



UTC Semi Annual Progress Report University Transportation Centers

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1. ACCOMPLISHMENTS: What was done? What was learned?

The information provided in this section allows the grants official to assess whether satisfactory progress has been made during the reporting period. The ABC-UTC 2016 grant was awarded in December 2016.

1.1 What are the major objectives of the program?

The objectives of the Accelerated Bridge Construction University Transportation Center (ABC-UTC) are to advance the frontier of Accelerated Bridge Construction (ABC); develop new ABC knowledge; effectively transfer the state-of-the-art of ABC to the profession; develop a next-generation ABC workforce; provide leadership in making contributions to solve national transportation issues; and collaborate with the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), Departments of Transportation (DOTs), other UTCs, and the transportation profession to make ABC the best solution for fixing the nation's aging bridge infrastructure, in line with ***Fixing America's Surface Transportation (FAST) Act research priority area: "Improving the Durability and Extending the Life of Transportation Infrastructure" and non-exclusive topic areas: "Construction Methodologies" and "Application of New Materials and Technologies."***

The ABC-UTC also contributes to FAST Act's priority areas of "Reducing Congestion (Improve Operations)", "Promoting Safety (Transportation Worker Safety/Construction Zones)," "Preserving the Environment (Environmentally Responsible Planning and Construction)," and "Preserving the Existing Transportation Systems (Retrofits and Multiple Uses of Infrastructure)". The major goals of the ABC-UTC program fall into six categories:

1.1.1 Research

Under this category, the ABC-UTC advances the frontier of ABC and fills knowledge gaps. Activities include research categories on 1) decision making; 2) durability, service life, and inspection of ABC bridges, 3) next generation of ABC bridge systems and methods; 4) ABC bridge systems and methods for mitigating extreme events and challenges created by climate change; and 5) high-speed rail (HSR) in seismic areas. All research categories are related to FAST Act in terms of 1) construction methodologies; 2) improving durability, preserving existing transportation system and environment; and 3) application of new advanced materials.

1.1.2 Leadership

ABC-UTC consortium members have well-established working relationships with one another that span decades. Collectively, the five institutions have the expertise and synergy to accomplish the Center's objectives. The ABC-UTC's research team, many of whom are recognized experts in the field and are in leadership positions, is particularly well suited to solve remaining barriers to widespread implementation of ABC practices and the construction of long-lasting bridges. The research team members continue their leadership through professional publications, articles, media outputs, and conferences to extend their leadership beyond the academic arena. The program also invests in young

faculty to become future leaders in the area. The ABC-UTC demonstrates leadership in innovations in education, workforce development, deployment of research results and conducting research.

1.1.3 Education and Workforce Development

All ABC-UTC partners have well-established education and workforce development programs that are further strengthened through the ABC-UTC. FIU, ISU, UNR, UW, and OU offer graduate degrees, leading to M.S. and Ph.D. degrees in all general areas of civil engineering, including transportation engineering, structural engineering, and construction engineering. The quality of these programs is best evidenced by the many awards and recognition that their students have received in recent years. The objectives of the ABC-UTC include the development of successful programs in the areas of seminars, workshops, and training courses for graduate and undergraduate students.

1.1.4 Technology Transfer

One of the strongest aspects of the ABC-UTC is the knowledge and leadership role that it plays in bridge engineering in terms of Technology Transfer. The keys to the FIU's ABC-UTC success in Technology Transfer are: a) solid and extensive knowledge of ABC; b) a strong focus (ABC); c) coordination of its activities with AASHTO, FHWA, DOTs, and consultants; d) identification of knowledge gaps, e) identification of bridge community needs; f) teamwork; g) identification of the best means, methods, and format of transferring the knowledge, and most importantly; h) involvement of stakeholders and adopters early in the process, and continuously seeking and receiving feedback from the community and making necessary improvements and adjustments.

Some of the highlights of technology transfer include:

- Partnerships across sectors to move research into practice
- Peer-reviewed journals and other publications to showcase research results
- Information exchanges
- Academic and continuing education programs
- Distance learning
- Conferences, webinars, and workshops
- Assessment of outreach and progress implementing research results

1.1.5 Collaboration

The ABC-UTC is a consortium of FIU (as the lead university) located in Miami, Florida (Region 4); ISU located in Ames, Iowa (Region 7); UNR located in Reno, Nevada, (Region 9); OU located in Norman, Oklahoma (Region 6); and UW located in Seattle, Washington (Region 10). This structure fosters collaboration among experts in various areas of ABC and results in the wider dissemination of results. In addition to the partnerships that occur through individual projects and the pooled-fund program, the ABC-UTC facilitates external collaboration through its overarching Advisory Committee, its focus area Advisory Boards, and its Research and Technology Transfer Advisory Panels, each consisting of external industry and US and state transportation members.

Partnership with Government Agencies:

The ABC-UTC has a strong working relationship with the AASHTO Committee on Bridges and Structures, including Technical Committees T-4 (Construction), T-3 (Seismic Design) and T-11 (Research); FHWA; and NCHRP; and these relationships are expanding and continuing. Established communication capabilities allow for remote collaboration on experimental work conducted at the five partner university facilities. Such real-time viewing, control, and data manipulation is just one example of how the partner universities work together.

The requirements for all partner universities for effective collaboration include:

- Linkage among research, education, workforce development, and technology transfer activities
- Working with minority-serving institutions
- Advisory boards and committees
- Metrics for measuring collaboration success

1.1.6 Diversity

- The lead university is a Minority Serving Institution and Hispanic Serving Institution. With a current enrollment of approximately 57,000, FIU is among the top 10 largest public universities in the U.S. and ***annually grants more than 11,000 BS, MS, and PhDs to Hispanic students. FIU also has an R1 Carnegie Classification***, which is the highest research activity rating universities can achieve. FIU has an established national reputation for excellence in Accelerated Bridge Construction and has an excellent Transportation Engineering program. Additionally, the consortium of universities is diverse. Specifically, 1) the consortium composes universities in large (Miami, Seattle), medium (Reno), and small (Ames and Norman) population areas; 2) the consortium encompasses the Eastern (FIU), Midwest (ISU and OU), and Western (UNR and UW) regions of the United States; 3) the consortium covers both seismic (UNR, UW) and non-seismic (FIU, ISU, and OU) regions; and 4) the consortium is multi-disciplinary, including both engineering (construction, structural, geotechnical, transportation and safety) and non-engineering (policy and management) disciplines. Further, FIU contributes to ABC, Intelligent Transportation Systems (ITS), and construction engineering expertise.
- ABC-UTC activities: FIU provides one of the best platforms for consortium member universities and other UTCs to attract and retain qualified underrepresented students to their graduate programs. OU has a large Native American student enrollment and provides opportunities for consortium members to attract Native American students; it also houses the Center for Diversity in Engineering and Computing (CDEC). The goals of the CDEC are to increase the overall number of students pursuing engineering careers and to increase the proportion of students from traditionally underrepresented populations in the overall number of students who pursue an engineering degree.
- One of the measures of success in ABC-UTC diversity activities is the number of minority students admitted from FIU into the undergraduate and graduate programs of ABC-UTC consortium member universities.

1.2 What was accomplished under these goals?

1.2.1 Research

- The ABC-UTC continues to update the Operation Manual as needed to best fit the center's goals and objectives.
- During the reporting period all active research projects in Cycles 1, 2, 3, 4, 5, and 6 are moving forward toward completion with final deliverables expected during the next reporting period.
- To date, the ABC-UTC has a total of 126 funded research projects within Cycles 1 through 6 (and the no-cost extension period) that cover all research areas mentioned in Section 1.1.1.
- A total of 54 research projects were completed to date (including 8 projects during this reporting period). Most of the outputs, including final report, 5-min video presentation, ABC-UTC Guide, and project data, were reported to the USDOT and are published online (<https://abc-utc.fiu.edu/research-projects/>)
- 2023 Research Day 1 was held on May 12, 2023. PIs made a total of 13 online presentations.
- Two quarterly Research Seminars (see table below) were conducted during the reporting period, with the number of registered independent sites also highlighted. Many sites have multiple attendees, so the actual number of attendees is higher. Research Seminars continue share our students dedicated efforts to the industry.

