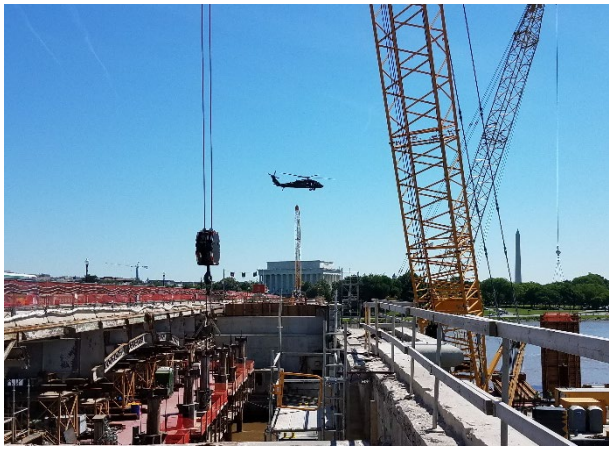
2023 BRIDGE CONSTRUCTION PRACTICES PEER EXCHANGE REPORT

NASHVILLE, TN
DECEMBER 5-6, 2023

PUBLICATION NO. FHWA-HIF-24-060 June 2024



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Federal Highway Administration

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TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA-HIF-24-060	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle 2023 Bridge Construction Practices Peer Exchange Report		5. Report Date June 2024 6. Performing Organization Code:
7. Author(s) Jarret Kasan, Anthony Ream, Chad Pasma, Michael LaViolette and Neil Richards		8. Performing Organization Report No.
9. Performing Organization Name and Address HDR One Oxford Center, 301 Grant St., Suite 1700 Pittsburgh, PA 15219		10. Work Unit No. 11. Contract or Grant No. DTFH6114D00049
12. Sponsoring Agency Name and Address Office of Bridges and Structures Federal Highway Administration 1200 New Jersey Ave SE Washington, DC 20590		13. Type of Report and Period September 2023 to March 2024 14. Sponsoring Agency Code
15. Supplementary Notes FHWA Representatives: Tuonglinh Warren, P.E. and Calvin Chong		

16. Abstract

This report synthesizes information from a desk scan of bridge construction procedures and processes of participating State transportation agencies (DOTs) and summarizes the proceedings of a peer exchange discussing these topics. The peer exchange was held on December 5-6, 2023, in Nashville, Tennessee. Sessions of the peer exchange consisted of presentations by State DOTs on best practices and subsequent discussions. Topics included construction inspector training, certification and staffing, statutory changes to the Buy America program, bridge demolition, use and implementation of innovative and unique materials, implementation of accelerated bridge construction techniques, constructability reviews, repair and rehabilitation practices, rising construction costs, supply chain issues, inflation, schedule delays, and other project considerations and prevalent or reoccurring construction issues. A total of 27 individuals from 17 agencies, the FHWA, and the consultant team participated in the peer exchange.

17. Key Words Bridge construction practices, construction inspection, construction certification, construction staffing shortage, innovative materials, constructability reviews, bridge repair, bridge rehabilitation and construction issues	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161. http://www.ntis.gov		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 64	22. Price N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized.

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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LIST OF ABBREVIATIONS AND SYMBOLS

AASHTO	American Association of State Highway and Transportation Officials
ABC	Accelerated Bridge Construction
ACI	American Concrete Institute
AGA	American Galvanizing Association
AHTD	(former) Arkansas State Highway and Transportation Department
AISC	American Institute of Steel Construction
ALDOT	Alabama Department of Transportation
ARDOT	Arkansas Department of Transportation
ASBI	American Segmental Bridge Institute
ASNT	American Society for Nondestructive Testing
AWS	American Welding Society
A+B	cost plus time bidding
BA	Buy America
BCI	Bridge Construction Inspector
BrIM	Bridge Information Modeling
Caltrans	California Department of Transportation
CBEI	Concrete Bridge Engineering Institute (University of Texas)
CIT	Construction Inspection Training
CMGC	Construction Manager/General Contractor (project delivery)
C&MS	Construction and Material Specifications (Ohio DOT)
CR	Constructability Reviews
CTP	Certified Technician Program (INDOT)
DelDOT	Delaware Department of Transportation
DES	Division of Engineering Services (Caltrans)
GFRP	Glass Fiber Reinforced Polymer (reinforcing bars)
DOT	Department of Transportation
E5	Element 5 (concrete admixture)
FAQ	frequently asked questions
FHWA	Federal Highway Administration
GDOT	Georgia Department of Transportation
GRS-IBS	Geosynthetic Reinforced Soil-Integrated Bridge System
HMA	Hot Mix Asphalt
INDOT	Indiana Department of Transportation

ITS	Intelligent Transportation Systems
KYTC	Kentucky Transportation Cabinet
LMC	Latex Modified Concrete
MALP	magnesium-alumino-liquid-phosphate
MMA	Methyl Methacrylate
MnDOT	Minnesota Department of Transportation
MSE	Mechanically Stabilized Earth
NCHRP	National Cooperative Highway Research Program
NECEPT	Northeast Regional Superpave Center (Penn State University)
NICET	National Institute for Certification in Engineering Technologies
NDOT	Nebraska Department of Transportation
NEXT	Northeast Extreme Tee (precast/prestressed concrete beam)
NHI	National Highway Institute
PTI	Post-Tensioning Institute
PDP	Professional Development Pay (UDOT)
PE	Professional Engineer (License)
PennDOT	Pennsylvania Department of Transportation
PPC	Polyester Polymer Concrete
PS&E	Plans, Specifications, and Estimate
RE	Resident Engineer (Caltrans, ARDOT)
S-BRITE	Steel Bridge Research, Inspection, Training, and Engineering Center
SC	Structure Construction (subdivision at Caltrans)
SCE	Structure Control Engineer (PennDOT)
SPMT	Self Propelled Modular Transporter
SSPC	Steel Structures Painting Council
TC3	Transportation Curriculum Coordination Council (AASHTO)
TDOT	Tennessee Department of Transportation
TRBA	Tennessee Roadbuilders Association
TxDOT	Texas Department of Transportation
UDOT	Utah Department of Transportation
UHPC	Ultra-High Performance Concrete
VTRANS	Vermont Agency of Transportation
WisDOT	Wisconsin Department of Transportation

CHAPTER 1 - OVERVIEW

This report synthesizes the information from a desk scan of procedures and processes of State department of transportation agencies (DOTs) related to focus areas pertaining to bridge construction practices. From this information, best practices were identified, and participants were asked to present this information at the peer exchange. Each session was organized to allow for presentations from participating agencies and information from the desk scan, all of which were intended to be the basis of discussions. A summary of discussions from the peer exchange are included in this report. The peer exchange was held in Nashville, Tennessee on December 5-6, 2023.

PEER EXCHANGE AND PURPOSE

The Construction Technical Committee of the American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures is a group of bridge practitioners from State DOTs and government officials meeting to share bridge construction practices and technologies. During committee meetings, DOTs have raised concerns regarding various construction issues. One approach to identify potential solutions to these issues is to facilitate sharing and discussion of various practices; therefore, the bridge construction practices peer exchange, which is the subject of this report, was held to accomplish this goal.

PEER EXCHANGE AGENDA

The agenda for the peer exchange was as follows:

Day One Agenda:

8:00 am – 8:15 am	1. Introductions
8:15 am – 8:50 am	2. Peer exchange opening and desk scan executive summary
8:50 am –11:30 am	3. Construction inspector training, certification, and staffing
12:30 pm – 1:30 pm	4. Statutory changes to Buy America
1:30 pm – 2:30 pm	5. Bridge demolition practices
2:40 pm – 5:00 pm	6. Innovative and unique materials

Day Two Agenda

8:00 am – 8:30 am	1. Tabled discussions
8:30 am – 10:20 am	2. Accelerated Bridge Construction (ABC) implementation
10:30 am – 11:30am	3. Constructability reviews
12:30 pm – 2:00 pm	4. Repair and Rehabilitation
2:10pm – 3:10 pm	5. Other construction issues, all States
3:10pm – 4:10 pm	6. Rising construction costs, supply chain issues, inflation, schedule delays and other project considerations
4:10pm – 4:40 pm	7. Tabled discussions
4:40pm – 5:00 pm	8. Closing remarks and action items

PEER EXCHANGE PARTICIPANTS

Agencies that participated in the peer exchange include Alabama, Arkansas, California, Delaware, Georgia, Indiana, Nebraska, Minnesota, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, Vermont, and Wisconsin (see Figure 1). Additionally, Kentucky gave a presentation to the peer exchange group.

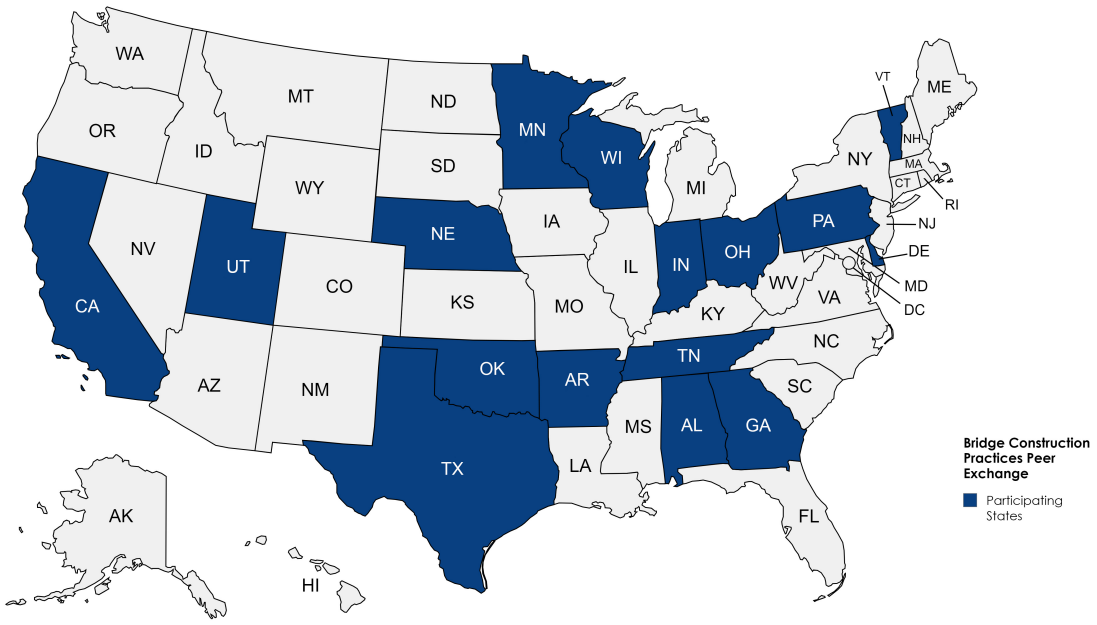

Figure 1– U.S. map showing participating States in the Bridge Construction Practices Peer Exchange

FORMAT OF THIS REPORT

This report summarizes the information received from the desk scan and presentations and discussions from the peer exchange. Each session of the peer exchange is captured in a chapter in this report. Each chapter provides the inquiries for each topic, presentations and discussion at the peer exchange, and a summary of the desk scan information from participants. Note that the presentations were based on the desk scan information and thus the summary information for presenting agencies is listed in the Presentations and Discussions section in each chapter.

Individual participant's names are omitted from this report and participants are identified by the department they represent.

CHAPTER 2 - WELCOME, INTRODUCTIONS, AND OVERVIEW

The peer exchange was organized with the intent of sharing information between DOTs regarding bridge construction practices. The goal was to capture the state-of-practice, identify best practices, identify challenges and potential solutions, and efforts to successfully implement these solutions in bridge construction.

The consultant team reviewed and identified nine (9) 'focus areas', and noted challenges, solutions, and best practices. This was used to develop the organization of the peer exchange and identify practices to be further discussed and presented at the peer exchange. The goal of the presentations and subsequent discussions at the peer exchange were to share information, discuss findings and considerations of the desk scan, and make connections between challenges and solutions. This report is the product of this work and is intended to help promote best practices and assist State DOTs to overcome current challenges.

The consultant team opened each session with a brief, high level overview of desk scan responses, with opportunity to discuss, as necessary. Following this introduction, invited individuals were asked to present on the focus of the specific session. The consultant team's role was to facilitate the discussions and moderate the session based on the allotted time, interjecting as necessary.

Following the discussion of the peer exchange format, each participant provided a brief introduction, and the peer exchange commenced.

