Present new technology early to contractors

Route B Bridge, Boone County, Missouri

Warren Avenue, Rhode Island

- Replaced highly deteriorated Warren Ave Bridge in Providence
- Lessons learned:
  - Semi twin bridge took over 400 days to build
  - New bridge closed road to traffic for 21 days
  - Very happy locals!

Warren Avenue, Rhode Island

Warren Avenue, Rhode Island

I-39/90, Wisconsin

- Replaced 5 bridges using accelerated precast pier technique.
- ABC applied to pier construction
  - Precast columns and caps on cast-in-place footings
- Five median piers between I-39 lanes
- Saved 3 weeks time per bridge
- Main ABC driver was safety
  - Less exposure of traffic to contractor
  - Less exposure of contractor to traffic

I-39/90, Wisconsin

I-39/90, Wisconsin

Lessons Learned, Wisconsin

- The first precast ABC project was pricey
- Better price with second contract
- Price was the same as cast-in-place on third contract

Seney National Wildlife Refuge, Michigan

- Federal Lands Highway applied R04 Toolkit to Seney National Wildlife Refuge PBES project
- Single lane, three-span continuous concrete box beam bridge
- Piers/abutments built with precast pile caps
- Placed a concrete overlay on top of boxes
- Concrete rails cast on to boxes before beam erection
- Prefabrication will limit impacts in an environmentally sensitive area

Seney National Wildlife Refuge, Michigan

Michigan

Seney National Wildlife Refuge, Michigan

Three R04 Showcases
Three Peer to Peer Exchanges

- Implementation projects, Showcases and Peer to Peer exchanges provided various lessons learned

Many Forms of ABC

- Multiple pieces assembled on site or off-site
- Slide in Bridge Construction (SIBC)
- Self Propelled Modular Transporters (SPMTs)
- Keep your toolkit open to all ideas when considering ABC

Contract Methods Vary

- Contracting methods can very depending on needs
    - Design, bid, build (Traditional)
    - Design, build (Less control)
    - Construction Manager/General Contractor (CMGC)
    - A + B, Cost plus time

Time Savings Considerations

- Determine need for speed (maximum closure time)
- SPMTs are very fast, but pricey.
- SIBC is a nice combination of speed and cost.
- If 14 to 21 days will work, assembling pre-built pieces is cost effective.
- Weigh cost for speed.
  – Choose the time line carefully!

Lessons Learned
(The Hard Way)

- Survey twice, make sure its right
- Need good concrete bond to UHPC
- Must use high quality joint grout material
  - Avoid maintenance issues down the road
  - UHPC has been a great step forward
- Double check all rebar clearances during shop drawing reviews
- If using rebar couplers in precast elements, templets, templets, templets!

Owner Lessons Learned

- “DOT’s need to be innovative to stay relevant.”
- Durable joints are a must to gain acceptance.
- A top-down team approach with real resources committed is critical.
- Cultural change from “we have always done it this way” is not easy.
- **DOT’s can gain real political capital from ABC.**

Concluding Thoughts

- Be open minded.
- Do not be afraid to experiment with the method and materials
- Seek designer and contractor input before AND after every job for improvements
- Expect great publicity from ABC projects
  - Let the public know what your doing and why it is special!

Questions?