	Date	Research Seminar Title	Student(s) Presenter	# sites registered
1	04/28/2023	Integrated Flood and Socio-Environmental Risk Analysis for Prioritizing ABC Activities	Nasim Mohamadiazar, Ph.D. student	312
2	07/28/2023	Design Guidance for UHPC Connections of Precast Girders Made Continuous for Live Load	Zachary Tiry, M.S. student	554

- The ABC-UTC maintains a Memorandum of Understanding with the lightweight concrete industry.
- During this period PIs from all participating universities continue working on the recently approved projects for Cycle 6.
- The ABC-UTC maintains a Memorandum of Understanding with Brazilian Company developing new construction materials.
- The ABC-UTC maintains a cooperative working relationship with PEER (Pacific Earthquake Engineering Research Center at the University of California at Berkeley California).

The following table provides a list of the research projects, with PI and the status of the project (Gray rows show completed project with final deliverable posted and sent to the USDOT).

Project #	Project Title	Principal Investigator	Status
FIU-2016-1-1	Development of Guide for Selection of Substructure for ABC Projects (Joint project with OU)	Armin Mehrabi & Hesham Ali	Completed Final Deliverables will be posted

Project #	Project Title	Principal Investigator	Status
			during the next reporting period
FIU-2016-1-2	Field Demonstration-Instrumentation and monitoring of Accelerated Repair Using UHPC Shell	Kingsley Lau	Completed Final Deliverables are posted
FIU-2016-1-3	Envisioning Connection Detail for Connecting Concrete Filled Tube (CFT) Columns to Cap Beam for High-Speed Rail Application (Joint project with UW)	Atorod Azizinamini	Completed. Final report is posted
FIU-2016-1-4	Innovative Foundation Alternative for High-Speed Rail Application (Joint project with UNR)	Seung Jae Lee	Completed. Final Deliverables are posted.
FIU-2016-1-5	Eliminating Column Formwork Using Prefabricated UHPC Shells: (Originally a subproject of "Envisioning Connection Detail for Connecting Concrete Filled Tube (CFT) Columns to Cap Beam for High-Speed Rail Application")	Atorod Azizinamini	Completed Final Report is posted
FIU-2016-2-1	Development of Non-Proprietary UHPC Mix (Joint project with all partner universities)	David Garber	Completed Final Deliverables will be posted in May. Final report is posted
FIU-2016-2-2	Performance of Existing ABC Projects - Inspection Case Studies (Joint project with all partner universities)	Armin Mehrabi	Completed Final Report is posted
FIU-2016-2-3	Development of ABC Course Module- Available ABC Bridge Systems for Short Span Bridges	Armin Mehrabi	Completed Final Deliverables will be posted in next reporting period
FIU-2016-2-4	Optimization of Advanced Cementitious Material for Bridge Deck Overlays and Upgrade, Including Shotcrete	Islam Mantawy	Completed Final Deliverables will be posted in next reporting period
FIU-2016-2-5	Robotics and Automation in ABC Projects: Exploratory Phase	Islam Mantawy	Completed Final report is posted
FIU-2016-2-6	Laminated Wood Deck System for Folded Plate Girder	Atorod Azizinamini	Completed Final Deliverables will be posted in next reporting period
FIU-2016-2-7	Understanding Critical Impacting Factors and	Lu Zhang	Completed

Project #	Project Title	Principal Investigator	Status
	Trends on Bridge Design, Construction, and Maintenance for Future Planning		Final Deliverables are posted
FIU-2016-2-8	Complex Networks Perspectives Towards Accelerated Bridge Construction (ABC)	Arif Mohaimin Sadri	Completed Final Deliverables are posted
FIU-2016-3-1	Alternative Materials and Configurations for Prestressed-precast Concrete Pile Splice Connection	Armin Mehrabi	Completed Final Deliverables will be posted in next reporting period
FIU-2016-3-2	Alternative Technical Concepts for Contract Delivery Methods in Accelerated Bridge Construction	Mohamed ElZomor	Completed Final Deliverables will be posted in next reporting period
FIU-2016-3-3	Work Zone Safety Analysis, Investigating Benefits from Accelerated Bridge Construction (ABC) on Roadway Safety	Islam Mantawy	Final report posted
FIU-2016-3-4	Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts- Phase I	Atorod Azizinamini	Completed Final Deliverables will be posted in next reporting period
FIU-2016-3-5	Prefabricated Barrier System Utilizing UHPC Connections	Islam Mantawy	Completed Final Deliverables will be posted in next reporting period
FIU-2016-3-6	Robotic Bridge Construction: Experimental Phase I	Atorod Azizinamini	Completed Final Deliverables will be posted in next reporting period
FIU-2016-3-7	Rapid Repair and Retrofit of Timber Piles Using UHPC	Islam Mantawy	Completed Final Deliverables will be posted in next reporting period
FIU-2016-3-8	Automated MFL System for Corrosion Detection	Atorod Azizinamini	Completed Final Deliverables will be posted in next reporting period
FIU-2016-3-9	UHPC connection for SDCL steel bridge system	Atorod Azizinamini	Completed Final Deliverables will be posted in next reporting period

Project #	Project Title	Principal Investigator	Status
FIU-2016-4-1	Developing ABC Success Index to Support Contractors During Pre-Project Planning	Mohamed ElZomor	Completed Final Deliverables are posted.
FIU-2016-4-2	Use of All Lightweight Concrete in Conjunction with UHPC Connection for Prefabricated Barrier System	Atorod Azizinamini	Completed Final Deliverables will be posted in next reporting period
FIU-2016-4-3	Life-Cycle Cost Analysis of Ultra High-Performance Concrete (UHPC) in Retrofitting Techniques for ABC Project	Carlos M. Chang	Completed Final Deliverables are posted.
FIU-2016-4-4	Integrated Flood and Socio-Environmental Risk Analysis for Prioritizing ABC Activities	Ali Ebrahimian	95% Complete
FIU-2016-4-5	Construction of Three Large-Scale Robots Capable of Constructing UHPC Shell, Repair of Culvert and Automated MFL	Anthony Abrahao	Completed Final Deliverables will be posted in next reporting period
FIU-2016-5-1	Development of Rapid In-Situ Testing for Concrete Deck Durability	Amer Awwad	90% Complete
FIU-2016-5-2	A Comprehensive Decision Support Tool for Accelerated Bridge Construction Considering Social Equity	Ali Ebrahimian	90% Complete
FIU-2016-5-3	Development of Accelerated Bridge Construction Handbook (ABC Handbook)	Atorod Azizinamini	80% Complete
FIU-2016-5-4	Use of Canines as a Corrosion Detection Device	Kenneth Furton	90% Complete
FIU-2016-6-1	Upgrading Capacity and Protecting Concrete Columns Against Corrosion	Atorod Azizinamini	30% Complete
FIU-2016-6-2	Comprehending the Structural Performance and Examining Potential Field Applications of Sileto, As A New Material	Atorod Azizinamini	30% Complete
FIU-2016-6-3	Equitable Restoration Strategies for Bridge and Road Infrastructure Networks after Hurricanes in Coastal Communities	Qianwen Guo	30% Complete
FIU-2016-6-4	Advanced Corrosion Detection Combining Chemical Odor and Magnetic Flux Measurements	Kenneth Furton	30% Complete
FIU-2016-6-5	High-Resolution Approach for Hurricane Risk and Resilience Analysis for Miami-Dade County	Omar Nofal	30% Complete