CHAPTER 3 - CONSTRUCTION INSPECTOR TRAINING, CERTIFICATION, AND STAFFING

This chapter summarizes how construction inspector training, certification, and staffing is administered and managed by various agencies. The agencies provided a summary of their experience based on the following topics:

- Bridge construction inspection training (CIT)
    - Procedures the agency have used for training construction inspectors
    - Availability of training to agency staff and consultant inspectors
    - Resources the agency has found to be effective in training construction inspectors
    - Challenges while administering training and how have they been addressed
    - Plans to administer bridge construction inspection training in the agency's future
- Construction inspection certification program
    - Certification process, if the agency has a program
    - Availability of training for:
        - Different experience levels, and how the training differs between levels
        - Measurements and surveys, inspector tools and equipment, personal safety, traffic control, site layout, reporting and compliance, and operations (e.g., work zone traffic control, erosion and sediment controls, or types of utility markings)
        - Roadway construction (e.g., asphalt pavement, concrete pavement, utilities, traffic signals, lighting, or intelligent transportation systems (ITS))
        - Earthwork and geotechnical construction (e.g., earthwork, soil and slope stabilization, or foundation construction)
        - Structure construction (e.g., concrete structures, steel structures, deck, substructure, or walls)
        - Complex or critical construction items, project schedule, budgets, or project administration
    - Availability of training to agency staff and consultant inspectors
    - Construction inspection qualifications if the agency does not have a certification program
- Construction inspection staff shortages
    - How staffing shortages are addressed
    - Use of consultants to perform construction inspection
    - Cross-training maintenance staff (such as snowplow operators) to serve as construction inspection staff

PRESENTATIONS AND DISCUSSIONS

CALIFORNIA

The California Department of Transportation (Caltrans) Structure Construction (SC) division has a comprehensive Winter Training Program that rotates five core topics, yearly. The SC Winter Training core topics include Falsework, Trenching and Shoring, Foundations/Earth Retaining Systems, Reinforced Concrete, and Prestressing/ABC/Alternative Delivery. This in-person training typically consists of 20 hours. In past Winter Training classes, Caltrans has also incorporated instruction modules on Deck Construction, Administration, Claims/Legal, Bridge preservation /Emergency Response and Building Construction. In addition to the core Winter Training classes, Caltrans also provide classes for Structural Steel Coatings and New Employee Field Engineer Training. The Winter Training program has typically been offered in-person, but Caltrans has also begun to utilize a web-based platform to make this training available continuously online. The Winter Training program is offered to consultants, typically done in a hybrid (in-person and live online) condensed format (i.e., 8 hours in lieu of 20). During the discussions, it was noted by Caltrans that training is more effective for individuals with a few months of field experience, rather than little to no field experience. Having field experience provided valuable context to the training.

As the SC division is a statewide organization, in-person training has proven and remains valuable for staff to share experiences and build networking work relationships. Regarding challenges to administering the training, budget/cost may be an issue. Strategically locating training facilities to reduce student travel cost helps minimize excessive costs.

Caltrans does not offer construction inspector certification for structures specifically but does offer the Resident Engineer (RE) Academy and RE certification program. Caltrans is currently experiencing a shortage of construction inspection staff and noted that hiring difficulties and employee attrition remain a significant challenge. It noted that starting pay and lack of telework availability for field employees have made recruitment and retention difficult. To address this shortage, Caltrans does utilize consultants for construction inspection staff, but notes there remains challenges with finding qualified staff. There have been considerations for cross-training maintenance staff, but most inspectors are engineers (often maintenance staff are not) and maintenance staff shortages also exist.

MINNESOTA

The Minnesota Department of Transportation (MnDOT) administers Bridge Construction Inspector training through a 2-week bridge construction inspection classroom training. There are prerequisites to taking the BCI course:

1. Aggregate Production Tester Concrete Field Tester course
2. Concrete Field Inspector course
3. Grading and Base Tester course
4. MnDOT eLearning courses: Preparing to Drive Piles
5. MnDOT eLearning courses: Plan Reading
6. AASHTO/TC3 Construction Inspection of Structures Series E-Learning courses

a. Subsurface (TC3CN053-17-T1)
b. Substructures (TC3CN054-17-T1)
c. Superstructures (TC3CN055-17-T1)
d. Rehabilitation and Maintenance of Structures (TC3MN032-17-T1)
e. Reinforcing Steel for Structures (TC3MS064-21-T1)

Additional references MnDOT uses from AASHTO/TC3 courses:

- Concrete Series: Basics of Cement Hydration (TC3MS009-15-T1)
- Concrete Series: Fresh Properties (TC3MS010-15-T1)
- Math Basics Series for Highway Technicians: Introductory Math Concepts (TC3ED004-17-T1)

This 2-week training course is open to MnDOT staff, local agency employees and consultants, and opened to contractors if class enrollment has not filled to capacity. In order to become a certified inspector, individuals are to pass one 75-question exam at the end of each week of instruction. Between 75 and 90 people successfully pass the course each year.

Effective teaching strategies include reviewing sample plans and contract specifications, inspection tasks, plan reading, sample calculations, quizzes and tests throughout, daily reviews, hands-on props (i.e., rebar bolsters, rebar, form liner, bolting, etc.) and contract change order case studies. MnDOT develops the courses and lectures but hires a consultant to manage the course delivery. Logistics (classroom supplies, materials, test scoring, and registration) is administered through a local college. The host consultants are contracted on a 5-year basis to facilitate consistency in the course delivery.

It is noted that developing training and lecturing places a significant demand on MnDOT staff. There has been an effort within MnDOT to pursue developing e-learning training content. Similarly, MnDOT is considering "just-in-time" learning to provide a training module on a specific concept available on-demand. MnDOT is interested in developing training material that can be available online to ease the annual teaching workload on staff. There remains a consideration to maintain the technical personnel presence in curriculum to establish connections with new inspectors, however.

Another challenge is to deliver content that students will be able to retain from instructors whose day job is not training. MnDOT conducts "Train the Trainer" courses to help overcome education background deficiencies, but there remain challenges when training is an additional task beyond the technical position's responsibilities. "Train the Trainer" curriculum is focused on best retention strategies, including teaching the "why" of construction inspection topics more so than the "how". This approach has been found to be effective in improving content delivery by training staff,

MnDOT administers BCI through the Technical Certification Program, from MnDOT's website. A BCI certification is an extra level of certification after completion of a general construction inspection course. The general construction courses certify technicians in two roles: tester and inspector. Testers are individuals with limited responsibility who normally work under the direction of a supervisor. Often, materials testing and/or sampling is the sole duty of a tester

technician. Inspectors are individuals in a decision-making role, such as project supervision or oversight. Chief Inspectors, Mix Designers, etc., obtain inspector certification.

It is noted that MnDOT is experiencing a shortage of construction inspector staff and is using recruiting efforts, hiring bonuses, consultants, and cross-training of maintenance staff.

MnDOT inspectors are issued an identification card with the inspector's credentials. Additionally, about every 3 years MnDOT offers a 3-day Construction Engineer Bridge Overview training course to provide an overview of bridge construction, processes, and inspection controls for project engineers that may have to run a bridge project.

PENNSYLVANIA

The Pennsylvania Department of Transportation (PennDOT) administers CIT with several in-house developed classroom-led bridge inspection training courses. The training courses are effective and available to department staff and consultants. PennDOT also has a "Winter School Training" program session that is effective. PennDOT is now also offering some courses virtually.

PennDOT administers CIT through the Northeast Regional Superpave Center (NECEPT) at Penn State University for asphalt, concrete, and aggregate certifications. Training courses are offered to prepare an individual for their initial certification and refresher courses for staff to maintain certifications. Additionally, during discussions, it was noted that PennDOT has developed a series of online bridge construction training videos. Videos for safety harness use, pile driving, bridge deck testing, placement, and pumping, deck pre-placement operations, deck finishing, compressive strength specimens and testing and culvert construction.

PennDOT is experiencing a shortage of construction inspection staff and is addressing this shortage through recruitment efforts, increasing pay, and utilizing consultants. PennDOT does not typically cross-train staff as it has been found to not be viable option.

CONCRETE BRIDGE ENGINEERING INSTITUTE GROUP DISCUSSION

From the first day's discussions, there was one topic that was tabled and revisited at the beginning of the second day of the peer exchange. TxDOT had mentioned the Concrete Bridge Engineering Institute (CBEI)[1] during construction inspector training.

CBEI was founded in June 2023 with the mission of serving the concrete bridge community as the leading resource on the most pressing issues encountered in concrete bridges across the Nation. The facility is administered through the University of Texas at Austin and is intended to be a resource focusing on concrete bridges, specifically concrete materials for bridges, concrete bridge deck construction inspection, and post-tensioning academy. CBEI will provide inspector training and certification, a concrete solutions center, and concrete bridge component collection.

[1] CBEI was formed utilizing a transportation pooled fund with support from Iowa DOT, Michigan DOT, MnDOT, TxDOT, GDOT, Florida DOT, TDOT, WisDOT, PennDOT, UDOT, Colorado DOT and the FHWA.

It is also intended that future topics will be identified, and additional capabilities included as CBEI matures.

The bridge deck inspection program component of CBEI will utilize a three-span, four-girder line concrete bridge structure that is in various phases of construction (a portion of the structure with the deck placed, a portion of the structure with wood formwork, stay-in-place formwork and precast panel deck segments), with built-in defects. This arrangement allows trainers to utilize a full-scale example to illustrate various components, aspects and defects that may be seen in the field.

TRAINING RESOURCES

It was also noted by the consultant team that there were additional resources and references that may be useful. Many were mentioned in the desk scan review and others were found while researching construction inspection training and certification, and are provided below for reference and consideration (note not all are bridge specific training):

- Federal Highway Administration (FHWA)
- National Institute for Certification in Engineering Technologies (NICET)
- Universities for specific training (i.e., NECEPT)
- 1983 AHTD Bridge Construction Inspection Manual (AHTD is the former ARDOT abbreviation)
- Various NHI courses (National Highway Institute)
- American Concrete Institute (ACI) technician training
- AASHTO Transportation Curriculum Coordination Council (TC3) – administered through VDOT University
- Steel Structures Painting Council (SSPC)
- American Institute of Steel Construction (AISC)
- American Welding Society (AWS)
- ACI Field Technician Certification
- Post-Tensioning Institute (PTI)
- American Segmental Bridge Institute (ASBI)
- S-BRITE Center (Purdue University)
- Concrete Bridge Engineering Institute (CBEI)
- National Cooperative Highway Research Program (NCHRP) Research Report 1027: Guide to Recruiting, Developing, and Retaining Transportation Infrastructure Construction Inspectors (2023)
- NCHRP Synthesis 20-05/Topic 55-12: Bridge Construction Inspection Training Resources and Practices.

The consultant team also identified information available on Virginia DOT and Oregon DOT websites pertaining to CIT and construction inspector certification that may be used as references.

During discussion, TxDOT noted positive experiences utilizing the S-BRITE center for training. Other participants agreed.

During discussions, it was posited that a construction inspection training and certification program be developed that could be available as a nationwide training or at least in multiple States. MnDOT noted that it would be unlikely they would accept such a training as the department tailors the training program for their State. However, others had noted that a widely accepted training program could be beneficial to the industry and their department.

Discussions also mentioned the use of 3D bridge plans and Bridge Information Modeling (BrIM). Some States noted issues with getting inspectors (and others) to understand 2D plans. However, it was noted by INDOT that younger engineers are much better equipped to understand 3D plans and software and could more readily identify conflicts and issues. UDOT noted utilizing 3D plans on several projects, note discussion points below:

- UDOT has completed several bridges with full BrIM: one was a CMGC, one was traditional design-bid-build, one is in construction right now, and 2 more will be let in the near future with model only and no plans).
- UDOT utilizes model rovers. Anecdotal feedback from surveyors has been positive.
- UDOT noted 3D plans are not right for every bridge due to software and equipment limitations.
- UDOT noted that rebar fabricators are leveraging the 3D model to create a 2D plan takeoff, but the steel fabricators largely have not adopted 3D plans.
- Regarding the final project record - general notes, specifications, etc. are stored in PDF and combined to make up the permanent record.
- Designers are retained throughout construction to make the field change updates for the as-built record.

During discussions, it was posited that departments consider a risk-based approach to construction inspection. It was noted that Ohio DOT has done this to some extent, and MnDOT stated that it was believed that the risk-based approach would be too significant of an effort to administer.

DESK SCAN INFORMATION

ALABAMA

The Alabama Department of Transportation (ALDOT) indicated that the department does not administer bridge construction inspection training.

The department has a construction inspector certification program with classifications of Engineering Assistant I, II, III, and Project Manager. Certifications offered are for ACI Concrete Field-Testing Technician, Roadway Hot Mix Asphalt (HMA) Pavement Technician, Earthwork Technician, ALDOT Temporary Traffic Control, Radiation Safety Technician, Contract Plan Reading and Qualified Credentialed Inspector – EA II/III/PM Only. ALDOT is currently putting together a Critical Path Method Project Scheduling class. When segmental construction has been done in the State, a select few individuals conducted training on the complex structure.

The department is experiencing a shortage of construction staff. To incentivize potential candidates, ALDOT has created a new classification called Engineer Aide that allows for the organization to make direct hires that are temporary for the first 6 months, but they complete certain math classes and a map reading class. Once they receive permanent status, the individuals will be able to apply for Engineering Assistant I which is a full-time permanent position. ALDOT utilizes consultants to perform inspections, as necessary.

During discussions, ALDOT noted that inspectors are issued identification cards.

ARKANSAS

The Arkansas Department of Transportation (ARDOT) provides CIT through an internally developed program by individual Districts to train their staff during the winter. Traditionally, department staff attend CIT, but ARDOT is not opposed to consultant inspectors attending. Noted references for CIT are 1983 AHTD Bridge Construction Inspection Manual (that has valuable information despite being dated), NHI courses such as NHI-132070 Drilled Shaft Foundation Inspection, NHI-132080 Inspection of Mechanically Stabilized Earth (MSE) Walls and Reinforced Soil Slopes, training for Hydrodemolition and Latex Modified Concrete Overlays, and American Concrete Paving Association Precast Concrete Installation seminars.

It is noted that there are challenges associated with taking staff from a jobsite to attend training.

ARDOT does not administer construction inspection certification as there is no agency certification for construction inspection. However, it is the responsibility of the RE and districts to verify that construction inspection staff are appropriately trained for their inspection assignment.

The department is experiencing a shortage of construction inspection staff. To address this shortage and increase attractiveness to the position, ARDOT has implemented hazardous duty pay for work on interstates and geographic pay increases for positions in areas with strong private competition for staffing. ARDOT has utilized consultants to perform construction inspection. The department has utilized construction inspection staff to assist maintenance staff during periods of inclement weather but have not trained maintenance staff to perform construction activities.

