SHRP2 R04 Innovative Bridge Design for Rapid Renewal Workshop Summary FINAL Report

Approved: November 21, 2018

Overview

This summary report includes the following sections:

- Purpose
- Attendees
- Executive Summary
- General Observations of Trainings
- Outcomes and Recommended Future Activities
- Conclusion
- Appendixes
    - Appendix A – Data by State Chart
    - Appendix B – Questions Raised During Trainings
    - Appendix C – Preliminary Agenda

Purpose

The purpose of this modification was to continue the progress of training states to use the SHRP2 R04 Toolkit and to discuss all aspects of Accelerated Bridge Construction (ABC). All total, there were twenty (20), one-day *Innovative Bridge Designs for Rapid Renewal* Accelerated Bridge Construction (R04) Toolkit workshops nationwide. A preliminary agenda was provided and then tailored to address bridge advancements relative to each state along with any specific area of interest expressed by that state. The goal was to present training on using the SHRP2 R04 Toolkit, present and discuss lessons learned from the pilot projects, and present detailed information about the 8 State Implementation Assistance Projects funded by SHRP2.

Attendees

Over an 9-month span starting in mid-December 2017 through the end of September 2018, twenty workshops were held in individual states with 1065 sets of workshop materials distributed to 882 present attendees with the remainder distributed within agencies. The actual number of participants per training is included in the chart attached and in the appendix. The workshops were attended by multi-disciplined DOT staff including designers, construction engineers and other key DOT personnel. Each state DOT also invited many consultants, fabricators, contractors and suppliers to expose them to the concepts of using ABC products.

Executive Summary

Nationwide, state bridge engineer turnover is roughly 7-8 state bridge engineers per year. This means over the past 10 years; a new group of leaders have emerged with the opportunity to embrace the potential of ABC techniques. Over the course of the SHRP2 *Innovative Bridge Designs for Rapid Renewal* Accelerated Bridge Construction (R04) product period of performance, 34 total states were presented the Toolkit Workshop Training (20 included in this report) and all were encouraged to invite stakeholders to attend. Each workshop included the following topics: Introduction to ABC, Prefabricated Elements and Systems, Bridge Movement Technologies, ABC Toolkit for Designers, Pilot Projects presentations (Keg Creek and I 84), Case Studies and Lessons Learned on the 8 SHRP2 Implementation Assistance Projects, Procurement, Cost, and Savings discussions, Contractors and Fabricators

experiences with ABC, Institutionalizing the use of PBES/ABC and an opportunity for the host state to present their own experience and perspectives on ABC projects.

The overall response to this training has been quite positive regardless of where each individual state is in the process of implementing ABC methods as part of their own bridge programs. Most states, even those with some ABC experience are still working to identify processes and procedures that will allow ABC implementations to become part of their routine bridge applications. Hardcopies of the R04 toolkit have been widely distributed across the country. The participants responded by asking for more technical support, training, incentives, case studies, lessons learned and continued updates from other states as the toolkit informs more ABC implementation across the country.

General Observations of Trainings

Every state that hosted a workshop expressed interest in the concepts of ABC. Six states are actively implementing ABC. Vermont, Wisconsin, and Utah have clear ABC processes in place while California, Washington, and Colorado are working toward the same goal. The Subject Matter Expert (SME) anticipated many states would be more advanced in ABC techniques but found most states still working to put processes in place including policies, procedures, standards, and contracting methods. Of the 34 states visited, approximately 1/3 or about 11 states were doing their own ABC designs and the rest were using design consultants.

State designers and design consultants rely heavily on conforming to bridge manuals, so it is imperative for states to have clear guidelines regarding design, cost and risk analysis, parameters for applying ABC and available contract methods. Most states use internal teams to write their bridge manuals, but Utah is an example where a state used consultants to develop new ABC components in their manual. Utah and Wisconsin have both included ABC decision matrices in their bridge manuals and both resources were shared at the workshops. Even with a published tool, Wisconsin is not currently using their matrix as part of a formal structure but looking to incorporate it in the future. In this case, there is an understanding within the contract community that the ABC tools found in the state standards are to be used as the need for ABC arises and the state regularly meets with their contractors to review and discuss this issue.