Project #	Project Title	Principal Investigator	Status
ISU-2016-1-1	Delivery Methods for Accelerated Bridge Construction Projects: Case Studies and Consensus Building	Katelyn Freeseaman	Completed Final Deliverables are posted
ISU-2016-1-2	Bidding of Accelerated Bridge Construction Projects: Case Studies and Consensus Building	Katelyn Freeseaman	Completed Final Deliverables are posted
ISU-2016-1-3	Accelerated Repair and Replacement of Expansion Joints	Brent Phares	Completed Final Deliverables are posted
ISU-2016-2-1	Development of Non-Proprietary UHPC Mix (Joint project with all partner universities)	Behrouz Shafei	Completed Final Report Posted
ISU-2016-2-2	Performance of Existing ABC Projects- Inspection Case Studies (Joint project with all partner universities)	Katelyn Freeseaman	95% Complete
ISU-2016-2-3	Synthesis of available contracting methods	Jennifer S. Shane,	Completed Final Deliverables will be posted in next reporting period
ISU-2016-2-4	Development of Link Slabs: A Short Course Module	Behrouz Shafei	98% Complete
ISU-2016-3-1	Investigation of The Efficacy of Helical Pile Foundation Implementation in Accelerated Bridge Construction Projects – Phase I	Justin Dahlberg	Completed Final Deliverables are posted
ISU-2016-3-2	Multi-Span Lateral Slide Laboratory Investigation: Phase 1	Katelyn Freeseaman	Completed Final Deliverables are posted
ISU-2016-4-1	Investigation of the Efficacy of Helical Pile Foundation Implementation in Accelerated Construction Projects – Phase 2	Justin Dahlberg	90% Completed
ISU-2016-4-2	Multi-Span Lateral Slide Laboratory Investigation – Phase 2	Justin Dahlberg	Completed Final Deliverables will be posted in next reporting period
ISU-2016-5-1	Accelerated Construction of Pile Foundations by Means of Elimination	Justin Dahlberg	65% Complete
ISU-2016-5-2	Accelerated Construction of the Highway Steel Overhead Sign Truss (SOST) through the Implementation of U-Bolt Connections	Zhengyu Liu	50% Complete

Project #	Project Title	Principal Investigator	Status
UNR-2016-1-1	Innovative Foundation Alternative for High-Speed Rail Application (Joint project with FIU)	Mohamed Moustafa	Completed Final Deliverables are posted
UNR-2016-1-2	Identify the Risk Factors That Contribute to Fatalities and Serious Injuries and Implement Evidence-Based Risk Elimination and Mitigation Strategies	Mohamed Moustafa	98% Complete Completed Final Deliverables will be posted in next reporting period
UNR-2016-1-3	More Choices for Connecting Prefabricated Bridge Elements and Systems (PBES)	Mohamed Moustafa	Completed Final Deliverables are posted.
UNR-2016-2-1	Development of Non-Proprietary UHPC Mix - Application to Deck Panel Joints (Joint project with all partner universities)	Mohamed Moustafa	Completed Final Deliverables are posted.
UNR-2016-2-2	Synthesis of Available Methods for Repair of Reinforced Concrete and Prestressed Concrete Bridge Girders	Mohamed Moustafa	Completed Final Deliverables are posted
UNR-2016-2-3	Performance of Existing ABC Projects - Inspection Case Studies	Mohamed Moustafa	80% Complete
UNR-2016-3-1	Quantitative assessment of soil-structure interaction effects on seismic performance of bridges with ABC connections	Elnaz Seylabi	Completed Final Deliverables are posted
UNR-2016-3-2	Investigating the Potential Applications of Elastomeric Polymers (Such as Polyuria and Polyurethane) For Accelerated Bridge Construction And Retrofit	Hamed Ebrahimian	95% Complete
UNR-2016-3-3	Application of Methacrylate Polymers for Seismic ABC Connections	Mohamed Moustafa	Completed Final Deliverables are posted
UNR-2016-4-1	Robust Methods for UHPC Early-Strength Determination and Quality Control for ABC	Mohamed Moustafa	95% Complete
UNR-2016-4-2	Towards Autonomous Drone-Based Dynamic and Seismic Response Monitoring of Bridges	Mohamed Moustafa	80% Complete
UNR-2016-5-1	Numerical Investigation of the Impact of Vertical Ground Motions on ABC Girder-to-Cap Connections in the Near-Field	Floriana Petrone	30% Complete

Project #	Project Title	Principal Investigator	Status
UNR-2016-5-2	Shake Table Testing of Precast UHPC Bridge Column with ABC Seismic Connection	Mohamed Moustafa	30% Complete
UNR-2016-6-1	Large-scale Implementation of Semi-proprietary UHPC with virgin and recycled fibers for full precast bridge columns	Mohamed Moustafa	20% Complete
UNR-2016-6-2	Simulation and Field Implementation of Autonomous Drone Based Vibration and Structural Health Monitoring of Bridges	Mohamed Moustafa	20% Complete
OU-2016-1-1	Development of Guide for Selection of Substructure For ABC Projects (Joint project with all partner universities)	Musharraf Zaman (Joint project with FIU)	Completed Final Deliverables will be posted during the next reporting period
OU-2016-1-2	Rapid Retrofitting Techniques for Induced Earthquakes	Philip Scott Harvey Jr.	Completed Final Deliverables are posted
OU-2016-2-1	Development of Non-Proprietary UHPC Mix (Joint project with all partner universities)	Royce W. Floyd	Completed Final Deliverables will be posted during the next reporting period
OU-2016-2-2	Development of ABC Course Module - The risk due to Induced Earthquakes and Accelerated Solution (under technology transfer activity)	Philip Scott Harvey Jr	Completed Final Deliverables are posted
OU-2016-2-3	Performance of Existing ABC Projects - Inspection Case Studies (Joint project with all partner universities)	Musharraf Zaman	99% Complete
OU-2016-3-1	Service Life Design Guidance for UHPC Link Slabs	Royce Floyd	98% Complete
OU-2016-3-2	Development of User-friendly Tools and Decision-making Algorithms for Service Life Design of ABC Bridges	Shima Mohebbi	Completed Final Deliverables will be posted during the next reporting period
OU-2016-4-1	Design Guidance for UHPC Connections of Precast Girders Made Continuous for Live Load	Royce Floyd	85% Complete
OU-2016-4-2	Project Management Plans to Support Successful Delivery of Accelerated Bridge Construction Projects	Matthew Reyes	Completed Final Deliverables will be posted during the next reporting period
FIU-OU-UNR-2016-4-Collab1	Risk and Resilience of Bridges: Toward	Islam Mantawy-FIU Musharraf Zaman-OU	Completed