DELAWARE

The Delaware Department of Transportation (DelDOT) does not offer CIT or construction inspector certification and relies on in-house inspection staff and consultant groups for construction inspection. To date, DelDOT has not had any construction inspection staff shortages.

GEORGIA

The Georgia Department of Transportation (GDOT) hosts annual group training, advanced group training, and internal self-paced training for CIT, which is open to department staff and consultants. The training focuses on basics of bridge inspection practices and specifications and lessons learned.

The department does not offer construction inspector certification.

INDIANA

The Indiana Department of Transportation (INDOT) provides CIT during winter months, where each District hosts a two-week training course and exam for Bridge Construction and Deck Repair for technician inspectors. The training is basic and if the technician can pass the exam of 70% or better, they get a certificate. Training is only available to department staff, but consultants take the exam to obtain a certification. INDOT has found that experienced staff teaching each section of the training manual is effective but notes that experienced individuals are not always available to teach, many do not have teaching techniques which are effective, and there are challenges with the training curriculum.

INDOT provides a construction inspection training course and exam for all construction inspection staff. The department has developed a certified technician program (CTP) to increase the number of experienced professionals able to perform construction contract inspection. The CTP is comprised of six areas of certification, with each exam lasting 2 hours and 45 minutes. The following are topics of certification; Bridge Construction and Deck Repair; Concrete Paving; Construction Earthworks; Construction Procedures 1; Construction Procedures 2; and Hot Mix Asphalt Paving. Any consultants performing onsite inspection for the department will have a certification on the topic unless they are a licensed professional engineer (PE) or hold a bachelor's degree in engineering or construction management from a regionally accredited university. Inexperienced staff are provided a full training course and experienced staff are provided an exam to determine their ability to perform activities in the field. All staff are to complete a competency evaluation on an annual basis for use of equipment and measurement tools.

INDOT has noted a shortage of construction inspection staff. To address this staffing shortage, INDOT has coordinated with internal staff to determine availability of construction inspection funds to add capacity through additional consultant inspectors and engage workforce development staff to promote construction inspection hiring at statewide hiring events.

NEBRASKA

The Nebraska Department of Transportation (NDOT) assigns CIT by District Construction Engineer to inexperienced staff through an internal training system: standard basic training on construction, contract management, internal process and software, and a bridge plan reading course. Training is only available for department staff. On-the-job training and intentional mentoring have been effective for training construction inspectors.

The department has faced challenges identifying necessary resources, resources needed to develop training, and tracking training. NDOT is targeting material or specialized process training through taking videos taken by department staff from construction sites. NDOT is also looking to develop a mechanism to allow field staff to provide requests for additional training resources. NDOT does not have a formal certification process, but construction inspectors have a high school diploma and previous construction experience is preferred.

Construction inspectors often have multiple roles, including duties in maintenance and snowplow operation. NDOT is experiencing a shortage of construction inspection staff. To address this shortage, the department is actively recruiting and pursuing increasing wages and benefits to attract candidates.

OHIO

The Ohio Department of Transportation has construction inspection training for Highway Technicians that perform this work. Training is only available to Ohio DOT staff. The department has found that training based on in-house developed training books and the department's specifications and standard drawings is effective. The use of Highway Technicians for the dual purpose of maintenance work and inspection has had mixed results. The department is exploring a path forward that would provide better inspection performance than is currently received from this approach. The department is exploring construction inspection training, but this is still under consideration.

Ohio DOT administers construction inspector certification. Inspectors who demonstrate understanding of the specifications and standard drawings and score an 80% or better on a test are put on the Prequalified Construction Inspector List.

The department is experiencing a shortage of construction inspection staff. To address these shortages, Ohio DOT hires consultants, has a program to allow interns to be mentored under a senior consultant, and a college program to encourage individuals to enter inspection jobs. The department also assists retired Ohio DOT employees to transition into a consultant role.

OKLAHOMA

The Oklahoma Department of Transportation offers CIT through classes at Oklahoma State University and the FHWA, open to both department staff and consultant inspectors. The department has found this approach to be effective but notes that additional and regular specific bridge inspection training could be beneficial due to employee turnover.

The department does not offer construction inspector certification.

To address construction inspection staff shortage, the department has utilized consultants, recruiting efforts, and cross-trained maintenance staff.

TENNESSEE

The Tennessee Department of Transportation (TDOT) does not have a formal CIT but does have material acceptance testing. TDOT Materials & Tests Division manages a Technician Training program that includes certifications for aggregate testing, concrete field testing, concrete plant QC, concrete mix design, HMA roadway testing, HMA plant tech, HMA mix design, radiation safety and nuclear gauge, and soils testing. The Construction Division of TDOT published a Construction Inspection Guide and Videos available on-line for all inspectors.

TDOT is experiencing a shortage of construction staff and is addressing this by developing competency programs for both construction and maintenance personnel and utilizing consultants

in various roles throughout the department including inspection and project management on active projects.

The department in the recent past has done some cross-training of staff to work where there is greatest need. Currently, TDOT is undergoing a reorganization and, as part of the worker competency program, will train construction staff to help maintenance during winter weather operations.

TEXAS

The Texas Department of Transportation (TXDOT) provides CIT through an 8-hour classroom training, offered to both department staff and consultants. This training program was part of efforts to establish bridge deck inspection training. TxDOT staff and consultants traveled and administered training to half of the districts in Texas. However, since training is not mandatory in their system (SiteManager[2]), participation by the districts was minimal. It was also determined the 8 hours of classroom training was not an effective method for training field inspectors.

TxDOT has now established the Concrete Bridge Engineering Institute (CBEI), which will have a partially constructed bridge deck and the training program will be formalized with a component of a bridge inspector's training through SiteManager[1]. Training through CBEI will be available to all TxDOT and consultant inspectors and will be managed by the CBEI team (more on CBEI in Chapter 7).

TxDOT does not administer construction inspection certification.

TxDOT notes experiencing a shortage of construction inspection staff and utilizes other department staff (from Construction Engineering Inspection) to address this shortage.

UTAH

The Utah Department of Transportation (UDOT) hosts CIT as part of their Transportation Technician Education Program. Currently the training is for new inspectors (with less than 24 months of experience). It is noted that the training UDOT has created to date is limited and basic in nature. Structures specific training has not been incorporated into UDOT's regular training program; however, more structures specific inspection training is available for crews that have been on more structure-heavy projects. CIT is identified as an area of need for UDOT. UDOT is in the development phase of a higher-level construction training program in which structures training will be a focus.

UDOT administers limited construction inspection certifications. Certified UDOT inspectors must obtain the structural steel fabrication and coating QA inspection certification per UDOT specifications. UDOT offers additional professional development pay (PDP) to these individuals above their salary if the certifications are maintained. This incentivizes them to stay and become experts. UDOT inspector certifications include Certified Welding Inspector, Bridge Coating Inspector, UT Levels 1 and 2, American Society for Nondestructive Testing (ASNT) Mag

[2] Trademarks or product names are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

Particle Level I-II, ASNT Radiographic Film Interpretation/testing Level I-II, ASNT Dye Penetrant Testing Level I/II, and American Galvanizing Association (AGA) Galvanizing Testing. Inspectors should also obtain minimum experience and maintain certifications as a UDOT employee. Increases in the PDP pay occur in steps as they gain experience and certifications.

UDOT is experiencing a shortage of construction inspection staff and has addressed this shortage through pay increases for new hires, training, and supplementing with consultant staff. Additionally, UDOT currently utilizes maintenance staff for construction inspection. It presents many challenges, including adequate time for training and does not allow inspectors to gain adequate time in construction to gain the expertise needed.

VERMONT

The Vermont Agency of Transportation (VTRANS) offers in-person and virtual training for CIT. Training is hosted by both department staff and external trainers with department developed discipline focused inspection tutorials. VTRANS has found this training to be effective. Trainings are offered externally to consultants as resources and capacity allow.

VTRANS does not administer construction inspector certification.

VTRANS is experiencing a shortage of construction inspection staff. To address this shortage, the department has relied on consulting firms. Also, the department has cross-trained maintenance staff on a voluntary basis, but this practice is not widespread.

WISCONSIN

CIT at the Wisconsin Department of Transportation (WisDOT) is a one-day, in-person training made up of modules for site prep/planning, foundations, substructures, superstructures, rehabilitations, etc., available to both in-house staff and consultants. The training is available in two locations throughout the State each spring and then is put on in different locations throughout the State in subsequent years. The training is compressed into one day to accommodate schedules, but it is a race to get through all of the content.

WisDOT notes a challenge to administering the course is instructor (WisDOT in-house staff) availability to have an extended training. Reviewing example projects and questions, in addition to having experienced inspectors weigh in with their experiences, are well received by attendees. Additionally, staff turnover, both in-house and consultant, who are inspecting bridge projects and inspection is common. Also, staff may go years between having a bridge or structure project, so awareness and expertise in structure construction inspection may be lacking. Due to this lack of expertise, a significant burden is put on WisDOT Bureau of Structures staff to assist in resolving issues seen in the field.

WisDOT currently has no specifications on certification for construction inspection on their projects (this is the case for structures construction projects as well), thus WisDOT does not offer construction inspector certification.

To address staffing shortages, WisDOT is trying to 'bundle' construction projects by geographical location to allow inspectors to visit multiple sites in a given day, if possible. Additionally, outreach and recruiting efforts have been increased to try to draw attention to the positive aspects of this career path. WisDOT does utilize consultants to perform construction inspection, as necessary. Staff within the WisDOT Region offices have some cross-training, but the resource shortage is consistent across all facets of the department, so there isn't an overabundance of staff in another area that can easily be shifted into construction. WisDOT does not have maintenance staff that operate snowplows to shift into these roles, as snow plowing in the winters is contracted to the local counties.

CHAPTER 4 - STATUTORY CHANGES TO BUY AMERICA

This chapter summarizes the effects of the statutory changes to the Buy America (BA) program, 23 CFR 635.410 on bridge construction projects. The agencies provided a summary of their experience based on the following questions:

- Impact of the statutory changes to the Buy America (BA) program on construction projects
    - Measures taken to operate within the parameters of the Buy America program

PRESENTATIONS AND DISCUSSIONS

The FHWA provided a presentation on the statutory changes to the BA program. This discussion included changes to BA program, exclusions, guidance, FHWA general waiver for manufactured products, existing general applicability waivers, de minimis costs and small grants waivers, and electronic vehicle waiver. It was also noted that the frequently asked questions (FAQ) section of the BA website is regularly updated, and it is best to visit the website for current responses.

Subsequent discussion between participants suggested that regular DOT outreach to local contractor's associations and similar organizations eased the transition to operating within the BA program.

DESK SCAN INFORMATION

ALABAMA

ALDOT contractors are to provide a certification that the construction materials defined under BA are domestically produced.

ARKANSAS

ARDOT noted that changes to BA have included iron and steel products, which were not previously covered by BA statutes and have had an effect on their construction projects. To operate within the BA parameters, ARDOT has included new special provisions in their Standard Specifications incorporating BA for the items not previously covered.

CALIFORNIA

Caltrans has not had any impacts to bridge work due to the statutory changes to the BA program. Caltrans Engineering Services – Materials Engineering and Testing Services Representatives are awaiting further clarification from the FHWA. To operate within BA, Caltrans anticipates using an Authorized Materials List to verify domestic sources.

DELAWARE

DelDOT notes that implementing BA have increased the cost of projects and delayed projects. Specifically, DelDOT has noted that cooperation from utility companies to BA statutes has been challenging.

GEORGIA

GDOT has noted that statutory changes to BA have impacted projects that include stainless steel and plastic ducts (used in post-tensioning). To operate within BA, GDOT has taken measures to identify affected materials.

INDIANA

INDOT has not noted any impacts or challenges of the BA program on the department's construction projects.

MINNESOTA

MnDOT bridge construction projects have been impacted by the BA program, particularly with stainless materials and products. To operate within the BA parameters, Mn DOT has tracked costs of some items and requested bidders to provide pre-bid notice of any supplier issues.

NEBRASKA

NDOT has not noted any impacts or challenges of the BA program on the department's construction projects.

OHIO

Ohio DOT has not noted any impacts or challenges of the BA program on the department's construction projects.

OKLAHOMA

Oklahoma DOT construction projects have been affected by the statutory changes to BA, noting that the changes to BA changed the emphasis from iron and steel only to manufactured products. Oklahoma DOT has enhanced their measures to achieve compliance with BA.

PENNSYLVANIA

PennDOT has not seen significant impacts to projects stemming from statutory changes to BA. To operate within the BA program, PennDOT has maintained a Bulletin of Qualified Products.

TENNESSEE

TDOT notes that thus far the impact of BA on bridge projects has been minimal. Materials and Testing developed Standard Operating Procedures for furnishing articles, materials, and supply certifications and created a material code list. TDOT has coordinated BA changes with the Tennessee Roadbuilders Association (TRBA) and TDOT staff.

TEXAS

TxDOT has not noted any impacts or challenges of the BA program on the department's construction projects.

UTAH

UDOT has experienced minor impacts to bridge construction projects due to statutory changes to BA. Items to note include application of BA to specific items, and updates to specification and contract documents (and additional updates with each change). The current manufactured products waiver in place has made the updates to BA more manageable. To operate within the parameters of the BA program, UDOT specifications were updated, and a new certification document was created for construction materials. UDOTs authorized product list is being updated to include whether products listed meet Buy America program parameters.

VERMONT

VTRANS has not noted any impacts or challenges of the BA program on the agency's construction projects.