In addition, the SME noted some specific highlights from the following state workshops:

- The **Arizona** workshop followed the IAP project that the Gila River Transportation Agency accomplished, and this ABC exposure encouraged the State DOT to revisit ABC techniques as part of their program.
- **Arkansas** found the training not only productive but extremely timely in their desire to move forward with this technology. Arkansas was interested in applying ABC four years ago but faced hesitations that hindered implementation. The State Bridge Engineer was pleased the one-day ABC course re-engaged their collective interest to apply ABC to future projects.
- **California** was given two workshops due to the geographic distance between teams. The workshops were specifically used by the state bridge engineer to focus the team statewide on this issues of using accelerated bridge construction particularly in disaster events and where there were environmental constraints.

- **Connecticut** was unique in that it was the only training requested specifically by the agency's bridge construction group. Having buy in and leadership from the construction group will positively change the dynamics of the effort to design and implement ABC in Connecticut.
- **Hawaii** clearly identified their needs for ABC but continues to struggle with staggering material and labor costs.
- **Oklahoma** proactively used the workshop to initiate conversation with their contracting community and intends to follow up with them moving forward.
- **Pennsylvania** had a workshop in the last modification but specifically requested and was given a second training in the western region of their state providing more of their somewhat autonomous districts the opportunity to participate.
- **Texas** has experienced significant turnover and desired this training workshop to help continue the progress of considering ABC techniques even during transition of leadership roles.
- **Wyoming** was especially interested in using ABC for detour management, but their state travel restrictions kept them from attending past peer exchanges, so it was valuable to the agency that the training came to their state.

Outcomes and Recommended Future Activities

The evaluation responses along with one on one conversations with the SME during and after the workshops revealed a concerted desire from the states for further guidance and encouragement from FHWA and AASHTO to see the toolkit used and the ABC technologies more widely implemented. Several participants suggested more effort to present this training and exposure to local agencies and hoped FHWA would take the roll to encourage state governments to be open to innovative contracting solutions.

Participants suggested future training might also include:

- A walk through a complete design of an ABC bridge,
- A more focused training on the steps to ABC implementation;
- A roundtable on how to gain contractor input and discussions of Construction Manager/General Contractor (CMGC) or Design Build (DB) methods;
- More guidance to the selection of projects suitable to ABC methods; and
- Clear steps to move from early implementation to programmatic ABC.

Large scale implementation of ABC will likely be pushed by Owners and the states are understanding the need to have contractors recognize the potential of ABC. There is a real need for outreach among bridge builders to gain their confidence and investment.

The participants asked to be updated and alerted to opportunities to share and discuss policies and processes as they are developed and published by other states as well as to be informed of new implementations, case studies and always new lessons learned. There was a high demand for lessons learned from around the country and even internationally. Regarding every issue from design to construction and the materials used, participants asked for specific stories of what went wrong, how problems were mitigated, and what solutions were applied.

There were many recurring issues that were discussed at almost every workshop. Whether through more peer exchanges, informative webinars, guidance documents, training videos, lunch time discussions, or specific success stories; the participants clearly wanted more opportunities to discuss the following issues that come with incorporating and implementing ABC into their bridge programs:

- States asked for more guidance and tools for calculating and assessing ABC costs and risks. They wanted more information on best practices when assessing and communicating costs to politicians and users.
- Participants asked for more information and help providing exposure to leadership and decision makers. There was a high level of interest from states to better understand the benefits of ABC both to their agencies and to the public. As the public is generally receptive to faster, safer, and less disruptive projects; the workshop provided multiple anecdotes of extremely positive public feedback and even bystander involvement as states creatively engage the public to view live ABC construction events.
- Many questions were raised regarding best contracting methods considering CMGC method of project procurement is only legal in 12 states. Participants asked for clarity on methods to put these bridges on the critical path and encourage contractors and fabricators to pursue these methods.
- Designers consistently asked for more details while others appreciated the broader overview of concepts.
- Ultra-High-Performance Concrete (UHPC) drew multiple questions at almost every workshop regarding details of performance, availability, technical issues, and associated costs. There were many questions surrounding all aspects of UHPC.
- Almost every state requested more FHWA incentive grants and additional technical assistance. States specifically asked for more incentive funds that would cover the increased costs incurred in applying ABC techniques, particularly when it's a state's first attempt as they will recognize costs decrease with experience and multiple projects. They want to know how to better estimate costs of ABC and several asked for training, tools and information on assessing costs such as the Connecticut DOT Total Cost Tool.
- AASHTO guidance manuals were regularly requested. Many responses mentioned anticipating Guidance documents and manuals from AASHTO. (The AASHTO Guide Specification for ABC is due out near the end of 2018)
- States requested more technical documentation including examples of details for precast piers, copies of sample Mathcad calculations, greater depth on distribution factors for steel girder bridges, and more case studies particularly for <40 LF span bridges, and urban areas. They asked for more information on alternative technical concepts (ATC's) method including how it is specified for a project.
- Many evaluations reflected gratitude for the enthusiasm of the instructor who kept the audience engaged.

Conclusion

Over the course of the SHRP2 *Innovative Bridge Designs for Rapid Renewal* Accelerated Bridge Construction (R04) product period of performance, 34 total states were presented the Toolkit Workshop Training and given the opportunity to invite their stakeholders to attend. The overall response to this training has been very positive regardless of where each individual state is in the process of implementing ABC methods as part of their own bridge programs. Hardcopies of the R04 toolkit have been widely distributed across the country. The participants have responded asking for more technical support, training, incentives, case studies, and lessons learned as the toolkit promotes more ABC implementation across the country.

Appendix A Data by State Chart

The attached chart lists the trainings by state, location, number of attendees and captures both what the states requested before the training and their responses after the training. Some states did not provide notes of their conversations, but the written evaluation replies are included in the chart. The basic logistics columns from the larger chart are included here:

State	Date of Training	Meeting Location	Contacts	Participants Signed In
Maryland (joint with MTA)	Wednesday, November 15, 2017	Maryland Transportation Authority 8019 Corporate Drive # F, Nottingham, MD 21236	Brian Wolfe Jeff Robert bwolfe3@mdta.state.md.us JRobert@sha.state.md.us	40
Pennsylvania (2nd)	Tuesday, December 19, 2017	Penn DOT District 11-0 45 Thoms Run Road Bridgeville, PA 15017	Lou Ruzzi LRUZZI@pa.gov	42
West Virginia	Wednesday, January 3, 2018	W.V.D.O.T. - Division of Highways Engineering Division 1334 Smith Street Charleston, WV 25301 304-558-9739	Ahmed Mongi Ahmed.N.Mongi@wv.gov	64
California - Sacramento	Tuesday, January 16, 2018	Caltrans Division of Engineering Services, 1801 30th Street, Room 102, Sacramento, CA 95816	Dorie Mellon dorie.mellon@dot.ca.gov	43
California - Diamond Bar	Thursday, January 18, 2018	South Coast Air Quality Management District, 21865 Copley Drive, Room CC6,	Howard Ng howard.ng@dot.ca.gov	27

		Diamond Bar, CA 91765-4178		
New Hampshire	Thursday, January 25, 2018	New Hampshire Bureau of Bridge Design, 7 Hazen Drive, Concord, NH 03301	Robert Landry Lynn Paquette Robert.Landry@dot.nh.gov Lynn.Paquette@dot.nh.gov	104
Arizona	Tuesday February 13, 2018	HRDC's training Center, 1130 N 22nd Ave, Phoenix AZ 85009.	David Eberhart DEberhart@azdot.gov	42
Texas	Tuesday, February 27, 2018	200 E. Riverside Austin, TX 78704	Jamie Farris Jamie.Farris@txdot.gov	31
Maine	Tuesday, March 6, 2018	MaineDOT Region 2 Office, 66 Industrial Drive, Augusta, ME	Michael Wight Wayne Frankhauser Jeff Folsom Michael.wight@maine.gov wayne.frankhauserjr@maine.gov jeff.folsom@maine.gov	64
Minnesota	Tuesday, March 20, 2018	MnDOT Training and Conference Center 1900 Country Road I West Shoreview, MN 55126	Kevin Western Arielle Ehrlich kevin.western@state.mn.us arielle.ehrlich@state.mn.us	29
Indiana	Thursday, March 22, 2018	Indianapolis Government Center South 302 W Washington St, Indianapolis, IN 46204	Jeremy Hunter Anne Rearick JHunter@indot.IN.gov arearick@indot.in.gov	100