Project #	Project Title	Principal Investigator	Status
	Development of Hazard-Based Assessment Framework, Research Needs, and Benefits of Accelerated Construction	Mohamed Moustafa-UNR	Final Deliverables will be posted during the next reporting period
OU-2016-5-1	Innovative Multi-Hazard-Resistant Bridge Columns for ABC	Jeffery Volz	30% Completed
OU-2016-5-2	Adoption and Implementation of Project Management Plans (PMPs) for ABC Projects: Benefits and Challenges	Matthew Reyes & Somik Ghosh	30% Completed
OU-2016-5-3	Bond Behavior of Nano-Enhanced Polymer Concrete for Bridge Deck Overlays	Shreya Vemuganti	30% Completed
OU-2016-6-1	An Agent-based Decision Support Tool to Identify Near-Miss Incidents and Accessibility Issues in Accelerated Bridge Construction	Arif Mohaimin Sadri	20% Completed
OU-2016-6-2	Precast Ductile End-Diaphragm System for Accelerated Construction of Slab-On-Girder Prestressed Concrete Bridges in Seismic Regions	Philip Scott Harvey Jr.	20% Completed
UW-2016-1-1	Performance Evaluation of Structural Systems for High-Speed Rail in Seismic Regions	John Stanton	Completed Final Deliverables are posted
UW-2016-1-2	New Seismic-Resisting Connections or Concrete-Filled Tube Components In High-Speed Rail Systems (Joint Project with FIU)	Dawn Lehman	Completed Final Deliverables are posted
UW-2016-2-1	Development of Non-Proprietary UHPC Mix - Evaluation of the Shear Strength of UHPC (Joint project with all partner universities)	Paolo Calvi	99% Complete
UW-2016-2-2	Development of ABC Course Module- Seismic Connections	John Stanton	90% Complete
UW-2016-2-3	Development of ABC Course Module - Design of CFST Components and Connections for Transportation Structures	Dawn Lehman	99% Complete
UW-2016-2-4	Performance of Existing ABC Projects - Inspection Case Studies (Joint project with all partner universities)	John Stanton	95% Complete

Project #	Project Title	Principal Investigator	Status
UW-2016-2-5	Tsunami Design Forces for ABC Retrofit	Marc Eberhard	92% Complete
UW-2016-3-1	Design Guidelines for ABC Column-to-Drilled-Shaft Foundation Connections in High Seismic Zones	Marc Eberhard	Completed Final Deliverables are posted
UW-2016-3-2	Economic Pier-to-Pile Connections for Permanently Cased Shaft (CFST) Piles	Dawn Lehman	Completed Final Deliverables are posted
UW-2016-4-1	Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction Applications	Travis Thonstad	90% Complete
UW-2016-4-2	Impact of Construction Eccentricity on Direct Pier-to-Pile Connections for Permanently Cased Shaft (CFST) Piles	Dawn Lehman	Completed Final Deliverables are posted
UW-2016-5-1	Exploring the Combined Use of Distributed Fiber and Deformed Bar Reinforcement to Resist Shear Forces	Travis Thonstad	30% Completed
UW-2016-5-2	Developing Prestressed Concrete Girder Cross-Sections for Longer Spans and New Materials	Richard Wiebe	30% Completed
UW-2016-6-1	High-Early Strength Concrete for Rapid Bridge Deck Repair and Rehabilitation	Travis Thonstad	20% Completed
UW-2016-6-2	Use of Advanced Materials to Enhance the Lateral Stability of Prestressed Concrete Girders	John Stanton	20% Completed

1.2.2 Leadership

Several of the partner universities faculty members and students serve on national committees, panels, and other volunteer positions. Below is a listing of the centers Co-Directors and their leadership roles.

Atorod Azizinamini- FIU	Vasant H. Surti Professor of Civil Engineering; Director, Infrastructure Research and Innovation, Office of Research & Economic Development; Director, Accelerated Bridge Construction University Transportation Center (ABC-UTC).
Mary Lou Ralls Newman	Principal of Ralls Newman, LLC; ABC-UTC Director of Technology Transfer
Armin Mehrabi- FIU	Associate Professor in the Civil and Environmental Engineering Department of the College of Engineering and Computing. ABC-UTC Director of Research, Florida International University
David Garber-FIU	Associate Professor and Interim Chair, Civil and Environmental Engineering Department at Florida International University (FIU) and ABC-UTC Director of Workforce Development, Florida International University
Terry Wipf- ISU	Professor, Civil Engineering Department Co-Director, Iowa State University

Brent Phares- ISU	Director of the Bridge Engineering Center, Iowa State University; Co-Director of the National Center for Wood Transportation Structures; Associate Director, Iowa State University Institute for Transportation
Mohamed Moustafa- UNR	Associate Professor, Civil and Environmental Engineering Department, University of Nevada, Reno
John Stanton-UW	Professor, Civil and Environmental Engineering, University of Washington.
Marc Eberhard- UW	Professor, Civil and Environmental Engineering, University of Washington
Musharraf Zaman- OU	David Ross Boyd Professor and Aaron Alexander Professor of Civil Engineering; Alumni Chair Professor of Petroleum and Geological Engineering; Director, Southern Plains Transportation Center
K.K. Muralee Muraleetharan-OU	Kimmell-Bernard Chair in Engineering; David Ross Boyd; Presidential Professor of Civil Engineering and Environmental Science at OU; Associate Director of the National Institute for Risk and Resilience at OU.

1.2.3 Education and Workforce Development

The core Education and Workforce Development tasks continued during this reporting period. These are summarized in the below table.

Task #	Brief Description of Task	04/01/23-09/30/23
WD-1	Student Education and Research Assistantships: Each ABC-UTC consortium member is expected to mentor a minimum of one graduate student for approximately each \$75,000 in project work and provide research assistantship opportunities for graduate students.	44 (FIU, UNR, ISU, OU, UW) MS/Ph.D. students have been supported
WD-2	Undergraduate Internships: Each ABC-UTC consortium member is expected to support undergraduate students on research projects.	8 (FIU, UNR, ISU, OU) Undergraduate students have been supported
WD-3	Student Publications: Each ABC-UTC consortium member is expected to support students to publish and present their work.	2 journal articles submitted, 5 journal articles published
WD-4	Travel Scholarships: Each ABC-UTC consortium member is expected to support students who travel to conferences to present their work.	15 travel scholarship were provided during this period for Transportation and Research Board (TRB) Annual Meeting in Washington, DC and the 2022 International Accelerated Bridge Construction Conference in Miami, FL.
WD-5	Quarterly Research Seminars: Selected graduate students are required to give a technical presentation at the conclusion of their research study. These presentations are delivered electronically and archived as part of the ABC-UTC technology transfer activities.	There were 2 quarterly research seminars, with 1 graduate student participating in each. 834 sites registered for the seminars

In the current reporting period, the following Education and Workforce Development activities were conducted:

- OU Event: NSF Research Experience for Teachers proposal entitled "Sustainable Energy Engineering for Empowering Rural Communities". K-14 teachers from Oklahoma's rural communities participated in OU Research Experiences for Teachers in Engineering and Computer Science, which is funded by the National Science Foundation. The program backs summer research experiences that help nurture long-term relationships between the state's school districts, community colleges, industry partners and universities. In the activity, from studying materials for energy-producing structures like wind turbines to learning about sustainable material innovation that uses 3D printing technology, teachers spend six weeks on OU's campus embedded in engineering research labs.
- OU Engineering Day: Dr. Royce Floyd led a day long summer camp session with approximately 30 high school students from Oklahoma and surrounding states. Three graduate students (Omar Yadak, H. M. Imran Kays, and Khondhaker Al Momin) assisted Dr. Floyd in the preparation and execution of the camp. Dr. Arif Sadri also provided support in planning the activities and sending graduate students to assist. This camp was conducted as part of the OU Engineering Days organized by the Gallogly College of Engineering. Engineering Days is a series of one-day camps with each day focused on the engineering majors offered by each of the departments in the College. While the day-long camp was focused on civil engineering in general with some discussion of Architectural Engineering, the majority of the day was spent on activities focused on structural engineering, infrastructure materials, and transportation. The morning activities were designed to progress through concepts required for structural design and consideration of hazards and the afternoon activities were focused on transportation.
- OU Symposium: 2023 Oklahoma Transportation Summer Symposium. The 2023 Summer Symposium was held on Monday, July 24 from 8:30 am to 4:30pm at the OSU Hamm Institute for American Energy in the OKC Innovation District. The Annual Oklahoma Summer Transportation Symposium is sponsored by the Oklahoma Department of Transportation, hosted by the Oklahoma State University (OSU) in collaboration with the University of Oklahoma (OU). The summer symposium serves as a forum to network, discuss, and understand transportation issues we face in Oklahoma for engineers interested in addressing some of these challenges, as well as to gain a better understanding of career options for civil engineering students. Symposium topics cover bridges, pavements, materials, planning, construction, geotechnical, and environmental issues. The symposium includes both podium and poster sessions. Dr. Royce Floyd assisted in organizing the 2023 Oklahoma Transportation Symposium led by Dr. Joshua Li at Oklahoma State University. Approximately 150 individuals registered for the event. Around 170 participants showed up in person at the event.
- OU Webinar: Past, Present and Future Trends in Bridge Engineering - In this one-hour free webinar, Dr. Atorod Azizinamini, Director of Accelerated Bridge Construction University Transportation Center (ABC-UTC) at Florida International University, discussed past, present and future trends in bridge engineering. Bridge engineering in recent years has gone through significant evolution, with even more changes expected in the future. In early 2000, the introduction of Accelerated Bridge Construction (ABC) in the U.S. created a paradigm shift in the way we design, construct, and maintain bridges. This webinar provided the history of ABC and its development through time, what the future holds, and