WISCONSIN

WisDOT notes that it has yet to be fully determined to what extent the new BA provisions will affect WisDOT projects, but yes, there have been impacts to construction projects. There are ongoing efforts at WisDOT to understand and implement the statutory changes to the BA program. In some cases, there have been documented delays in projects due to limited supply of certain materials in the United States. WisDOT anticipates challenges implementing changes both as the department works to interpret the change, incorporate these changes into department standard specifications and contract documents, and convey these changes to contractors and project staff. WisDOT anticipates there may be delays as contractors need more time to source materials and project staff need more time to understand and document the changes when implementing BA.

To operate within BA statutes, WisDOT is currently evaluating the list of standard bid items to determine all items that have become subject to BA changes; working to implement these changes in their specifications; and conveying this information to contractors.

CHAPTER 5 - BRIDGE DEMOLITION PRACTICES

This chapter summarizes the participants' approach to bridge demolition practices and projects. The agencies provided a summary of their experience based on the following questions:

- Practices regarding the decision-making process for the demolition of bridge structures (e.g., decision-making matrix, risk assessment, flowcharts, or grading scale)
- Differences in the decision-making process for demolition of bridges between situationally routine or complex bridge structures
- Practices to reduce costs, improve safety, and minimize user impacts

PRESENTATIONS AND DISCUSSIONS

TEXAS

TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges addresses the bridge demolition process. It is noted that project complexity and risk is factored into the expectations of the contractor's engineered demolition plans and noted in the contract documents. To minimize impacts to traffic and increase safety, TxDOT has utilized explosives for bridge demolition. Recently, a segmental bridge was demolished using explosives in the downtown Austin area. The use of explosives was selected to minimize impact to traffic and safety precautions to the public.

It was suggested that when specialty work is being performed (i.e., explosives for demolition), DOTs may want to consider contracting another specialty contractor to review the work plan. This allows for specialty work to be reviewed by competent professionals. Additionally, with some specialty work it is good to have developed contingency plans available in advance of the operation.

DESK SCAN INFORMATION

ALABAMA

For demolition, ALDOT stated the decision-making process for the demolition of bridges is the responsibility of the contractor due to their means and methods. Demolition plans are to be submitted to ALDOT for review and approval.

ARKANSAS

ARDOT indicated that demolition decisions are typically at the behest of the contractor (often a function of maintenance of traffic), unless specific permit processes need to be followed. It is noted that large structure demolitions are generally controlled by USACE (United States Army Corps of Engineers) or USCG (United States Coast Guard) permit process.

CALIFORNIA

Caltrans utilizes a specification for bridge removal work:

- The specification limits the tools that may be used (no explosives, no freely falling mass, no tools with striking energy greater than 1200 ft-lb per blow, etc.).

- The contractor submits a detailed bridge removal work plan for each structure, including calculations for protective covers, signed by an engineer registered in the State of California. The engineer signing the work plan has experience in bridge removal plan design and must be present during removal activities. (Additional Caltrans specifications are in Caltrans Contract Specifications Section 60-2.02A(4)(c).)

- Preconstruction meetings are held for bridge removal work. Attendees include the contractor and Engineer of Record for the bridge removal work plan.

- The specifications also provide design criteria for temporary supports and temporary bracing, stipulations on protective covers, and additional agency specifications for preliminary work.

The Caltrans specification is used for all bridges including complex bridges. Other structure removal (slope paving, minor portions of structures, etc.) may be covered under a separate specification.

Caltrans notes the following additional practices they have implemented to demolish bridges more safely, more economically, and with reduced impact to users:

- The preconstruction meeting was recently added to their standard specifications. The qualifications for the Engineer of Record for the bridge removal work plan have also been expanded recently.

- Bridge removal is considered work that should include 100% inspection by Caltrans, an engineer should be present during the operation, and (among other activities) providing enough barricades in place to effectively restrict access to the site.

- In general, Caltrans reduces impacts to the traveling public as much as possible through ABC methods and by working at night.

DELAWARE

DelDOT does not have a formal decision-making process pertaining to bridge demolition. It is noted that when demolition is occurring over live traffic, bridge demolition is planned for the night to reduce impacts to motorists.

GEORGIA

For bridge structure demolition, GDOT notes that these operations are contractor's means and methods and thus are the responsibility of the contractor.

INDIANA

INDOT indicated that routine demolition is covered by their standard specifications. The contractor is responsible for determining demolition methods for routine structures. INDOT does not determine means and methods. Assumptions are made by the designer for environmental permit applications, but those do not dictate the method. For complex structures, additional information may be provided in the form of a unique provision from the designer.

MINNESOTA

MnDOT bridge demolition plans are specified in special provisions. Contractors submit equipment and methods along with engineering calculations for any falsework or unusual loading on the bridge. The means and methods are the responsibility of the contractor except where superstructures are to be preserved there are limitations on equipment sizes used in demolition.

MnDOT prohibits the use of explosives for bidding purpose unless a specific plan is submitted and the plan adequately addresses all written comments by the Engineer. Limitations such as this are broadcast to semi-annual meetings with Minnesota bridge construction contractor members of the Associated General Contractors, and a collaborative effort with AGC is sought when rolling out both prescriptive and restrictive specifications.

MnDOT utilizes saw cutting and slabbing on superstructures sensitive to impact equipment such as steel girder top flanges less than 7/8" thick or prestressed beams with thin top flanges. Bridge removal by default has complete removal of all concrete, including buried elements. There is a formal environmental process for justifying leaving existing bridge concrete pre-bid when there are engineering justifications for doing so. In those situations, the buried concrete will have as-built record of coordinates and depth.

During discussions, MnDOT expressed concern regarding painting containment on a rehabilitation project. For example, a scenario where a truss is being painted on one side (with containment installed), but open to traffic on the opposite side creating uneven loading during high wind events. Contractors normally don't include this high level of analysis since the work is not structural in nature.

During discussions, MnDOT noted that CMGC (Construction Manager/General Contractor) contracting was beneficial for demolition projects. This arrangement provided good information regarding the equipment and intended demolition methods for the project.

During discussions, MnDOT posed a question regarding damage to components intended to remain in service during other demolition operations and the manner in which this is handled by other agencies. For example, during a re-decking project, the contractor inadvertently damaged a superstructure member which will remain in service. Ohio DOT includes a clause in their contract and specifications that the contractor is to provide the repair solution. WisDOT utilizes on-call preauthorized consultants to design repairs. TxDOT and PennDOT stated that it is the contractor's responsibility to provide a design and implement the corrective solution.

NEBRASKA

For bridge demolition projects, NDOT implements a coordination meeting, focusing on phasing and environmental considerations.

OHIO

For bridge demolition projects, Ohio DOT has a process including an engineered drawing plan performed by an Ohio Registered Engineer (Signatory Engineer). This is followed up by a meeting (the engineer drawing meeting) where the Signatory Engineer and Superintendent discuss the work plan during the meeting. The meeting includes the Project Engineer, Designer of Record, and other stakeholders that reduce the risk. The Project Engineer accepts the plan before proceeding. The process of removal with appropriate details should be part of the stamped plan and the details, dependent on the complexity, and will be reviewed during the meeting. The department has found that the Engineer Drawing Meeting process has allowed the department to perform demolition tasks more safely, economically, and with reduced impacts to users.

During discussions, Ohio DOT stated that including demolition plans has resulted in an improvement in this operation as more topics and the work plan are discussed in meetings. It was also noted that all demolition projects should be assessed with the same level of consideration regardless of the bridge's size or complexity.

OKLAHOMA

Oklahoma DOT does not have a formalized decision-making process regarding the demolition of bridges, but this is currently under consideration. The decision-making considerations are dependent on the type, location, and complexity of the bridge. To demolish bridges more safely, economically, and with reduced impact to users, the Oklahoma DOT noted that thorough PE stamped submissions have been of assistance and more emphasis needs to be considered for methods of removal and inspection.

PENNSYLVANIA

Bridge demolition falls under PennDOT Publication 408, Section 1018. Contractors submit a demolition plan to the Structure Control Engineer (SCE). The SCE reviews and accepts the contractor's plan then holds a pre-demolition meeting with the contractor and field staff to review the plan. The crane operator is to attend the meeting. The contractor's demolition plan is to be signed and sealed by a PE registered in Pennsylvania. Demolition is the same for all structure types; however, PennDOT may utilize consultants for review assistance in more complex scenarios.

TENNESSEE

Regarding bridge demolition, TDOT stated that the contractor is responsible for designing the structure removal and needs to coordinate and receive approval from railroad entities when over rail lines. One practice that has made demolition activities more economical, safer, and with reduced impact to users is allowing roadway closures with weekend around-the-clock work.

UTAH

UDOT bridge demolition is deferred to the contractor's means and methods. The contractor submits a work plan to UDOT. Maintenance of traffic and closure durations are provided to the contractor through the project specifications.

VERMONT

VTRANS utilizes a risk assessment for demolition on each project. A demolition plan should be submitted for any demolition over roads. For demolition of bridges that are not over roads, a demolition plan submittal is typically not included for routine bridges but may be necessary for complex bridges if demolition could present a risk to public safety. Where bridge demolition could present a risk to public safety, the agency includes a pay item for public protection in the contract and includes a demolition plan submittal that is signed and sealed by a PE.

WISCONSIN

WisDOT does not have any processes for bridge demolition/removals on typical projects. The onus and risk are on the contractor through the bid items in the plans. The contractor develops a removal plan, but a review of that plan by WisDOT is not specified. There are spot locations with highly complex sites or structures where special actions are taken by the design team to lay out a removal process, with the contractor having an option to modify it with their final removal plan; however, such instances are rare.

CHAPTER 6 - INNOVATIVE AND UNIQUE MATERIALS

This chapter summarizes the incorporation and challenges associated with implementing innovative and unique materials in bridge construction projects. The agencies provided a summary of their experiences based on the following questions:

- Use of innovative and unique materials (e.g., non-proprietary Ultra-High Performance Concrete [UHPC]) in bridge construction and rehabilitation projects
    - Materials incorporated and steps taken to successfully incorporate innovative and unique materials?
    - Challenges with materials or implementation, and how they were addressed
    - Reasons for not adopting emerging materials?

PRESENTATIONS AND DISCUSSIONS

CALIFORNIA

Caltrans notes the following items for bridge construction projects, regarding innovative and unique materials:

- Caltrans launched UHPC acceptance criteria via an Authorized Materials List database to create an open competition for multiple manufacturers meeting these criteria. Additionally, Caltrans is planning to expand implementation of UHPC for a variety of purposes (e.g., link slab, deck overlay, joint header repair, etc.).

- One of the obstacles is that contractors in California and Caltrans' staff are not completely familiar with UHPC and often want to treat it like conventional concrete. Caltrans Division of Engineering Services (DES) continues to provide educational resources. More education and training will be necessary going forward to avoid errors and mistakes during construction.

- Concrete for concrete bridge decks or Polyester Polymer Concrete (PPC) deck overlays contain polymer fibers to combat early age deck cracking issues. Each cubic yard of concrete contains at least 1 pound of microfibers and at least 3 pounds of microfibers.

- Using Clearcast^2 forms as permanent deck forms to provide visibility to see under the deck. It's noted that this isn't an innovative material but a construction material. At the time of this report, the project was ongoing. When utilizing Clearcast^2 forms, Caltrans instructs designers to consider typical stay-in-place formwork for dead load in the design to allow for flexibility in the formwork used in construction. During discussions, Oklahoma DOT noted use of the Clearcast^2 forms but has not seen this system widely employed throughout their program.

- Employed electrically isolated post-tensioned tendon on one project. This technique provides a greater level of corrosion protection than many other methods and provides the ability to monitor the post-tensioning tendon throughout the structure's service life.

- During discussions, it was noted that Caltrans utilizes a concrete mix design that reaches 4,000 psi in approximately four hours. This product has been utilized for a full-scale bridge deck replacement, replacing 9,000 linear feet of bridge deck in nine days.

DELAWARE

DelDOT has employed the following innovative materials and notes the following benefits and challenges associated with each technique:

- UHPC for ABC projects and deck overlays:
  - Successful implementation in both instances but should be noted this material comes with a cost increase over traditionally used concrete or overlay material.
  - Utilize UHPC in shear key void for adjacent box girder bridges.
- Use of 56-day break strength, Class D bridge deck concrete:
  - Concrete suppliers were providing mixes with significantly greater cement than anticipated, resulting in concrete that is much greater strength than that of the 7-day breaking strength test. It is believed that these mixes provided decks that cracked earlier in the service life of the structure than anticipated. DelDOT is working with concrete suppliers to address this issue.
  - Utilizing the 56-day break strength instead of the 7-day strength has allowed for more flexibility in the mix design and suppliers are providing more reasonable concrete mixes.
- Utilized Phoscrete[2], a concrete repair mix that contains magnesium alumino phosphate concrete for joint headers:
  - Very expensive.
  - Bonds well to a variety of other materials
  - Performs well in a wide range of temperatures.
- Employed URETEK[2], an injection of substrate strengthening material to raise approach slabs:
  - Expensive solution but effective.
  - May not necessarily bring slab to exact desired elevation.
  - Implementation is of a 'proprietary' design nature, with operations being completed and coordinated by the manufacturer/installer.
  - May utilize multiple core holes for 'injection ports.'
  - Soil boring report to be provided for installer's design.

GEORGIA

GDOT responded that the department has not utilized innovative and unique materials but will evaluate and consider implementation of non-proprietary UHPC. Currently, GDOT is using proprietary UHPC mixes for connection pours for full-depth precast panels but are evaluating and researching non-proprietary UHPC research.