Wyoming	Thursday, March 29, 2018		Keith Fulton Vickie Hintze Mike Menghini keith.fulton@wyo.gov vickie.hintze@wyo.gov Michael.Menghini@wyo.gov	26
Hawaii	Monday, April 23, 2018	601 Kamkila Blvd. Room 577 Kapolei, HI 96707	Neil Hasegawa Dean Takiguchi James Fu Neil.S.Hasegawa@hawaii.gov Dean.Takiguchi@hawaii.gov James.Fu@hawaii.gov	25
Idaho	Tuesday, June 5, 2018	Idaho Transportation Department East Annex Conference Room 3293 W. Jordan St. Boise, ID 83703	Matt Farrar matt.farrar@itd.idaho.gov	28
Oregon	Tuesday, June 12, 2018	Chemeketa Eola 215 Doaks Ferry Road NW Salem OR 97301	Bruce Johnson Bruce.V.JOHNSON@odot.state.or.us	14
Oklahoma	Tuesday, July 31, 2018	Association of Oklahoma General Contractors 636 NE 41st ST. Oklahoma City, OK	Steve Jacobi sjacobi@odot.org	81

Connecticut	Tuesday, August 21, 2018	DOT Training Center 2780 Berlin Turnpike, Newington, CT 06111	Eric Tallarita eric.tallarita@ct.gov Susan Baillargeon Susan.Baillargeon@ct.gov Michael Bright Michael.Bright@ct.gov Emilio Flores Emilio.Flores.Jr@ct.gov	31
Colorado	Tuesday, August 28, 2018	Colorado Transportation Department 2829 W. Howard Pl. #105 T-Rex, Denver	Behrooz Far behrooz.far@state.co.us	18
Virginia	Thursday, September 6, 2018	VDOF Headquarters Fontaine Research Park 900 Natural Resources Drive, Suite 800 Charlottesville, VA 22903	Debbie Moore Andy Zickler Debbie.Moore@VDOT.Virginia.gov andy.zickler@vdot.virginia.gov	16
Washington State	Thursday, September 25, 2018	Bridge and Structures Office 7345 Linderson Way SW, Tumwater, Washington	Bijan Khaleghi, KhalegB@wsdot.wa.gov	29

Appendix B

During the workshops, the following questions/answers and lessons learned are below. *Questions*/**Answers** recorded by State Hosts include:

California

Costs

- *How do we determine user costs?* **FHWA has a method to calculate.**

Alternative Technical Concepts

- *3D Modeling or BIM and what its future is with ABC? How Alternate Technical Concepts are incorporated in project delivery? Are there examples of precast piers across the country?* **Trainer answered the questions, state agency provided information on how what we are doing now and where we want to go.**
- *Does any state require BRIM for erection plans?* **No one requires it yet. AASHTO T90 coming with requirement soon.**

Massachusetts Example

- *For Massachusetts bridge, did they use overlay on Precast deck panel?* **No overlay used.**

Splicing

- *Does splice length change for epoxy coated bars**?*** **No, splice length for epoxy coated bars is the same as regular bars when using UHPC.**
- *When splicing, how do you handle the requirement to stagger the splice locations (either lap or coupler)?* **It is good practice to stagger, but not required. We want a minimal connection width.**

UHPC

- *Is it harder to grind UHPC?* **A little harder, but not much harder. The grinder goes right through UHPC.**

Idaho

Costs

- *Was money provided with SHRP2 assisted projects?* **Yes. $250,000 to $500,000 for the projects**
- *Any savings for total cost (staging/traffic control) using precast pier members?* **Some savings, but project objective was to do fast replacement and get out of traffic quickly**
- *Is there a quick and dirty way to estimate user costs?* **FHWA has an accepted method.**
- *Final price on I-84 project?* **Do not know the number.**