trending ideas and concepts in additive manufacturing as it applies to bridge engineering. The webinar was jointly organized by Southern Plains Transportation Center (SPTC) and ABC-UTC in association with Oklahoma Department of Transportation (ODOT). The webinar was attended by nearly 80 people.

- OU Webinar: Longitudinal Joints in Asphalt Pavements - Best Practices - Danny Gierhart, the Deputy Director of Engineering at the Asphalt Institute conducted a webinar on “Longitudinal Joints in Asphalt Pavements - Best Practices”. The webinar was jointly hosted by SPTC and ABC-UTC in association with ODOT. Longitudinal joints are widely recognized as the weakest point of an asphalt pavement structure. This webinar discussed why longitudinal joints in asphalt pavements are so important, as well as longitudinal joint best practices. Several case studies were presented during the webinar on longitudinal joint failures of asphalt pavements. This free webinar was attended by nearly 75 people. One professional development hour (PDH) was provided for attending the webinar.
- OU Webinar: Innovative Multi-Hazard Resistant Bridge Columns for Accelerated Bridge Construction - The SPTC in association with ABC-UTC and ODOT organized another webinar on “Innovative Multi-Hazard Resistant Bridge Columns for Accelerated Bridge Construction” on July 25. Dr. Volz, Director of the Donald G. Fears Structural Engineering Lab, and a Lloyd G. and Joyce Austin Presidential Professor within the School of Civil Engineering and Environmental Science at the University of Oklahoma, presented the topic. The Federal Highway Administration (FHWA) and state departments of transportation are actively promoting accelerated bridge construction (ABC) to minimize construction costs and time and to enhance work-zone safety. While several techniques are available to accelerate construction of bridge superstructure, limited techniques are available to accelerate construction of bridge substructure. This presentation was focused on accelerating substructure construction using an innovative multi-hazard resistant bridge column. The column consists of a concrete core sandwiched between an outer fiber-reinforced polymer (FRP) tube and an inner steel tube. Both tubes will act as stay-in-place forms and confine the concrete core. The concept for this innovative column as well as its design, fabrication, and cyclic testing of half-scale versions of the columns was discussed. This free webinar was attended by nearly 100 people. One professional development hour (PDH) was provided for attending the webinar.
- OU Webinar: The Elements of Balanced Mix Design (BMD) - In this one-hour webinar, Fujie Zhou, the Senior Research Engineer at the Texas A&M Transportation Institute, discussed the elements of Balanced Mix Design (BMD). In recent years, the concept of BMD has been widely adopted by many states Department of Transportation (DOT). This webinar presented the following essential elements of BMD: (1) practical performance tests for rutting, cracking, and moisture damage; (2) loose mix aging protocols; and (3) performance acceptance criteria. This webinar also discussed some practical issues associated with the BMD implementation, such as quality control and quality acceptance testing and various approaches for balancing mix performance. The webinar was jointly organized by SPTC and ABC-UTC in association with ODOT. The webinar was attended by nearly 75 people from academia, government agencies and private industries.
- OU Webinar: Utility Mapping AI Conflation Engine: Real-Time, Remote Access to Comprehensive Utility Data - Raz Ezra, co-founder of 4M Analytics (the first digitized and up-to-date map of subsurface and above ground utilities), conducted the webinar on “Utility Mapping AI Conflation Engine: Real-Time, Remote Access to Comprehensive Utility Data” on September 19, 2023. It was jointly hosted by SPTC, ABC-UTC and ODOT.

This webinar introduced attendees to current AI applications in subsurface utility mapping technology. In the rapidly evolving world of construction, accessibility to accurate and real-time utility data can be a game-changer locating and identifying critical utilities and subsurface conditions. This technology aggregates an extensive array of utility data, both above and underground, and transforms it into a user-friendly digital map. Imagine having access to the "Google Maps or Waze" of utility systems, but with a focus on industry-specific demands, especially during the critical planning phases and supporting/validating subsurface utility engineering (SUE) investigation reports. This webinar delved into the proprietary technology that 4M Analytics has developed. The webinar was attended by approximately 80 people. One PDH was provided to the attendees.

The following Education and Workforce Development activities are being planned:

- NSF Research Experience for Teachers proposal entitled "Sustainable Energy Engineering for Empowering Rural Communities". K-14 teachers from Oklahoma's rural communities will participate in OU Research Experiences for Teachers in Engineering and Computer Science, which is funded by the National Science Foundation. The program backs summer research experiences that help nurture long-term relationships between the state's school districts, community colleges, industry partners and universities. In the activity, from studying materials for energy-producing structures like wind turbines to learning about sustainable material innovation that uses 3D printing technology, teachers spend six weeks on OU's campus embedded in engineering research labs. Related to the ABC-UTC funded project, some teachers will be chosen to learn nano modification techniques for polymer resins to incorporate into concrete and reinforced concrete for 3D printing applications.
- 2023 Oklahoma Transportation Research Day (OTRD) - Oklahoma Transportation Research Day is a major workforce development and tech transfer event, which is going to be co-organized by the SPTC and ODOT. The OTRD will be held on October 17, 2023, at National Cowboy & Western Heritage Museum, Oklahoma City, Oklahoma. Approximately 300 people are expected to attend this one-day event. Attending this FREE event will give participants the opportunity to receive up to five (5) Professional Development Hours (PDHs). This event will include keynote and technical sessions with domain experts and poster sessions by students. Several demos are also planned.
- The ABC-UTC continues to host all their digital K-12 resources at <https://abc-utc.fiu.edu/education/k-12-resources>.

1.2.4 Technology Transfer

The ABC-UTC Director attended the May 2023 American Association of State Highway and Transportation Officials (AASHTO) Committee on Bridges and Structures (COBS) Annual Meeting in Kansas City, Missouri and presented an update on ABC-UTC activities in the Technical Committee for Construction (T-4) meeting per their request.

Six Monthly Webinars were conducted during this reporting period. Registered sites ranged from 637 to 836 for these free webinars. Four of the presentations featured State Departments of Transportation (DOT) projects (Michigan, Rhode Island, Texas, and Utah), given by the DOTs and their industry partners, and featuring design and construction details and lessons learned on state-of-the-art ABC technologies incorporated in their recently completed highway bridge

projects. One presentation featured a Michigan County-owned bridge replacement project that is the first U.S. 100% Ultra-High Performance Concrete (UHPC) superstructure bridge

Preparations were completed for the 2023 annual In-Depth Web Training, and it was held on September 12. This year's free training featured the latest developments related to bridge precast substructures, and examples of their use. The 4-hour training consisted of six 40-minute modules (each a 30-minute presentation and 10-minute Q&A session), starting at 11:00 a.m. Eastern and ending at 3:15 p.m. Eastern, with a 15-minute break after Module 3. The first module discussed currently available precast substructure specifications and resources. The next four modules featured completed U.S. bridge projects that included precast substructures in Washington State, Louisiana, Alabama, and Utah. The sixth and last module described ABC-UTC precast substructure research outputs ready for implementation. The training was well attended, with 586 registered sites.