GDOT also presented on NCHRP 20-68, Domestic Scan 22-01 entitled "Recent Leading Innovations in the Design, Construction and Materials used for Concrete Bridge Decks". The

objective of the study was to identify lessons learned from construction of bridge deck projects that utilize innovative materials and strategies. Notable findings from the desk scan include (amongst other findings):

- Low paste content, controlled plastic concrete temperature, restricting temperature difference between concrete and adjacent surface, and limiting ambient temperature fluctuations can reduce cracking.
- Shrinkage reducing admixtures are effective.
- Wet curing within minutes of deck finishing is essential.
- Internal curing can be very efficient when quality and conditioning of the aggregate is controlled.
- Fiber reinforcement can be used as an additional measure for crack mitigation. Fiber type, size, amount, and distribution impact the results
- Glass fiber reinforced polymer (GFRP) bars do not corrode, but also do not allow deck replacement or widening.
- The success of concrete in reducing cracking depends equally on the mix and care in placement.
- UHPC:
    - Construction needs for UHPC and normal concrete are very different.
    - UHPC joints between precast deck panels and between panels and girders have generally performed well and have performed like post-tensioned joints.
    - UHPC link slabs have successfully eliminated joints in some States.

OHIO

Ohio DOT has utilized the following innovative and unique materials: Element 5 (E5) admixture for cracking, macro synthetic fibers for crack control (5 lbs per cubic yard), UHPC on some unique precast locations, GFRP Reinforcement, galvanized reinforcement, stainless steel reinforcement, and chromium reinforcement. The department utilizes research and trial projects to work through details and evaluate products.

Recently, Ohio DOT has expanded their use of GFRP bars used in barriers and are still evaluating their use.

PENNSYLVANIA

PennDOT has utilized innovative materials such as UHPC in the longitudinal deck joints for ABC projects and PPC for bridge deck overlays. PennDOT has a New Products and Innovations Section administered by the Central Office Bureau of Construction and Materials. PennDOT is interested in new products for structural overlays. The department has utilized hydro/latex modified concrete (LMC) overlays which is still a viable option, but there is interest in new products. PPC is not considered structural in Pennsylvania.

PennDOT attempted to utilize an Epoxy Polymer Concrete overlay on a bridge deck. However, test patches revealed finishers and crew experienced skin rashes and the contractor elected not to use the product due to the unknown reason for the skin rashes.

TENNESSEE

TDOT incorporates innovate materials through the use of a non-proprietary concrete for ABC closure pours. This concrete mix was found to be beneficial to the department as it can be made by local ready-mix suppliers and is cost effective. This non-proprietary Class X mix design was created, prioritizing cure time over the need for high strength. This mix reached 4,000 psi within 4 hours of cure time. As such, it has largely been used for deck closure pours. When employed for closure pours, TDOT also utilized a thin epoxy overlay for durability and resistance to freeze thaw effects.

It was also noted that a conveyor was used to assist with concrete placement instead of the traditional pump truck to limit the possibility of the concrete setting up within the equipment.

ULTRA-HIGH PERFORMANCE CONCRETE DISCUSSION

UHPC concrete and its use was mentioned multiple times by participants. The conversations are summarized below:

- Pros:
  - Favorable mechanical and durability properties.
  - Reduction of project completion time.
- Cons:
  - Lack of contractor familiarity/treating as conventional concrete.
  - Lack of local producers.
  - Cost per cubic yard is greater than conventional concrete.
  - Proprietary mixes.
  - Additional training, standards, and testing investments before greater acceptance (MnDOT).
  - Forms need to be watertight.
  - Pour high with chimney and top forms, followed by grinding. Timing of grinding operations challenging due to concrete strength (MnDOT).
  - UHPC performance when exposed to fire is being investigated. This consideration is particularly of importance when considering girders made of UHPC (GDOT).
- Discussion:
  - UHPC has been popular in Europe for long time.
  - Important to get a rough surface finish before pouring UHPC.
  - UHPC overlay is more sensitive than conventional concrete and can be susceptible to direct sunlight.
  - Forms need to be watertight. It is effective to test formwork and arrangement with a mockup or water test prior to UHPC placement operations.
  - DelDOT utilizes UHPC in shear key void of adjacent box girder bridges.

DESK SCAN INFORMATION

ALABAMA

ALDOT has utilized UHPC in conjunction with Northeast Extreme Tee (NEXT) beams on one project, greatly reducing the construction time on the bridge. Latex modified concrete overlays along with milling/hydroblasting were used on several maintenance bridge projects to extend the life of the structures. One noted challenge was the utilization of UHPC and the lack of local producers providing the mix. The cost per cubic yard was extremely high due to the producer and materials having to come from out-of-state.

ARKANSAS

ARDOT identified using UHPC and prefabricated (precast concrete) elements in ABC projects. The use of UHPC was still early in construction at the time of this report and thus no additional experience was noted. However, for prefabricated bridge components there have been challenges and issues with quality and the contractor requesting to omit prefabrication and to construct onsite conventionally; this issue is ongoing.

INDIANA

INDOT generally has not incorporated innovative or unique materials but notes that through the use of design and construction memos, INDOT has allowed the use of proprietary UHPC and proprietary E5 materials.

MINNESOTA

MnDOT has utilized innovative materials in bridge projects including a trial project with proprietary UHPC, hybrid anodes, new concrete wearing course mixes, and fiber usage. To accept these techniques more widely, MnDOT states that successful trial projects with follow-up inspection are key to increased usage. Contractor and project staff interviews are conducted to gage suitability for further deployment of technologies. MnDOT also noted a number of implementation issues with their UHPC mix and specification development (noted previously in the UHPC discussion).

NEBRASKA

NDOT has utilized non-proprietary UHPC, elastomeric concrete nosing, and various deck membranes. The department has found it valuable to the project's success to involve consultants or design engineers during construction. The department has faced challenges with implementing these innovative materials and they addressed challenges by identifying the failure cause and modifying the application or material specification for the next attempt. It is noted that the unfavorable climate limits "within specification" condition of many materials and thus limited use of some materials.

OKLAHOMA

The Oklahoma DOT has utilized UHPC, magnesium-alumino-liquid phosphate (MALP) concrete, elastomeric coating (i.e., CIM Industries 1000[1] liquid-applied urethane coating), stainless steel bearings, alternate reinforcing, innovative concrete mix designs, and internal curing for innovative and unique materials. The department has faced challenges and utilized education to gain acceptance of these materials.

TEXAS

TxDOT innovative material use includes UHPC for closure pours during ABC bridge construction on a very limited basis. TxDOT bridge division provided expertise and oversight to assist the district inspectors. Implementation of this material in the manner described was found to be successful.

UTAH

Regarding incorporating innovative and unique materials, UDOT has completed two pilot projects incorporating UHPC. One project was a bridge deck replacement using UHPC as the connection between full depth precast deck panels. The other project was completed using UHPC for deck repairs. Both projects were very successful. UDOT is currently working on a research project that is focused on non-proprietary UHPC mix using Utah-based material sources. This work is ongoing but has been challenging. Additionally, confidence in the mix, material testing needs, and inspection support for these materials is a challenge.

VERMONT

VTRANS has incorporated use of innovative materials into their projects by way of incorporating proprietary UHPC. VTRANS noted challenges with UHPC including high material costs, contractor push back due to working with new material, and coordination with out-of-state subcontractor that has caused delays.

WISCONSIN

WisDOT has mainly utilized innovative delivery and design processes to accelerate construction, more so than materials to date. Precast elements, geosynthetic reinforced soil-integrated bridge System (GRS-IBS) abutments, bridge slides, self-propelled modular transporters (SPMT), etc., have all been used on WisDOT projects in the past. Rapid setting materials and high strength materials have been used on WisDOT projects as well. Additionally, alternative bridge types have been utilized recently (InQuik[1] bridge system, press brake steel tub girders, etc.).

WisDOT is currently starting a research project in conjunction with Minnesota DOT to develop a non-proprietary UHPC mix that fabricators can use locally. That research is expected to take place over the coming 1-2 years.

WisDOT's greatest challenge to utilizing innovative materials on projects is due to staffing/resourcing shortages. In order to continue to deliver the program, it is difficult to fit in

time and identify staff that are able to do the research necessary to identify all of the pros/cons, implementation challenges, etc.

CHAPTER 7 - ACCELERATED BRIDGE CONSTRUCTION IMPLEMENTATION

This chapter summarizes implementation of accelerated bridge construction (ABC) techniques for bridge construction projects. The agencies provided a summary of their experience based on the following topics:

- Accelerated Bridge Construction (ABC) methods (e.g., SPMTs, sliding, launching, precast components, innovative contracting methods, construction incentives, or innovative techniques) on new construction, rehabilitation, repair, or preservation
- ABC decision-making process to systematically evaluate the suitability of future projects for a specific ABC method

PRESENTATIONS AND DISCUSSIONS

CALIFORNIA

Caltrans notes the following items for ABC methods and implementation:

- Techniques
    - Prefabricated Bridge Elements & Systems
    - Temporary Bridge
    - Incremental Launch
    - Lateral Slide
    - SPMT
    - UHPC
- Caltrans DES keeps track of lessons learned from pilot projects built for the first time in the State and applies those lessons to new projects. As a result, a majority of Caltrans ABC projects have been recognized nationally.
- For instance, Echo Summit Sidehill Viaduct project on Highway 50 towards Lake Tahoe received 2021 America's Transportation Award – Best use of technology and innovation in the small project category.
- All of the Caltrans ABC projects have a minimum of two occurrences for each ABC method; meaning, successful implementation and lessons learned. In addition to actual projects, DES also manages three ongoing Caltrans-funded research projects with Iowa State University on various applications of UHPC as part of expanding its knowledge of ABC methods and innovation.

Caltrans has systematically approached the decision making for employment of ABC techniques. Caltrans launched its first edition of its ABC Manual in 2021. Section § 3.1.4 of this manual includes detailed ABC decision making guidance. The ABC Decision Making Guidance is comprised of the ABC Design Impact Questionnaire, the Description of Terms in ABC Design Impact Questionnaire, and the ABC Decision Making Flow Chart. These documents can be downloaded from the Caltrans ABC Decision Making Guidance webpage.

The ABC Design Impact Questionnaire is a qualitative assessment of how ABC methods may reduce or minimize construction impacts on the overall project. The questionnaire allows for the consideration of a project's direct and indirect costs not usually included in an engineering estimate, such as the construction related impacts on the travelling public, economy, environment, and safety. Each question in the ABC Design Impact Questionnaire is further described in Table 3.1.4-1 of the Caltrans ABC Manual.

The questionnaire is to be completed by the project engineer in cooperation with the technical liaison engineer, the district project engineer, and the project development team. The district project engineer is often the best and most effective way to gather input from the project development team. When all the questions are scored for relevance and priority, individual question scores are calculated and then summed to get the project's ABC rating. The ABC rating is then used to enter the ABC decision flow chart. Through a series of questions that are scored based on relevance and priority, the flow chart will help the user to determine whether an ABC alternative should be developed for comparison with conventional construction alternatives. The ultimate decision to advance an ABC alternative further into the project development process will be made by the district.

MINNESOTA

MnDOT has a formal ABC technique vetting process and has utilized a variety of ABC methods in bridge construction.

MnDOT employs a 3-stage vetting process. The first stage is an automated screening tool based on bridge inventory data that classifies any existing bridge as worthy of consideration for ABC techniques during rehabilitation or replacement. The second stage is a questionnaire that walks though site-specific considerations such as detour, importance, etc. The third stage is investigating any techniques identified in Stage 2 more fully for time savings, risk and cost ramifications. MnDOT has utilized SPMTs, sliding, launching, precast components, innovative contracting methods, and construction incentives for ABC techniques. Most projects were considered successful and would be acceptable for use on future projects if the project warrants an ABC technique. They all came at a high cost which has not been applied at scale to reduce the technology hurdles.

MnDOT noted the following lessons learned: project manager ownership of the project is critical for success, involve subject matter experts early in the project, plan for staff turnover, and use paid mockups. Having a bid item for a mockup was found to be beneficial to a project as it creates an opportunity for the contractor to practice particular construction or installation techniques successfully (prior to final installation). The mockup bid item is compensable and thus satisfactory completion of the mockup is enforceable by the DOT. In many cases the mockup serves to teach both MnDOT staff and the contractor for mutual benefit.

During discussions, other departments also noted the successful use of mockup bid-items in projects.

UTAH

UDOT has widely accepted ABC methods and ABC techniques are regularly employed. UDOT maintains ABC lessons learned reports, project highlights, Structures Design and Detailing Manual, working standards drawings, structures design drawings, sample sheets drawings, various checklist tools, and a decision making flowchart on the UDOT Structures and Geotechnical Guidance and Manuals website (see the section titled Accelerated Bridge Construction (ABC) Information).

DESK SCAN INFORMATION

ALABAMA

ALDOT has utilized a sliding bridge method, precast components, segmental construction and incentive/disincentive contracting on several projects. These projects were noted to be successful and would be acceptable for use on future projects, but implementing these measures come with a cost premium. Therefore, these noted ABC techniques have not been employed on a wider basis.

ARKANSAS

ARDOT has utilized prefabricated bridge modules and completed two lateral bridge slide projects. To date, the project utilizing prefabricated bridge elements (which also utilizes UHPC) is underway and has experienced issues with prefabrication of modules. The lateral bridge slides were both successful and would be considered again.

DELAWARE

DelDOT has utilized precast components including substructure components (abutments, pier columns and caps, piles), decks using precast panels with UHPC, innovative contracting methods, and construction incentives/disincentives for ABC techniques. DelDOT has completed multiple bridge projects utilizing ABC and will continue to do so where it makes sense to shorten construction durations and limit traffic impacts to the public.