UHPC

- *Why do contractors see it as risky/less profitable?* **Based mostly on it being new/different.**
- *Cost of UHPC girders in Malaysia?* **Cost not known, but UHPC price about $800 yard.**
- *Is diamond grinding used for the finished surface?* **Yes. Works well for UHPC too.**
- *Tension capacity of UHPC and what is cracking under stress?* **Micro cracks and steel fibers account for 3-7 ksi strength. Wouldn't account for it in design.**
- *Fill in pockets for studs with UHPC?* **Can use grout or UHPC.**
- *How did closure pours in decks set in time? (Fast 14 project)* **Used fast setting concrete not UHPC**
- *How much does UHPC weigh?* **A little heavier than regular concrete, but not significantly so.**
- *Practical based on cost to make UHPC columns and such with the weight?* **Can make 40% smaller member but material price does not make things practical.**

Contracts

- *What type of contract was used for Fast 14?* **Not CMGC, maybe low bid with 55 hour max contracted time.**
- *For design bid build, slides designed by designer...?* **Can be designed but contractor has experience and may be better prepared using their equipment.**
- *Best solution for recommending a process?* **Show at least one recommended reasonable solution. Contractor will likely modify.**
- *12-hour shifts for work, part of contract?* **Not contracted but should be a conversation with the contractor.**
- *Union issues for projects?* **Consideration needed since working at night/weekends.**
- *Why ABC at Keg Creek?* **Experimenting.**

Overlays

- *Is Minnesota still using overlay process on new decks?* **Yes, but may be moving away from it.**
- *Wisconsin doesn't use overlays and Minnesota does?* **Minnesota is backing off using overlay as they are not sticking well.**

SPMT

- *Utah still uses SPMT's?* **Used based on purpose, not as much as people think.**
- *Cracking of member while using SPMT? Why isn't it more popular?* **Mostly based on price and scheduling. SPMT's are costly.**

Other Technical Issues

- *Span of Malaysia bridge?* **Around 200 feet**
- *Type of girder?* **Box girder sections.**
- *How far Montana Single girder with deck system transported?* **Unknown as not involved with the project.**
- *Depth of NEXT beam**?*** **24" to 36" varied.**
- *Driving piles through precast abutment?* **Not seen it done. Would not suggest it.**
- *What are the spread footings sitting on for full bearing?* **Looks like a geosynthetic fabric.**
- *How does Wisconsin deal with Deck bulb tee decks?* **Wisconsin does not use Deck bulb Tee's.**
- *Some designers design their own falsework and systems?* **Designers would like it constructed as designed but contractor can change it with the engineer's approval.**

- *Why avoid post-tensioning?* **Interest in type, simplicity, and use nation wide**
- *Inspectors for the pre-cast elements are certified by the State?* **They are state reps, if not from the State contracted by the State.**
- *Stress analysis of girder on tilted girders for girders not on level beam seats?* **Analysis done and was found to be less than 1% different.**
- *Since piers can be pre-poured ahead of time, how was Abutment handled?* **They were pre-poured also with drilled shaft support.**
- *No water in creek during demo?* **No. They used culverts. Waterf lowed under the site.**
- *How was the gap behind the hanging abutment filled?* **The flowable backfill was used. An Iowa standard.**
- *Does backfill have cement in it?* No. *Does it have compression strength?* **No.** *Does it drain?* **Yes.**
- *Did you form the bottom of the bottom of approach slab joints?* **No, that's why fill was built up so high.**
- *Why did they leave culverts in for five years***? They were not required to remove them right away.**
- *Did they have extra piles on site for the mistakes?* **Piles were readily available. Standard size.**
- *Leave the existing pavement in place?* **Left most of it in place.**
- *How long was the approach?* **About around 40 feet.**
- *MSE walls?* **No bin walls for the abutments.**
- *How did they drive pile for structure (Arizona)?* **Had a 2-day closure for driving piles over a weekend.**
- *Strength of carbon fiber prestressing strands?* **Same or more than steel.**
- *Why don't you have a footing for super structures on GRS abutments?* **Not needed so it would cost extra, but if the footing cracks, will have differential settling of super structure.**
- *Concern of member weight for transport?* **Concern is of cost if special equipment is needed from precaster who does not normally move large beams.**
- *How long is the span of Kentucky truss?* **Approximately around 250 feet.**