The ABC-UTC website (<https://abc-utc.fiu.edu/>) was updated with the latest ABC-UTC research, workforce development, and technology transfer activities. Included were postings on research progress; workforce development initiatives; outcomes from the December 2022 International ABC Conference and pre-conference workshops; and Monthly Webinar, quarterly Research Seminar, semi-annual Research Day, and annual In-Depth Web Training announcements and archives. Updates were also made to the ABC Project and Research Databases and other web pages including State DOT, Federal Highway Administration, and industry contacts and ABC-related activities. In addition, various other ABC-related events, news items, and details were posted on the website.

1.2.5 Collaboration

Collaboration among partner universities and advisory board members continues on an ongoing basis for the areas of research, technology transfer, and education and workforce development. The ABC-UTC continued working closely with the 2024 Conference Planning Committee on the development of the December 2024 International ABC Conference in Miami (set for December 11-13, 2024).

1.2.6 Diversity

The ABC-UTC is committed to advancing diversity, inclusion, and equity. Our students come from various demographics and identify with many cultural groups. Some of the cultural groups are Asian or Pacific Islander, Black or African American, Hispanic, Native American, White, etc. In the current period we graduated a total of 1 female student and 4 male students.

1.2.7 How have the results been disseminated?

- Research Day 1 was held on 5/12/2023 where the progress of various projects from the 2016 grant was presented by PIs to a general audience (comprising of State DOTs, Industry FHWA, and other affiliates)
- Quarterly and Final Progress Reports posted on the website
- Publications
- Presentations
- Conference Proceedings
- 6 Monthly Webinars, 2 quarterly Research Seminars, annual In-depth Web Training

- Research Day, Monthly Webinars, In-Depth Web Training, and Research Seminars archived on website
- Sponsored and hosted Summer 2023 CUTC Meeting in June 2023. This meeting (<https://abc-utc.fiu.edu/2023-cutc-summer-meeting/>) included 3 US DOT presentations and 6 Host Session Topics addressing climate change and infrastructure resiliency.

1.2.8 What do you plan to do during the next reporting period to accomplish the goals?

Expected highlights of the next reporting period include:

- Completion of all pending research projects which are near completion.
- Plan to send out call for abstracts for the 2024 International ABC Conference
- Monthly Webinars and other related technology transfer activities
- Planning for the next Annual In-Depth Web Training
- Continuation of research projects and other activities.
- Continuation of Cycle 6 research projects.
- Working with bridge owners to implement the results of ABC-UTC research projects
- Commercialization of patented products developed by ABC-UTC
- Assisting State DOT engineers to identify funds available through demonstration projects for implementing ABC-UTC developed products and bridge solutions
- Develop small companies for marketing products and solutions developed by ABC-UTC
- Work with State DOTs, FHWA and bridge owners to organize workshops across the U.S. for educating bridge professionals with latest in the ABC area; specifically, we are attempting to organize a day-long ABC workshop at different locations
- Work with State DOT engineers and other entities who have developed Non- Proprietary Ultra-High-Performance Concrete (UHPC) mixes to organize a daylong workshop that will include hands-on activities to promote the use of UHPC which is an advanced cementitious material
- Host meeting with 2024 conference planning committee
- Continue ABC Project Database maintenance, development of project submissions, and development of AI enhancements to search engine.

2. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS: Who has been involved?

2.1 WHAT ORGANIZATIONS HAVE BEEN INVOLVED AS PARTNERS?

- Atorod Azizinamini, Florida International University
- Ahmad Itani, University of Nevada, Reno
- Mohamed A. Moustafa, University of Nevada, Reno
- Terry Wipf, Iowa State University
- Brent Phares, Iowa State University
- John Stanton, University of Washington
- Musharraf Zaman, The University of Oklahoma University

2.2 HAVE OTHER COLLABORATORS OR CONTACTS BEEN INVOLVED?

The ABC-UTC has an Advisory Committee that provides recommendations on ABC-UTC operations. The ABC-UTC also has advisory boards that provide recommendations under each of its focus areas of Research, Workforce Development, and Technology Transfer. Additionally, advisory panels and committees make recommendations on specific projects or activities. These groups include representatives from state DOTs, FHWA, and industry.

3. OUTPUTS

PERFORMANCE METRICS FOR CURRENT REPORTING PERIOD:

Research	Goals	Research Performance Measures	04/01/23-9/30/23
Outputs	ABC-UTC Guides documents – Short documents that provide essential information needed to put results of research into practice; note that projects with similar topics may have a combined document	Number of documents submitted	0
	Research Seminar – Principal Investigator(s) and graduate student(s) will co-present project findings in quarterly Research Seminar series; products of the research project, at completion, will be presented	Number of seminars	2 (see 1.2.1)
	Publications – Peer-reviewed publications on research products	Number of peer-reviewed publications on research products	1 journal articles submitted, 4 journal articles published. (see 3.1.1, 3.1.2)
	Presentations – Research projects presented at conferences and other events	Number and quality of conferences and events during which results of the research are presented	34 (see 3.1.3, includes 13 Research Day presentations)
	Development of Educational Materials – Continuing education courses, web-based training, part of conference workshops, or modules for college courses	Number of developed educational materials	0 (see 1.2.1 research table)

3.1 PUBLICATIONS, CONFERENCE PAPERS, AND PRESENTATION

3.1.1 Journal Articles Submitted

Citation for Article	Peer-Reviewed?
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Author(s). "Article Title". <i>Journal Title</i> , Submitted <Month>, <year>.	Yes or No
Dickinson, R. Morgan, Afzal, Muhammad Faheem Ud Din, Mantaway, Islam M and Azizinamini, Atorod "Non-Proprietary Ultra High-Performance Concrete Mixtures for Pneumatic Spray Applications" in Structures, Elsevier.	Yes
Ali, S.A., Zaman, M. and O'Rear, E. "Effects of Surface Free Energy Estimation Methods and Probe Liquids on the Moisture-Induced Damage Potential of Asphalt Mixes." International Journal of Pavement Engineering, Submitted June, 2023.	Yes
Ali, S.A., Foley, K.A., Zaman, M. and Walters, K.B. "Micro-Structural Evaluation of The Effects of Aggregate Type, Aging, and Additives on The Moisture Susceptibility of Binder-Aggregate Systems Using Chemical and Thermodynamic Approaches". Journal of Materials in Civil Engineering, Submitted May, 2023.	Yes
Ghos, S., Ali, S.A., Zaman, M., Elaryan, A.E. and Shawn, J. "Comparative Evaluation of Two Intelligent Compaction (IC) Systems for Pavement Quality Evaluation". International Journal on Pavement Research and Technology, Submitted May, 2023.	Yes
Ali, S. A., Arevalo, P. F. C., Zaman, Floyd, R.W. and Rojas-Pochyla, J. "Durability of Recycled Concrete Aggregate as a Pavement Base Material including Drainage: A Laboratory and Simulation Study. 103rd Annual Meeting of Transportation Research Board, Submitted July, 2023.	Yes
Jiaqing Lu, Qianwen Guo, Shumin Chen and Paul Schonfeld. "Adaptive Delivery Models: Comparing Conventional Truck and Drone-Assisted Methods in Flood-Prone Areas with Demand Uncertainty". Transportation Research Part E: Logistics and Transportation Review, Submitted <Sep>. <2023>.	Yes
Low Cycle Fatigue Based Convolutional Neural Network for Fracture Prediction of Reinforcing Steel Bars	Yes