During discussions, a question was posed: "how fast is fast enough?" for a project. It was noted that the fastest project is not necessarily the best solution when considering all factors. DelDOT noted that public perception also effects the project's success and suggested outreach to the community will help inform the desired approach and thus the desired duration of project completion. For example, DelDOT solicited the community to consider either a 30-month project that would entail traveling on a direct route to a beach through construction zones, or a 30-day road closure in which there would be a detour and thus a longer route to this beach. The public overwhelmingly selected the 30-month option as the desirable solution.

GEORGIA

GDOT has utilized self-propelled-modular-transporters, UHPC connection pours, deck beams, precast components, and innovative contracting methods for ABC methods. The department has an excel sheet used in a formalized decision-making process to systematically evaluate suitability of projects for ABC methods.

INDIANA

INDOT has utilized the following ABC techniques: lateral slide, NEXT beams, precast substructure and superstructure components, and A+B contracting methods, but notes that ABC methods are still generally considered experimental, and research-based at this time.

NEBRASKA

NDOT has utilized precast components and contractual incentives as ABC techniques. NDOT found their use to be successfully implemented in practice and would consider their use on future projects. Full-depth precast is available for use but geosynthetic reinforced soil abutments are rarely used. NDOT is currently developing a two-phase process to identify project application and complete a cost/benefit analysis for considering ABC techniques on a project.

OHIO

Ohio DOT has utilized the following ABC techniques: A+B contracting, incentive/disincentive contracting, window contracts, design build, launching, sliding into place, and precast components (e.g., precast deck). These techniques generally have been successful and acceptable for use on future products with the exception of precast products. With precast products, there have been mixed results with fit-up and quality issues.

For implementation on a wider basis, Ohio DOT has a proposal note for Work Day Contracts, I/D Contract, Quick Completion Incentive, A+B Bidding, Lane Value Contract, Design Build, and others. There are also Alternative Project Delivery Staff dedicated to these efforts. Ohio DOT considers the use of ABC during the scoping process of the project.

OKLAHOMA

Oklahoma DOT has used SPMT, sliding, precast decks, prefabricated bridge elements, UHPC, and construction incentives as ABC techniques in their bridge construction projects. The department notes that these projects and thus these ABC techniques were considered successful and acceptable for use on future projects, but their implementation is not widespread.

PENNSYLVANIA

PennDOT has utilized ABC methods such as precast modules or components, bridge slides, SPMTs, and accelerated components or materials (used, for example, to accelerate expansion dam replacement or LMC overlays). ABC techniques are considered on all projects, particularly in urban regions with high average daily traffic roads and areas where a detour may be excessive.

TENNESSEE

TDOT ABC techniques employed consist of SPMT of bridge components and partial spans, precast bridge elements including beams, deck panels, and abutment elements, and bridge slides. Additionally, ABC delivery methods employed include projects with CMGC and Design Build.

The projects utilizing ABC techniques have been successful and these techniques would be acceptable for use on future projects.

The decision-making process for ABC projects is an informal review during project planning, but ABC methods are considered for all projects in urban or rural locations with consideration given to traffic, detour length, or other site-specific factors.

During discussions, TDOT noted that some suppliers are no longer working nights or weekends and thus project costs are increasing, and there may be other challenges associated with completing a project at an accelerated pace.

TEXAS

For ABC bridge construction, TxDOT has utilized SPMT, precast components, and innovative contracting methods and incentives. These methods have been successful and would be considered acceptable for use on future projects. Implementation of ABC techniques is considered on a case-by-case basis.

VERMONT

For ABC bridge construction, VTRANS has implemented lateral slide precast components (including prefabricated bridge units consisting of a pair of steel girders and concrete deck fabricated off site and joined with closure pours), CMGC contracting, and construction incentive/disincentive contracting.

These techniques have been successfully employed and VTRANS has implemented ABC methods on a wide basis.

WISCONSIN

For ABC bridge construction, WisDOT has utilized precast elements, bridge slides, SPMT's, GRS-IBS, and design build contracts for bridge construction projects. The projects utilizing the ABC techniques were successful (to varying degrees) and would be considered for use on future WisDOT projects. The consideration of ABC methods has been standardized in the WisDOT Bridge Manual and Standards, Section 7.2, and uses a decision-making matrix and flow chart to evaluate if ABC methods are appropriate for a particular project.

CHAPTER 8 - CONSTRUCTABILITY REVIEWS

This chapter provides department practices pertaining to constructability reviews (CR) for bridge construction projects. The agencies provided a summary of their experience based on the following topics:

- Constructability reviews on new construction, replacement, widening, rehabilitation, repair and retrofit projects including:
    - Personnel resource: agency-staff or consultants
    - Criterion for projects to undergo a review
    - Standard policy or procedure for review

PRESENTATIONS AND DISCUSSIONS

CALIFORNIA

Caltrans completes CR in-house, with some limited use of consultants. For project selection for CR, pursuant to Project Directive (PD-05), Constructability Reviews are an integral part of project delivery and are performed on all major projects on the State Highway System that exceed the Minor A limit as defined by the California Transportation Commission. Constructability Reviews are completed for all projects and at the following four checkpoints: Advance Planning Study, Type Selection, Unchecked Details, and Draft Structure Plans, Specifications & Estimate. Exceptions at these checkpoints may be made based on project specific situations as determined by the Bridge Design Office Chief and/or Branch Chief. Additional constructability reviews may be requested throughout the project development process and should be expected for more complicated projects. Additionally, reviews at Unchecked Details are not necessary for Minor Projects including deck rehabilitation, joint seal replacement, approach slab, and barrier upgrades (except for widenings).

DES has established a Constructability Review Process and Procedures. The process gives SC division and other functional units, such as Geotechnical Services and Structure Hydraulics, the opportunity to take an active role in the quality of the final Structure Plans, Specifications, and Estimates as it is developed. The process includes specific procedures for a collaborative, real time, and transparent shared review session by which reviewers are requested to review project documents (plans, specifications, etc.) make comments, and provide responses. Additionally, the procedures specify the primary focus of each reviewer at each check point. Not only does a shared review session allow for constructability feedback to be incorporated into all projects without impacting their timely delivery but the review also provides other functional units the opportunity to incorporate suggestions into their respective functional deliverables (hydraulic reports, foundation reports, specifications etc.).

PENNSYLVANIA

PennDOT completes CR on projects. Many PennDOT districts have a full-time position for a Constructability Review Manager, Construction Scheduler, and an Assistant Constructability Engineer.

Constructability reviews are performed by department personnel or consultants, depending on the project. Consultant-designed local municipality-owned or state-owned projects typically have consultant constructability reviews with department concurrence of the review. Department designed projects typically are reviewed by the district's staff.

Early in the design process, typically at or before the start of preliminary engineering, the district's constructability review manager will attend the scoping field view meeting where the designer's intentions on what work is to occur are given. Constructability efforts are then suggested for various stages in the project's development (typically 30% in preliminary engineering, 60% and 90% in final design) based on factors such as the project location, complexity of the proposed scope of work, anticipated traffic phasing/work zone measures, utility impacts, public involvement, anticipated duration of project, etc. Depending on project complexity, reviews may also be performed with a constructability meeting. Consultant-reviewed projects have their constructability reviews submitted to the department for concurrence and confirmation that a quality review has been performed. Most projects will receive a 90% constructability review prior to advertisement with the exception being simple highway safety improvement projects such as guiderail or interstate line painting contracts, at the discretion of the Constructability Review Manager. It is noted that one goal of the CR is to check that early project assumptions are confirmed and applicable to the project. Additionally, another goal of a CR is the confirmation that the selected foundation type is appropriate.

PENNDOT Publication 10X, Design Manual 1X, Appendix N outlines the agency specifications and expectations of a Constructability Review as well as what needs to be established to develop an internal Constructability Review Standard. Such review areas include temporary construction easements versus right-of-way acquisition, plans and specification review, construction schedule development/review, material types/availability, traffic control restrictions versus working conditions for the contractor, site constraints, utility involvement, complex demolition and erection plan review, etc. Appendix N provides a general workflow for items to be checked during a constructability review. Additionally, PennDOT uses a District Executive Memorandum (DEM006C - Constructability Review Process) that is updated periodically to set forth criteria on how/when constructability reviews are to be performed, documented, and submitted. Many districts also adopt best practices from lessons learned or input from design and field staff (note that districts maintain a best-practices document).

It is also noted that after-action reviews are completed after each project and best-practice takeaways are documented.

Additionally, PennDOT CR considers maintenance activities. The maintenance staff are aware of projects being developed and maintenance activities are attempted to be scheduled to occur simultaneously within a closure for a project, as applicable.

TENNESSEE

TDOT performs CR on select projects and has developed a review manual entitled Constructability Review Procedures Manual. Department staff host the review with consultants involved in project development in attendance. Department staff host meetings where typically three contractors (individually) are invited to comment on the project. Design consultants are at the meeting if they are involved with the design process. Projects considered for review are:

- Projects with unusual or critical construction sequencing.
- Projects with critical traffic control, especially in the 4 major urban areas.
- Projects where utilities may impact construction phasing and scheduled completion.
- Projects where retaining walls, structures, and grading are a major design component.
- Any project that may benefit from the experience provided by outside resources.

It is noted that this process is best when completed early in the project.

DESK SCAN INFORMATION

ALABAMA

ALDOT Construction Bureau performs constructability reviews of all projects let to contract by ALDOT. This is performed in house and by a consultant who has vast experience of bridge and roadway construction. ALDOT Construction Bureau provides a standardized review of all plans let to contract and supporting documentation (e.g., foundation reports, materials reports, etc.).

ARKANSAS

ARDOT Construction Staff Engineers and RE office staff routinely review project plans prior to construction and comment to Design on constructability, but there is no formal criteria or procedure for such reviews.

DELAWARE

DelDOT does not have a standardized policy or procedure for CR, but projects undergo a CR, selected on a case-by-case basis. CR for project design by a consultant are completed by the consultant. For more complex projects, DelDOT may engage an independent consultant to perform a CR.

GEORGIA

GDOT indicated that projects undergo CR as part of plan development. GDOT has a template of topics and questions utilized for CR and both department staff and consultants perform reviews.

INDIANA

INDOT completes a CR on all projects, utilizing both in-house staff and consultants to complete the review. The formal process includes INDOT construction engineers completing project reviews with construction inspection staff that will work on the project to determine what best practices can be used in the design review phase. This occurs prior to the project being advertised and the construction schedule is made at that time.

MINNESOTA

MnDOT performs CR on projects that show unique challenges, such as site access, new technology or staging complexity. While department staff or consultants may perform the CR, it is usually completed by MnDOT staff. MnDOT formalizes a contractor constructability review when there are significant unknown risks of project complexity or uniqueness to gain insight into packaging an appealing job. Schedule risk is a frequent conversation topic.

During discussions, MnDOT noted that engaging contractors early and soliciting feedback has been a beneficial practice. MnDOT also noted that, for example, it may take the State four years to develop a project, yet the contractor is given three months to provide a quality bid.

NEBRASKA

NDOT completes CR using both in-house staff and consultants. There are no formalized processes, but NDOT staff determine the complexity significance and constraints (i.e., environmental considerations, schedule consideration, etc.) for the project.

OHIO

Ohio DOT performs CR on all projects. District Staff (usually the Construction Area Engineer) review plans during the design process for constructability. The Area Engineer may designate another Engineer to perform the review. Group reviews are common for larger or more complicated projects. A final review is performed on each project by the District Construction Engineer and Staff (per Ohio Construction and Materials Specifications 109.12).

There were also discussions seeking information if any participant had a process during a design-bid-build project's advertisement to consider alternatives and share cost savings with the contractor (rather than rely on the value engineering process). Ohio DOT noted that they tried using an alternative technical concept process for design-bid-build projects, but it was unsuccessful as the suggestions proposed during this process greatly changed the bridge design.

OKLAHOMA

Oklahoma DOT performs CR on all projects and utilizes both in-house and consultant staff for reviews. All projects undergo a constructability review throughout the design process with design and field personnel. Some projects have additional reviews depending on location and size. The standard review process occurs throughout the design process with design and/or field personnel at individual meetings, depending on the project. Certain projects due to location and

size have additional personnel perform constructability reviews. All projects valued at $35-million or greater go through a specific CR and value engineering review.

TEXAS

TxDOT performs CR utilizing department-staff. Project plans are reviewed through the preliminary bridge layout review process. Reviews typically occur at the project's 30-60-90% stages.

UTAH

UDOT performs CR utilizing both in-house staff as well as consultants. In more recent years UDOT has utilized more consultant staff where the construction expertise is declining within the department.

VERMONT

All VTRANS projects undergo a CR, typically when preliminary plans are complete. The review is circulated to several sections within the department, with each section focusing their review on their specific discipline. CR are performed by VTRANS staff and consultant staff with extensive construction experience are often used on moderate to complex projects.

WISCONSIN

WisDOT performs CR on bridge projects, but there is not a standard policy or procedure identifying projects for a review. Generally, a review is called for by the project team when there are elements of a project that are unclear on how they will be handled by the contractor. These reviews, when called for as a part of project (which typically occurs on larger or complex projects only), are completed by committee. The committees are generally made up of in-house, consultant, and contractor staff to gauge all perspectives and areas of expertise.