Maryland

Costs

- *Would an adjacent alignment be cheaper than replacing a bridge in the same location with ABC?* **It can be but the approach geometry may make the alignment shift undesirable. This option should be explored however.**
- *Would the high cost of UHPC be offset by the life cycle cost savings if the material was used for full girders?* **Not yet, given the high unit cost of around $2500 per CY and the types of girder shapes currently in use in the US.**

Lessons Learned

- *Any project stories that show and ABC project going from bad to worse?* **Up until now, no major failure issues. Some small issues (i.e. clear spacing for rebar splicers) but nothing larger.**
- *How does weather play a role in the contract time? For example, construction time is 14 days but it rains 5:* **Typically, this is the contractor's risk and factored into his bid.**
- *Do you put worker fatigue issues into the contract specifications?* **Typically no but you raise this issue at normal meetings with contractors.**

- *What about using owner supplied materials on an ABC project (county has seen savings by providing materials to contractors on more conventional projects)?* **Typically have not seen this approach used nationally.**

Resources

- *Question on where information is available for ABC?* **Take a look at the ABC website developed by Florida International University. It has extensive information. As a follow up later on, Utah DOT's website was mentioned as having numerous ABC manuals.**

Technical Issues

- *How long can a PBES superstructure unit be?* **Can be up to a couple hundred feet. Length is usually dictated by depth requirements for the girder. For bridge slides, the roller systems available can move a tremendous amount of weight.**
- *How do you handle LL distribution on PBES superstructures with variable girder spacings?* **Suggest using an average girder spacing and using the typical AASHTO LRFD LL distribution factor equations. Don't complicate the design!**
- *Once closure pours are completed, can you leave the deck grinding until a following weekend for a local bridge (non-interstate)?* **Yes, the grinding is purely for rideability.**
- *Are any PBES superstructures cast with shoring so the composite system carries all load?* **Typically, they are not, the units are constructed in the shop just like they would be in the field**.

Oklahoma

Superstructures

- *Were the substructures old?* **Yes but new beams and deck elements**
- *Was the pre stress work, deck overlay new*? **No, standard casts**
- *Were they NEXT Beams?* **They were not.**
- *How does it reinforce the bursting stress on the ends?* **Reinforced by small fibers around the bar, keeps it from cracking.**

Prefabricated Systems

- *How well does the UHPC perform for torsion?* **It is based on the particular situation, but usually always performs well. We don't design for torsion very often.**
- *What is used to adjust for deck haunches?* **Metal angles and straps across the girder can be used. Same as for SIP Forms.**

ABC Toolkit for Designers

- *Are there specific guidelines for diaphragm and connection placements?* **If done in place and done before there are none different. We use steel diaphragms not cast-in-place.**
- *Can diamond grinding be done at 32000 psi?* **Yes, best if you wait between 2 days to 7 days, it will take longer the higher psi. You can do it also at 10 ksi**
- *Are there grouting connections volume metric calculations?* **Have not done the calculations as long as you use the right materials (self-consolidating concrete) it will fill every void.**

- *What about sleeve connections?* Response: Grout comes with the complete connection. **Everything is included.**
- *What about precast elements against the UHPC 6" joints? Are there design considerations?* **Nothing significant, there were no major problems when used pre cast concrete and joints. ABC uses State of the art materials (UHPC) and technology. No post tensioning required.**
- *Are there other maintenance concerns with joints needing sealer?* **You could use a penetrating sealer but no need at all if it is done correctly. Make sure the cast is in place prepped right, there is no problem.**

Case Studies and Lessons Learned

- *Michigan – Where did they get the concrete?* **Overlay mixed on site.**
- *Michigan - What were the environmental concerns?* **Mostly noise concerns.**
- *New York - What was the length of the Roadway asphalt replacement on the New York Slide?* **Sorry I do not have that information.**
- *Do they have to jack up the bridge to put in place?* **The SPMT not only goes back and forth and left and right but it also has hydraulics to enable the bridge to be moved up and down 18" as well.**

Wyoming

- *Constructability of composite steel systems - who assembles/puts deck on girders?* **The contractor usually fabricates on project site.**

Lessons Learned Recorded by State Hosts Include the Following:

California

UHPC

- Good practice to wait until UHPC reaches 10,000psi-12,000 psi (24 hours) to grind decks This strength is needed to make the short 5" bars splices work.
- Pour UHPC with top forms since it runs like liquid (will run to low point).
- Do not use UHPC at top of sidewalks due to steel fibers on surface affecting bare feet.