3.1.2 Journal Articles Published (TT Plan Output)

Citation for Article	Peer-Reviewed?
Author(s). "Article Title". <i>Journal Title</i> , vol., pp, date.	Yes or No
Azizinamini, Atorod, and Abbas Khodayari. "UHPC Based Solutions for Accelerated Bridge Construction." In International Interactive Symposium on Ultra-High Performance Concrete, vol. 3, no. 1. Iowa State University Digital Press, 2023.	Yes
Mendez Larrain, M., Ali, S., Hobson, K., & Zaman, M. "Calibration of Effective Structural Number and Tensile Strain Models Using Traffic Speed Deflectometer (TSD) Data for Enhanced Project-Level Assessment on Flexible and Composite Pavements." Sustainability, 15, x, (accepted, in press).	Yes
Qianwen Guo, Shumin Chen, Yanshuo, Sun and Paul Schonfeld. "Investment timing and length choice for a rail transit line under demand uncertainty". Transportation Research Part B: Methodological, 175., 102800, 09, 2023	Yes
Harnessing data from benchmark testing for the development of spalling detection techniques using deep learning, book chapter, interpretable machine learning for the	Yes

analysis, design, assessment, and informed decision making for civil infrastructure, M.Z. Naser, Elsevier	
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3.1.3 Meeting/Conference Presentations/Posters Made by key researchers & Students (TT Plan Output)

Meeting / Conference Name	Citation for Presentation
Meeting/Conference name, location, mo/yr	Author(s). "Presentation Title"
International Interactive Symposium on Ultra-High Performance Concrete. Wilimington, Delaware	Azizinamini, Atorod, and Abbas Khodayari. "UHPC Based Solutions for Accelerated Bridge Construction." International Interactive Symposium on Ultra-High Performance Concrete. Vol. 3. No. 1. Iowa State University Digital Press, 2023.
ACI concrete convention, TX, October 2022	Haibe, A. (Author & Presenter), Vemuganti, S. (Author & Presenter) Investigation of Flexural Response of Concrete Reinforced with 3D Printed GFRP
Oklahoma Transportation Research Day, October, 2022	Castillo, S. (Author & Presenter), Liever, A. (Author & Presenter), Vemuganti, S. (Author) Investigating Freeze-Thaw Behavior of Nanommodified Fiber-Reinforced Polymers
Structural Engineering Institute Invited Talk, Norman, October, 2022	Infrastructure Rehabilitation & Strengthening with Fiber-Reinforced Polymer Composites
ABC UTC research day, Online, November 9, 2022	Vemuganti, S. Bond Behavior of Nano-Enhanced Polymer Concrete for Bridge Deck Overlays
New Faculty Research & Creative Activities Showcase, Online, March 23, 2023	Vemuganti, S. Innovative Materials and Methods for Emerging Research in Structural Engineering
ABC UTC research day, Online, May 12, 2023	Vemuganti, S. Bond Behavior of Nano-Enhanced Polymer Concrete for Bridge Deck Overlays
2023 Oklahoma Transportation Summer Symposium, Oklahoma City, OK, 07/2023	Akbarpour, A. (Author & Presenter), Vemuganti, S. (Author) An Insight into Polymer Concrete Pull Off Strength for Bridge Deck Overlays
2023 Oklahoma Transportation Summer Symposium, Oklahoma City, OK, 07/2023	Omar Yadak, Dip Banik, Royce Floyd, "Flexural Resistance of Ultra-High Performance-Concrete Subjected to Freeze-Thaw Cycles"
ABC-UTC Research Seminar, Virtual, 07/2023	Royce Floyd, Zachary Tiry, "Design Guidance for UHPC Connections of Precast Girders Made Continuous for Live Load"
Oklahoma Summer Transportation Symposium, Oklahoma City, OK, 7/2023	Villalobos Vega, E., Harvey, P.S., Floyd, R.W. "Precast Ductile End-Diaphragm System for Accelerated Construction of Prestressed Concrete Bridges in Seismic Regions"
2023 Oklahoma Transportation Summer	Arevalo, P. F. C., Ali, S. A., Zaman, Hobson, K. R. and Rojas-Pochyla, J. "Laboratory Study on Strength, Durability and Drainage of Recycled Concrete Aggregate for use in Pavement Base Course."

Symposium, Oklahoma City, OK, 07/2023	
2023 Oklahoma Transportation Summer Symposium, Oklahoma City, OK, 07/2023	Ghos, S., Ali, S. A., Bauer, S., Hobson, K. R. and Zaman, M., "Fracture Characterization of Asphalt Mixes Containing Recycled Plastics using Different Cracking Tests."
2023 Oklahoma Transportation Summer Symposium, Oklahoma City, OK, 07/2023	Urbina Barrios, L., Ali, S. A., Mendez Larrain, M., Zaman and Khalife, R. "Assessing the Effectiveness of Empirical Models to estimate Swelling Potential of Oklahoma soils."
APTA Fare Collection System Committee Presentation, Jun/2023	Qianwen Guo. "Role of the Transit Network System in Enhancing Disaster Response and Strengthening Community Resilience"
Bridging Transportation Researchers (BTR) Conference, Zoom-based conference, Aug/2023	Jiaqing Lu and Qianwen Guo. "Drone-Supported Truck Methods Amidst Demand Fluctuations in Disaster-Impacted Regions"
AMPP Corrosion 2024. New Orleans, 03/24	Kingsley Lau, Amer Awwad, Samanbar Permeah, Atorod Azizinamini. "Preliminary Study to Characterize Concrete Durability by Water Permeation and Electrochemical Impedance Spectroscopy,"
ASCE-EWRI World Environmental & Water Resources Congress, Henderson, NV, May 2023	Nasim Mohamadiazar & Ali Ebrahimian. "Spatial Multi-criteria Flood Risk Assessment Using Machine Learning and Socio-environmental Factors"
Quarterly Research Seminar, Accelerated Bridge construction-University Transportation Center, Online, April 2023	Ali Ebrahimian & Nasim Mohamadiazar. "Integrated Flood and Socio-Environmental Risk Analysis for Prioritizing Accelerated Bridge Construction Activities"
GSAW Scholarly Forum, Miami, FL (FIU), April 2023	Nasim Mohamadiazar & Ali Ebrahimian. "Integrated Flood and Socio-environmental Risk Analysis for Prioritizing Accelerated Bridge Construction Activities"

3.1.4 Conference Proceedings (TT Plan Output)

Citation for Conference Proceedings:

- Ghos, S., Hobson, K. R., Chen, D. H., Ali, S. A., Zaman, M., Behm, M., Wang, K., & Pittenger, D. "Repair Evaluations of Depressed Transverse Cracks in Asphalt Pavements." International Airfield and Highway Pavements Conference, June 2023.
- Hobson, K. R., Ali, S. A., Vivanco, D., Ghos, S., and Zaman, M. "Estimating Optimum Rejuvenator Rate for Asphalt Recycling Based on Binder Rheological Properties." International Airfield and Highway Pavements Conference, June 2023.
- Mendez Larrain, M. M., Ali, S. A., Hobson, K. R., Zaman, M and Scullion, T. "Subsurface Investigation using Traffic Speed Deflection Device (TSDD) in Oklahoma." International Airfield and Highway Pavements Conference, June 2023.
- Arevalo, P. F. C., Ali, S. A., Zaman, M, Vellingiri, A., Hobson, K. R. and Rojas-Pochyla, J. "Assessment of Durability and Strength of Recycled Concrete Aggregate (RCA) for Use in

Pavement Base Construction.” International Airfield and Highway Pavements Conference, June 2023.