CHAPTER 9 - REPAIR AND REHABILITATION

This chapter summarizes policies and procedures for bridge repair and rehabilitation construction projects. The agencies provided a summary of their experience based on the following topics:

- Specific policies and procedures the agency employed to deliver the successful repair and rehabilitation of bridges in the following areas, perhaps varying from the methods for delivery of new structures:
    - Plans, specifications, and estimate (PS&E)
    - Department construction specifications and special provisions
    - Working drawings and submittals
    - Other aspects relating to repair and rehabilitation

PRESENTATIONS AND DISCUSSIONS

ARKANSAS

ARDOT has an extensive bridge deck preservation program using department hydrodemolition and latex modified concrete overlay specifications, polymer overlay specification, and bridge deck repair specifications for each type of overlay. Per the specifications, the contractor experience statements, and work plans are provided to the department to demonstrate knowledge and experience with the preservation work. Additionally, ARDOT has standard drawings for hydrodemolition and latex modified concrete overlay of bridge decks, joint repairs and modification, and backwall repairs.

The department attempted to combine polymer and LMC overlay work, however, it was found that the contractors did not work well together.

For bidding purposes of LMC overlay projects, the department typically specifies a specific amount of deck removal and replacement. After hydrodemolition, the deck is chain-dragged to identify any deficient areas, which are then removed and the replaced material is paid for based on actual quantity replaced.

ARDOT also has significant in-house capabilities for epoxy polymer overlays and utilizes these crews extensively throughout its program.

INDIANA

INDOT did not identify any differences between delivery of new projects and repair and rehabilitation projects.

INDOT and KYTC presented on the ongoing Sherman-Minton Bridge rehabilitation project.

- The Sherman-Minton bridge is a twin arch bridge, built in 1962 (6 lanes, each span is 800’).

- Structure is currently undergoing a major rehabilitation, including replacement of hangers and deck, overlay approaches, structural repairs, and painting.
- Design-build best-value contracting used.
- Kentucky approach pre-construction inspection performed, consisting of 'hands-on' of all primary members to confirm location of steel repairs, measurements of steel member deterioration, stability, etc.
- An approach span experienced anchor bolt failure and bearing uplift during the rehabilitation project.
- The span was stabilized through installation of a temporary post-tensioned hold-down system. A monitoring system was also installed.
- This failure resulted in a 16-day total closure of the lower and upper decks, and an additional 11 days with restricted lanes.
- It was noted that engineering plans should follow the load to the foundation for every construction phase, confirm bearing uplift does not occur during construction stages, consider utilizing temporary shoring, cost of monitoring included in the bid items, review specifications such as AASHTO Load and Resistance Factor Design Bridge Construction Specifications[3] Chapter 2.3.3 on Partial Removal of Structures, Manual for Refined Analysis for Bridge Design and Evaluation, and internal processes.
- It was suggested that an opportunity for advancement of the industry is to specify nondestructive testing of anchor bolts during routine inspections.
- Another opportunity suggested for industry advancement is to advance the accuracy of anchor bolt testing. There are currently no procedures to test anchor bolts or pins and there are inconsistent/inaccurate results in nondestructive testing methods. INDOT suggested that consistent training and procedures may address these issues.

TEXAS

For repair and rehabilitation, contractors should follow the TxDOT Concrete Repair Manual for proper execution of structure repairs. Material representatives are to be on site, so manufacturer's suggested practices are followed.

TxDOT Bridge Division has a sample set of working drawings on the Bridge Standards webpage, to assist in detailing effort and to have consistency in design and notes across Texas.

DESK SCAN INFORMATION

ALABAMA

For bridge repair and rehabilitation projects, reviews at 60% PS&E plans done by ALDOT Bridge, Design Bureaus. Construction specifications and special provisions are reviewed at 95% for constructability, specifications, special provisions, and overall plan quality by ALDOT Construction Bureau staff. Additionally, all working drawings for a bridge repair and

[3] AASHTO LRFD Bridge Construction Specifications, 4th Edition (2017) is incorporated by reference at 23 CFR 625.4(d)(1)(iv).

rehabilitation project are reviewed for correctness and distributed by ALDOT Construction Bureau staff.

CALIFORNIA

Caltrans has developed the following policies and procedures for repair and rehabilitation of bridges:

- Plans for bridge rehab projects are somewhat more streamlined than plans for new structures, with slightly different detailing standards. Multiple bridges are shown on one General Plan (vs. standalone plan sets for each new structure).
- Bid items and specifications are very standardized for most bridge rehab work. A high volume of projects every year gives the department good cost data.
- Caltrans is also moving towards using Job Order Contracting as a method of delivery for maintenance work.
- Specifications and bid items for bridge maintenance work is standardized.
- The Standard Specs contain language for most necessary submittals.
- Submittals include work plans for: chip seal removals, methacrylate, and deck overlays.
- Shop drawing submittals for some work like heat-straightening damaged steel girders.
- Public safety plans are submitted for methacrylate work within 100-ft of a public space, business, or residence.
- Nearly all bridge maintenance projects are developed by four specialized design branches within Structure Maintenance and Investigation. This creates a more consistent product.

DELAWARE

DelDOT bridge repair and rehabilitation projects undergo the same process as the new construction of a bridge. There are preliminary, semi-final, and final plans developed. DelDOT has developed checklists and project development processes for designers in each project phase, which can be found on DelDOT's Design Resource Center website.

GEORGIA

For repair and rehabilitation of bridge projects, GDOT noted coordination and estimates on traffic management in PS&E, and consideration of constructability on working drawings and submittals.

MINNESOTA

For bridge repair and rehabilitation projects, MnDOT varies from the delivery of a new structure by shortening repair plan delivery schedules, on occasion using photos in plans and specifications, use of drawings within special provision boiler plate specs to standardize deck repair types, early materials contracts, use of stockpiled or salvaged bridge materials, color rebar plans, using drone-imaged bridge viewpoints with markups on the 2D drawing to communicate

defects and repair type locations, use of paid mockups when repair concept is not fully vetted, and listing of products deemed acceptable or equivalent criteria in lieu of an approved product database.

For temporary shoring, MnDOT has worked with contractors to develop bid items and specifications that presented reduced submittal and engineering efforts where the risk was lower. A matrix of shoring types was developed that categorized shoring according to complexity and risk, and accordingly amplified the specified submittal.

NEBRASKA

For bridge rehabilitation and retrofit projects, NDOT is working to utilize modeling to support isometric drawings, cut-away sections, and 3D PDFs to be used as contract plans in the bridge rehabilitation and retrofit projects.

OHIO

Ohio DOT bridge rehabilitation and retrofit projects utilize details from the Ohio Bridge Design Manual for PS&E. Additionally, the department uses their Construction and Material Specifications (C&MS), which is updated quarterly.

For working drawings and submittals, Ohio DOT conducts engineer drawing meetings on designated working drawings. C&MS 501.05 includes specifications for demolition, erection, cofferdams and excavation bracing, falsework, jacking and temporary supports, and construction loading on structures.

OKLAHOMA

Oklahoma DOT did not identify any differences from delivery of new projects and repair and rehabilitation projects.

PENNSYLVANIA

For items specific to bridge repair and rehabilitation projects, PennDOT uses the current standard construction specifications, Publication 408. This document has been updated to include information from best practices and special provisions used throughout the State to construction standard items and drawings.

TENNESSEE

TDOT bridge rehabilitation and retrofit projects include a traffic management plan with traffic control plan sheets. Specifications for repair and retrofit projects allow for performance-engineered concrete, the maturity method for strength of concrete, and Special Provision 604FRP for fiber reinforced polymer material.

UTAH

UDOT approaches bridge repair and rehabilitation through specific items in the Structures Design and Detailing Manual, sample sheets drawings, working standard drawings, plan sheet and situation and layout plan checklists, and UDOT specifications. This information can be found on the UDOT Structures and Geotechnical Guidance and Manuals website in the 'Preservation' section.

VERMONT

VTRANS utilizes the same delivery mechanism for bridge repair and rehabilitation projects as with new structures (regarding PS&E, specifications, special provisions, working drawings, submittals, etc.). However, Indefinite Delivery/Indefinite Quantity is typically used for minor to moderate rehabilitation projects.

WISCONSIN

WisDOT reported no difference in the PS&E documents, specifications, special provisions, working or working drawings for the design, letting, awarding, and construction of structures rehabilitation projects as compared to new structures.

CHAPTER 10 - OTHER CONSTRUCTION ISSUES

This chapter summarizes prevalent, reoccurring, or other issues pertaining to bridge construction projects. The agencies provided a summary of their experience based on the following topics:

- Major or prevalent construction issues or incidents including results of root cause investigations, lessons learned, measures taken to prevent future issues or incidents
- Other significant or reoccurring construction issues
- Other construction issues that could benefit other agencies (e.g., regional approved product list)

PRESENTATIONS AND DISCUSSIONS

ARKANSAS

ARDOT has encouraged the use of advance materials estimates/stockpiles to secure materials at bid prices/quotes before materials are needed on the project. Due to price fluctuations for asphalt binder and fuel, the department has implemented a price indexing system for these products in order to pay actual costs for the project. From discussions at the peer exchange, it was noted that this practice has been successfully implemented to alleviate contractor's from needing to minimize risk and bidding with high fuel prices and in some instances, resulted in a cost savings for the department.

ARDOT has also developed a process to analyze claims for schedule impacts due to unusually wet weather by using National Oceanic and Atmospheric historical data versus local weather station data (near the project). During a presentation on this at the peer exchange, it was noted that in comparing historical data and recent rainfall information, the department can assess the validity of the wet weather claim with data.

GROUP DISCUSSION

During discussions of rising costs, most participants stated the same sentiments that there is little that can be done to address rising costs and inflation. Many participants noted using current cost information and adjusting project estimates to reflect the most current information available (Caltrans, DelDOT, GDOT, NDOT, PennDOT, Oklahoma DOT, UDOT, and WisDOT).

TDOT noted that quarterly meetings with the local contractor's association helped the department remain aware of current costs and issues (like long lead time items).

It was mentioned that some may consider advertising a steel and a concrete (superstructure) option for projects to allow for more competitive bids, considering the market at bid time. TxDOT and ARDOT stated that they have done this in the past in rare instances, but it is not a common practice, noting that this approach necessitates more design resources. Other participants noted that they are not interested in pursuing this approach in general as a means to address rising costs and inflation.

PennDOT expanded use of provisions allowing for purchase and payment for longer lead time items (prestressed beams, precast units, steel beams, light poles, etc.).

DelDOT allows for early work packages on CMGC projects on items with longer lead times.

It was also noted that inspection consideration should be given to bridge items that are under water for extended periods, but the conditions don't necessarily identify these elements as an underwater inspection (i.e., the water is present intermittently or is shallow). While many factors may indicate that these elements typically do not necessitate an underwater inspection, if water is regularly present, the component should be inspected and assessed by some means as the water may be hiding portions of elements that should be assessed. This may consist of identifying the elements to have an underwater inspection or to have an additional inspection or assessment occur when the water level has receded (or potentially during an extended dry-weather period).

Additional prevalent construction issues discussed were:

- Early-age cracking of concrete decks:
    - UDOT has ongoing research to optimize mix design. This project consists of testing existing bridge decks, crack mapping, and analysis of mix designs for 14 structures. For new deck installation, this project consists of employing various mix designs (including lowering cementitious material), verifying wet cure techniques are employed, trying various rebar cover depths, and monitoring performance and condition of these decks.
    - UDOT emphasized the importance of getting the wet cure for the specified duration to minimize early age deck cracking.
    - DelDOT consulted with FHWA and concrete suppliers and have switched from 7-day to 14-day wet cure and so far, no cracking.
    - There were discussions regarding the fiber size to be used in deck concrete mix to help reduce cracking, but there was no consensus in the discussion regarding a best practice.
    - Ohio DOT noted that using the E5 admixture for mitigating deck cracking is still being evaluated.
    - PennDOT noted the department has staff available to conduct the pre-deck placement meeting, check the cure method, burlap placement, etc. Inspector-in-charge on-site may not be familiar with deck placement, so PennDOT tries to include staff experienced with deck placement and curing operations to assist during these operations.
    - DelDOT Bridge Maintenance and Construction unit provides support to construction staff during deck placement.
    - It was noted that early-age deck cracking is a durability concern, not a strength concern. It was also noted that Caltrans applies Methyl Methacrylate (MMA) on a 10-year cycle to address cracking.
    - PennDOT utilizes double burlap with no plastic practices for the 14-day wet cure. After water curing for 14 days, a penetrating sealer is used at 28 days. The liquid membrane that is added after the 14 days is like wax and there is no penetration.

PennDOT experience has shown linseed oil is an effective sealer and uses a 5-year system.

  - PennDOT noted that they have utilized Bidwell to train individuals on screed usage. This practice has facilitated good understanding of the screed and associated equipment use and potential issues.
  - DelDOT is open to considering an additional 7 days of cure time and implementation of cure practices (to make it to 14-days or wet cure) over the use of MMA. Applied to a bridge deck, MMA highlights the cracking and yields poor public perception.
  - GDOT noted there are challenges in design intent being realized in the field. It was suggested that designers who have spent time in the field or in construction are more well-rounded and provide better designs. Caltrans added that their designers spend time in the construction division, and therefore provide more practical designs, better details, and can assist for construction inspection.
- Work zone intrusion incidents:
  - PennDOT noted an incident in which a worker was stuck by a vehicle entering the work zone; just having barrels/channels is not enough and they have successfully used zipper barriers.
  - MnDOT employs longer buffer lanes to control speed and additional patrols. On a project, the spacing between cones was halved as compared to that dictated by MnDOT standards and drivers still attempted to enter the work zone.
  - DelDOT utilized speed cameras in a work zone and found this to be the most effective speed limit enforcement tactic.

DESK SCAN INFORMATION

ALABAMA

ALDOT does not have any other construction issues of note.