Precast Abutments and Girders

- Hair pin rebar are not needed on precast abutment segments make it difficult to lower and connect to other segments. Use straight bars to avoid conflict.
- Designing precast girders for zero tension requires a few extra strands but helps with possible stresses caused by the possible need for camber leveling while the precast units built with prestressed girders are installed.
- Placing precast girders slightly off vertical (2% cross-slope) simplifies casting of precast abutment with little effect on the performance of the girders. Makes the girder haunches equal on both edges of the flange also.

Scheduling

- Worker shifts, truck scheduling, and safety is important to make an ABC project run efficiently when working within a small timeframe and in a congested area, like on a major California Highway.

Maryland

Strategy Thinking

- Railroads use ABC extensively; delayed trains mean lost revenue. Transportation agencies need to start thinking like a RR in terms of using ABC.

UHPC

- Be aware of connections when erecting precast substructure units; make sure the reinforcing in the UHPC closure pours can pass each other.
- For UHPC deck closure pours – USE STRAIGHT BARS! Hooks and hoop bars are overkill and can cause fit up issues.

Precast

- Always double check geometry in the field to ensure proper fit up. Measure twice, install once.
- When using steel culverts (CMP) as a sleeve in a precast substructure unit to allow a connection to a pile (H-pile), how do you get adhesion between the pile and unit? Response: the CMP obviously provides a good connection; the pile has bolts (or shear studs?) placed on them to provide load transfer.
- For precast piers, minimize the number of columns supporting a precast cap. Continuous caps can have fit up issues due to spanning three or more columns. Spanning between just two columns allows a little more flexibility for bar splicers.
- Alternate Technical Concepts are a great way to get contractor innovation that can reduce costs.
- Georgia example project utilized a steel frame template to form precast pier caps that was then used to set column reinforcing and coupler locations for proper fit with cap. A very simple effective way to guarantee the bar splicers will fit every time.

Piling

- Order piling longer than anticipated (if pile needs to be 45 ft., order 50-55 ft.) to reduce risk of needing pile splicing. Material is cheap when time counts. Cutting off steel piles is fast compared to welding on pile extensions.

PBES and SPMTs

- For bridges being replaced using SPMTs keep in mind that if multiple structures are involved, the design load for a bridge may actually be another bridge being carried by an SPMT! This happens when one bridge is rolled over the earlier installed bridges. Planning is key to recognizing that early.
- When using PBES such as modular superstructure units, each unit is transported on its own truck/trailer and arrive one right after another. Speed is key, not efficiency in transportation of units.

Oregon

Oregon comments

- Oregon wants to emphasize aggressive consideration of user costs to support increased use of ABC. This will help justify the increased costs of the first few projects.
- ODOT has a fish passage program funded by the legislature that requires ODOT to spend a certain amount on fish passage projects.
- There seems to be confusion about what environmental regulations permit us to consider. It appears things are handled differently in other parts of the country.

Costs

- The cost of ABC comes down the more you use it.
- Global overall average of ABC increased costs are around 18%, but individual costs vary greatly from a savings to doubling the cost normal cost of the bridge.
- Total project cost graph. The lowest cost to society (construction cost + user cost) will require somewhat less time than what a contractor would consider ideal.
- Consider engaging a specialty construction schedule consultant (usually a retired contractor) when estimating the cost of larger ABC projects.

UHPC

- Hairpin bars in closure joints are not necessary when UHPC is used.
- UHPC has almost no carbonation and is essentially impermeable to chlorides.
- UHPC should not be used for sidewalk joints where it could come in contact with skin/feet..
- Where UHPC joints are used, the forms of the conventional concrete side of the joint is coated with set retarder and then hit with a water blast to create a roughened surface. The UHPC has a tenacious water-tight bond to this type of surface.