CALIFORNIA

Caltrans has not recently experienced any major or prevalent constructions issues; although, they do have procedures for performing root cause analysis investigations and lessons learned if one were to occur. One new item to note, Caltrans is starting to pilot new forms of procurement (Progressive Design Build, Job Order Contracting)

DELAWARE

DelDOT notes that there are widespread deck cracking issues in their inventory on new decks and new concrete overlays. DelDOT has engaged FHWA and concrete suppliers and is considering practices of other States to address this issue. Additionally, coordination and planning with railroad entities is noted as a challenge.

GEORGIA

GDOT has noted that one issue is verifying that design and detailing intent is realized in construction.

INDIANA

INDOT noted on a specific project there is an issue of corroded anchor bolts and the need to complete additional testing of anchor bolts during inspection cycles. INDOT has also experienced issues rehabbing pile bents as the steel sheeting will be deteriorated just below the ground line and the pile will fracture during removal. INDOT is moving away from rehabbing this type of pile bent. INDOT also has a Qualified Products Lists Qualified Sources Lists.

MINNESOTA

MnDOT noted the following prevalent construction issues:

- Numerous incursions into work zones increased patrols and enforcement. Public accidents within work zone due to speed and inadequate braking distance – longer single lane to control speeds.
- Working on a pre-bagged concrete mix resource that MnDOT hopes can be a national effort.
- Working on a research and trial tracking method because MnDOT has tried many products over the years without long-term follow-up.

NEBRASKA

NDOT has noted no additional prevalent or reoccurring construction issues.

OHIO

Ohio DOT has noted no additional prevalent or reoccurring construction issues.

OKLAHOMA

Oklahoma DOT has noted that an important construction issue to note is personnel shortage and turnover, and thus knowledge transfer. Another prevalent issue is material and labor shortages which was addressed by coordination with the contractor.

PENNSYLVANIA

PennDOT noted a prevalent construction issue is work zone intrusions. Recently, an incident injured a PENNDOT inspector. Traffic Control was set up according to standards. However, channelizers were used. Some districts have adopted the use of positive protection on phased bridge projects and have had good success with using zipper barrier to facilitate traffic control.

TENNESSEE

TDOT noted that prevalent construction issues include:

- Skilled labor, operators, and truck driver shortages.
- Ready-mix plants closing on weekends or choosing not to provide concrete at night or weekends due to driver shortages, work hours, and employee resistance.

TEXAS

TxDOT has noted no additional prevalent construction issues. TxDOT has a material producer list for pre-approved materials in TX.

UTAH

UDOT identified prevalent construction issues related to premature bridge deck cracking, maintaining cover on new deck placements, and quality of precast concrete. UDOT is currently doing a study to optimize bridge deck concrete mix design materials and suggestions and improvements to curing methods and construction practices.

VERMONT

VTRANS has noted no additional prevalent construction issues.

WISCONSIN

WisDOT reports there are several different construction issues that the department encounters regularly on structures construction projects.

One issue is damage to existing girders during deck removals (which occurs on both concrete and steel girder superstructure projects). Considerations have been given to modifying the equipment restrictions for this work action, but with limited inspection resources these issues persist.

Another prevalent issue seen is in soils stratifications and structure geometries (i.e., bridges with large fills and/or MSE walls), is settlement shortly after construction is completed of approach slabs. This is an issue that WisDOT hasn't been able to isolate to one issue – in design or construction – in order to resolve/eliminate it on future projects.

Over the past several years WisDOT has had several instances where a bridge is supposed to receive a second concrete overlay and the condition of the deck is significantly worse than anticipated during construction. This has caused a rescope of the project to a deck replacement during construction, causing significant disruptions to project schedules and costs.

The department also continues to see concrete overlay quantity overruns on rehabilitation projects, noting that WisDOT bids overlays by the cubic yard.

WisDOT also states that maintaining an approved products list is challenging due to resources available. WisDOT utilizes the AASHTO Product Evaluation and Audit Solutions program and other nationwide programs to help facilitate reviews of various materials.

CHAPTER 11 - RISING CONSTRUCTION COSTS, SUPPLY CHAIN ISSUES, INFLATION, SCHEDULE DELAYS, AND OTHER PROJECT CONSIDERATIONS

This chapter provides experience with rising construction costs, supply chain issues, inflation, schedule delays, and other project considerations for bridge construction projects. The agencies provided a summary of their experience based on the following topics:

- Rising construction costs
- Supply chain issues
- Inflation
- Schedule delays
- Other cost related issues

PRESENTATIONS AND DISCUSSIONS

The peer exchange discussion of this topic was hosted adjacent to the 'Other Construction Issues' session (which is discussed in Chapter 10). Due to the similarity of the topics and the quality conversation from the participants, these sessions were combined to facilitate sharing of ideas and not lose conversational momentum. Therefore, see Chapter 10 for discussion items while agency desk scan responses are provided below.

DESK SCAN INFORMATION

ALABAMA

ALDOT noted the rise in construction costs has allowed them to let less projects and is continually considering ways to make better budgetary decisions. It was also noted that supply chain issues have greatly decreased in 2023 and currently have minimal impacts on construction.

ARKANSAS

ARDOT notes that precast elements have been challenging (as noted in Chapter 7) as there has been an increase in the quantity of precast products that have not met department specifications.

CALIFORNIA

Caltrans notes that costs have increased and have seen escalation on all items, but especially structure concrete. The Bridge Cost Index values have nearly doubled over the last two years.

Caltrans continues to hear about various shortages and longer lead times. Shortages may be driving the increased cost of structural concrete.

Caltrans noted a significant increase in polyester concrete overlay prices in 2023. Industry outreach indicated that this was partially due to raw material supply, but also inflation.

Caltrans stated that inflation is definitely a component of rising construction costs. It's difficult to separate out how much of increased costs are due to supply chain issues vs. bidding environment vs. inflation vs. other factors.

The department has also observed a lower number of bidders per project (and currently tracking downward). In 2022, Caltrans averaged five or more bidders per project. For 2023, the average is around 3.8 bidders per project. One way to mitigate this effect is continued partnering with industry groups.

DELAWARE

DelDOT has seen rising construction costs, specifically noting costs in steel. To address the rise in cost, the department has implemented a steel cost adjustment in their contracts. However, it was noted that increasing costs and inflation are reflected in their bids and thus projects demand more financial resources. DelDOT has seen supply issues with steel, paint, and lumber products and has granted time extensions on a case-by-case basis.

GEORGIA

GDOT notes that rising construction costs have caused the department to adjust cost estimating values. Regarding schedule delays, the department considers justifiable time extensions.

INDIANA

INDOT has taken efforts to identify scope items for reduction and reviews construction timelines to determine if timing modifications can alleviate costs increases. To address supply chain issues, INDOT works with suppliers to determine where additional capacity can come from. If vendors are not currently pre-qualified, INDOT pre-qualification staff works with new suppliers to back fill the demand. Considering inflation, INDOT reviews construction estimates to determine where costs are increasing and updates the overall program to determine where projects move to in future years. Lastly, to address schedule delays, INDOT works with contractors to determine causes of schedule delays and modifies contracts to meet the delay or identifies ways the contractor may be able to meet the schedule through planned schedule modifications.

MINNESOTA

MnDOT has experienced rising construction costs, supply chain issues, inflation, and schedule delays.

With rising costs and inflation, projects have been down scoped, re-analyzed for efficiency, or repackaged and re-let in response to high bid prices.

For supply chain issues, MnDOT solicits contractor feedback on material supply issues. When a problem is known with a particular item, early materials procurement has been used or direct contact with material suppliers to understand delays. In response, MnDOT has adjusted work schedules to accommodate delays, delayed start dates of work, or changed materials.

For schedule delays, MnDOT negotiates with contractors for cause of delay within contract provisions. COVID-19 pandemic impacts were tracked separately and given no-cost schedule extensions.

NEBRASKA

NDOT is focusing on estimates with additional contingency, and in some cases not awarding projects, in order to address rising construction costs.

To address supply chain issues, the department has also considered allowing extensions to the project schedule, if delay is justifiable.

To mitigate inflation, NDOT has coordinated with local contractor's association to address issues, including revisions to department specifications and specific project cost escalation considerations.

OHIO

Ohio DOT has experienced rising construction costs, supply chain issues, inflation, and schedule delays. Ultimately, it means fewer projects going to bid or projects put on hold until money is available. Considering supply chain issues, depending on the item, the department considers alternate products or provides a time extension until the item is available. Inflation has been challenging to navigate. Schedule delays due to COVID-19 pandemic or supply chain issues were present, but it was noted that this situation has recently improved, and fewer delays were incurred.

OKLAHOMA

Oklahoma DOT has experienced rising construction costs, supply chain issues, inflation, and schedule delays. Addressing cost issues is considering the workplan and budget. The department has also used asphalt and fuel index adjustments to assist in mitigating these effects. When there are delays on some items, the department has worked with contractors on extensions. Similarly, due to material and labor shortages, some contractors have had delays in starting the project. To mitigate these effects, the department has used flex start dates on contracts and coordinated with the contractor on work order effective dates, when warranted. It was also noted that inflation has caused an increase in unit prices, which the department has tracked in order to make necessary adjustments to engineer's estimates.

PENNSYLVANIA

PennDOT has experienced rising construction costs, supply chain issues, inflation, and schedule delays. To mitigate rising construction costs and inflation, PennDOT utilizes more recent cost history for program estimates and inspection costs. The Constructability group tracks lead times for certain items to reflect accurate lead times in pre-bid construction schedules. Additionally, construction projects have expanded the use of contract provisions permitting the payment for materials that are purchased in advance and stored, to reduce the effects of a potential supply chain issue or delay. In a few instances, time extensions have been granted for items with long lead times (and with proper justification).

TENNESSEE

TDOT has utilized item substitution to mitigate supply chain issues (such as allowing the use of different sized glass beads or pipe types, etc.).

TEXAS

TxDOT noted no specific issues pertaining to rising construction costs, supply chain issues, inflation, and schedule delays.

UTAH

UDOT has experienced issues pertaining to rising construction costs, supply chain issues, inflation, and schedule delays. UDOT has instructed projects to update the engineer's estimate and, in many cases, obtain an independent cost estimate prior to bid letting. UDOT has also obtained additional funding from the UDOT Transportation Commission for some projects. Regarding schedule delays, UDOT has granted additional time on projects where the delay was no fault of the contractor, depending on the nature of the delay.

UDOT has granted non-compensable time on projects that have experienced supply chain issues. In rare cases, UDOT has compensated the contractor to expedite materials if it is in the department's or public's best interest to do so.

VERMONT

VTRANS has experienced issues pertaining to rising construction costs, supply chain issues, inflation, and schedule delays. Labor shortages have led to rising construction costs and limited competition on many projects. Where possible, VTRANS has provided more time in the contract to reduce risk on the contractor. The labor shortage has also contributed to schedule delays in some cases. VTRANS has provided more time in the contract to account labor shortages, when possible. Inflation has led to challenges with cost estimating. VTRANS has shifted focus to only recent bid history when developing estimates. Lastly, lead times for materials have increased. VTRANS has adjusted to advertise projects earlier to mitigate the increase in lead times.

WISCONSIN

WisDOT has seen rising construction costs on projects in general. The department has a rolling letting system in place where they track let savings and modify future lettings within a fiscal year depending on what we have for a set program amount. WisDOT has not observed any significant supply chain issues yet. WisDOT also notes that while it has seen rising construction costs, it is hard to differentiate between rising costs and inflation. Schedule delays have occurred on some WisDOT projects but notes that the cause of the delays seem to be inconsistent and vary per project.

CHAPTER 12 - FUTURE RESEARCH AND KNOWLEDGE GAPS

Considering bridge construction related issues, the consultant team identified knowledge gaps and potential research topics. While not all-encompassing regarding bridge construction issues, the topics noted in this section are identified based on the desk scan information and peer exchange discussions. For every item below, there is varying levels of research and investigation being done separately by various agencies; national or pooled-fund studies could provide a beneficial and efficient means of addressing these widespread issues and concerns.

- During the peer exchange, participants expressed interest in creating, developing, bolstering, or modifying their construction inspector training and certification programs. Training and certification program needs, availability, enhancements, and development varied greatly between participants, and thus it is suggested that additional research be completed to address industry needs.

- Early age deck cracking and potential mitigating solutions was discussed during the exchange. The efficacy of various solutions and practices were also discussed. As this was mentioned by multiple DOTs as a prevalent and reoccurring issue, the consultant team identified this issue as a topic for future research. Deck materials and details, and placement techniques, practices, and finishes are all components to providing a deck in which early age deck cracking is not an issue. This is a common issue that is being investigated and addressed separately by multiple agencies. Therefore, these considerations should be explored in greater detail through additional research.

- Use, experience, benefits, and challenges associated with UHPC were discussed during the peer exchange. In particular, UHPC material standards, testing, and mix-design (specifically, availability of a non-proprietary mix) were noted areas for potential advancement. Some DOTs noted that work is being completed in these areas but is not available at the time of this report.

- Effective work zone speed enforcement and traffic control were noted as pertinent issues during the exchange. Considering unpredictable environments and traditional traffic control measures, additional research should be completed to increase safety in work zones and provide contemporary solutions.

Participants stated that the exchange was informational and had valuable take-aways for their consideration. Participants showed preference to revisit the peer exchange on bridge construction issues on a 2-year cycle. Therefore, it is recommended by the consultant team that another exchange occur on the 2-year cycle. Additionally, the consultant team suggests a desk scan and peer exchange with other DOTs which did not participate in the initial meeting.