Design and Construction

- Designer must be on-site or available to make quick decisions during ABC operations.
- Alternative Technical Concepts (ATC) are proposed during the bid stage. DOT provides approval of concepts prior to receiving bids. Contractor bids project with their preapproved concepts. Stipends can be considered.
- Wisconsin developed a spec for block walls to make the blocks longer lasting. This solved a problem with block walls that were turning back to rubble due to freeze/thaw.
- For erection using cranes, designer needs to have at least one reasonable solution. Contractor will likely tweak it.
- Need to think about your state's policy regarding casting members on site vs. requirements for casting in a certified precast plant. Contractors cast concrete all the time, but they don't typically move the items they cast.
- Aesthetics still need to be considered for ABC projects. Precast handles aesthetics well.
- ABC is about how long the facility is closed to public use.

Resources

- New AASHTO guide specifications for ABC due to be published in the fall of 2018.

- NCHRP Project 12-98 – Report released in December 2017, covers impact of SPMT moves and tolerance of fit up of precast elements. http://www.trb.org/NCHRP/Blurbs/177187.aspx
- Utah and Wisconsin have good ABC resources.

Wyoming

Precast

- Precast deck panels on skewed bridges can be problematic. Skew complicates all projects and ABC work is no exception.

Decks

- Long-term needs to be considered. ABC projects and joints need to last 75 plus years.
- Deck replacement vs. superstructure replacement. Sometimes replacing the whole super works better than just trying to replace the deck.

Safety

- Safety to workers & public is critical. ABC should improve safety of constructed projects.
- Crane capacities for lifting elements and systems needs to be considered during the design phase of an ABC project.

UHPC

- Top forms for UHPC are required as it will run to the lowest point of the joint. Curing for UHPC takes about a day to get to the minimum required 10,000 psi for deck grinding.
- Specialty contractors for UHPC are best used for the first few projects to make sure the project is successful.

Foundations

- Geotechnical engineers can be conservative which results in larger footings and foundations. Foundation consideration can have a major effect on the ABC time line.

Appendix C Preliminary Agenda

Agenda

SHRP2 Solutions: *Innovative Bridge Designs for Rapid Renewal*
Accelerated Bridge Construction (R04) Toolkit Workshop
January 25, 2018

XX Department of Transportation

This workshop is designed to introduce the attendees to the *Innovative Bridge Designs for Rapid Renewal ABC Toolkit* and provide an in-depth overview of accelerated bridge construction issues.

MEETING LOCATION

8:00 - 8:15 am	**Welcome & Introductions**
8:15 - 8:30 am	**SHRP2 Introduction and Overview of Innovative Bridge Designs for Rapid Renewal (R04) Using ABC/PBES**
8:30 – 8:45 am	**State ABC Background/Presentation**
8:45 – 10:15 am	**SHRP2 *Innovative Design for Rapid Renewal* Toolkit**
	• Lesson 1: Introduction to ABC • Lesson 2: Prefabricated Elements and Systems
10:15 – 10:30 am	**BREAK**
10:30 – 11:45 pm	• Lesson 3: Bridge Movement Technologies • Lesson 4: ABC Toolkit for Designers from SHRP2 – Part 1
11:45 – 12:45 pm	**LUNCH**
12:45 – 1:45 pm	• Lesson 5: ABC Toolkit for Designers from SHRP2 – Part 2 • Lesson 6: ABC Keg Creek Project & I 84 • Toolkit Discussion, Participant Questions
1:45 – 2:30 pm	**Case Studies and Lessons Learned: 8 Projects SHRP2 Implementation Assistance Program (IAP)**
2:30 – 2:45 pm	**BREAK**
2:45 – 4:00 pm	• **Procurement, Costs, Savings and ABC** • **Contractors, Fabricators and ABC**
4:00 – 4:30 pm	**Status of States DOTs Institutionalizing the Use of PBES/ABC**
4:30 – 5:00 pm	**Group Discussion and Questions**
5:00 pm	**Wrap Up and Adjourn**