- Kingsley Lau, Amer Awwad, Samanbar Perme, Atorod Azizinamini. “Preliminary Study to Characterize Concrete Durability by Water Permeation and Electrochemical Impedance Spectroscopy,” Proceedings AMPP Corrosion 2024. Submitted 10/2/23

3.2 WEBSITE AND OTHER INTERNET SITES (TWITTER, FACEBOOK, INSTAGRAM)

ABC-UTC Website (<https://abc-utc.fiu.edu/>): The ABC-UTC website continues to be updated on an ongoing basis to document the status of research, workforce development, and technology transfer activities.

All social media outlets have been created and are updated on an ongoing basis, such as:

- Twitter: <https://twitter.com/ABCUTC>
- Facebook: <https://www.facebook.com/abc.utc/>
- Instagram: <https://www.instagram.com/abc.utc/>
- YouTube: <https://www.youtube.com/watch?v=XovjflDA3Lk>. For links to unlisted webinars, please visit our website monthly webinar archives page at <https://abc-utc.fiu.edu/webinars/webinar-archives/>
- LinkedIn: <https://www.linkedin.com/company/abc-utc>

3.3 TECHNOLOGIES OR TECHNIQUES

The ABC-UTC joint projects with all partner universities have been underway to develop a non-proprietary UHPC mix promising low cost and availability to all users. The projects will be available at the end of the year and reported in the next period.

3.4 INVENTIONS, PATENT APPLICATIONS, AND/OR LICENSES

Nothing to report.

3.5 OTHER PRODUCTS

Nothing to report.

4. OUTCOMES: What outcomes has the program produced? How are the research outputs described in section (3) above being used to create outcomes?

PERFORMANCE METRICS FOR CURRENT REPORTING PERIOD:

Research	Goals	Research Performance Measures	04/01/23-09/30/23
Outcomes	<i>Separate Contributions for Research Projects, or Follow-on Research Projects</i>	Number of separate financial or in-kind contributions for research projects, or follow-on research projects	12
	<i>Activities Requested by Outside Entities –</i> Presentations, workshops, etc.	Number of activities conducted	9

	Use in the Field – Output(s) used in processes or projects	Number of times research outputs are incorporated in bridge processes, construction projects, etc.	1
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Outcomes descriptions for current period (4/1/23- 9/30/23)

#	Title	Outcomes (1-Separate Contributions for Research Projects, or Follow-on Research Projects; 2-Activities Requested by Outside Entities; or 3-Use in the Field)
2016-FIU-06-01	Upgrading Capacity and Protecting Concrete Columns Against Corrosion	1-Florida Building Commission provided grant for \$100,000 to study effect of carbon-induced corrosion on the project test specimen; study was completed and submitted in June 2023
2016-FIU-06-01	Upgrading Capacity and Protecting Concrete Columns Against Corrosion	3-In summer 2023 began discussions with major contractor for field application of strengthening of bridge and building columns; currently in search of small (\$3-4M) retrofit project
2016-FIU-06-02	Comprehending the Structural Performance and Examining Potential Field Applications of Sileto, as a New Material	1-A grant was received from Sileto for \$120,000 to find application areas for the new material
2016-FIU-06-03	Equitable Restoration Strategies for Bridge and Road Infrastructure Networks after Hurricanes in Coastal Communities	1-PI submitted a proposal "Risk Assessment and Adaptation Strategies for Roadway Networks in Florida Coastal Areas under Extreme Rainfall Events" to FDOT Traffic operation office in September 2023
2016-FIU-06-03	Equitable Restoration Strategies for Bridge and Road Infrastructure Networks after Hurricanes in Coastal Communities	2-Presentations were given by PI and student in two different meetings: - APTA Fare Collection System Committee Zoom-based presentation in June 2023 - Bridging Transportation Researchers (BTR) Conference (Zoom-based Conference) in August 2023
2016-FIU-05-04	Use of Canines as a Corrosion Detection Device	1- \$70,000 Award received for next cycle.
2016-FIU-C5-01	Development of Rapid In-Situ Testing for Concrete Deck Durability	Applied for Patent in May 2023
2016-FIU-03-04	Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts - Phase I	2-Invited as 1 of 4 speakers at upcoming FHWA EDC-6 webinar, to be held April 23, 2023, on use of UHPC for repair and retrofit
2016-FIU-03-09	UHPC Connection for SDCL Steel Bridge System	2-Virtual presentation by PI in September 2023 to Caltrans engineers and staff per their request

#	Title	Outcomes (1-Separate Contributions for Research Projects, or Follow-on Research Projects; 2-Activities Requested by Outside Entities; or 3-Use in the Field)
2016-FIU-02-04	Optimization of Advanced Cementitious Material for Bridge Deck Overlays and Upgrade, Including Shotcrete	2-Invited as 1 of 4 speakers at FHWA EDC-6 webinar, held April 23, 2023, on use of UHPC for repair and retrofit
2016-UNR-04-01	Robust Methods for UHPC Early-Strength Determination and Quality Control for ABC	2-Invited presentation was given to PCI Subcommittee on UHPC in Spring 2023
2016-OU-05-01	Innovative Multi-Hazard-Resistant Bridge Columns for ABC	2-Joint one-hour webinar with Southern Plains Transportation Center on July 26, 2023 for research update on conception to full-scale testing to date
2016-OU-05-02	Adoption and Implementation of Project Management Plans (PMPs) for ABC Projects: Benefits and Challenges	2-Caltrans and Iowa DOT have requested research outputs, and have asked for and will be receiving feedback on their current processes
2016-OU-05-03	Bond Behavior of Nano-Enhanced Polymer Concrete for Bridge Deck Overlays	1-Per request of ACI NEx (Center of Excellence for Nonmetallic Building Materials) through ICC (International Code Council), PI submitted a proposal in September 2023 for RFP SG24.05 to ACI NEx for design standard for polymer concrete structures
2016-OU-04-02	Project Management Plans to Support Successful Delivery of Accelerated Bridge Construction Projects	2-Caltrans and Iowa DOT have requested research outputs, and have asked for and will be receiving feedback on their current processes
2016-OU-03-01	Service Life Design Guidance for UHPC Link Slabs	3-Received \$840,000 funding from Technology and Innovation Deployment Program (TIDP) to replace 36 joints with UHPC headers, half with link slabs, on the Oklahoma DOT's I-35 over Cimarron Overflow Bridge, including \$75,000 assigned to OU for monitoring performance
2016-OU-03-02	Development of User-Friendly Tools and Decision-Making Algorithms for Service Life Design of ABC Bridges	1-Decision made by ABC-UTC Director for separate project to enhance the tool by incorporating AI
2016-UW-06-01	High-Early Strength Concrete for Rapid Bridge Deck Repair and Rehabilitation	1-CTS Cement provided in-kind materials for the research project
2016-UW-06-01	High-Early Strength Concrete for Rapid Bridge Deck Repair and Rehabilitation	1-Research project is using Louis Stokes Alliance for Minority Participation students to assist on the project
2016-UW-06-02	Use of Advanced Materials to Enhance the Lateral Stability of Prestressed Concrete Girders	1-WSDOT and PCI have committed \$235,000 to fund large-scale experiments at UW for girder stability and strength of precast girders; this will inform cross-section torsional strength; Concrete Technology Corporation is donating the girders

#	Title	Outcomes (1-Separate Contributions for Research Projects, or Follow-on Research Projects; 2-Activities Requested by Outside Entities; or 3-Use in the Field)
2016-UW-05-02	Developing Prestressed Concrete Girder Cross-Sections for Longer Spans and New Materials	1-WSDOT and PCI have committed \$235,000 to fund large-scale experiments at UW for girder stability and strength of precast girders; this will inform cross-section torsional strength; Concrete Technology Corporation is donating the girders

5. IMPACTS: What is the impact of the program? How has it contributed to transportation, education, research, and technology transfer?

PERFORMANCE METRICS FOR CURRENT REPORTING PERIOD:

Research	Goals	Research Performance Measures	04/01/23-9/30/23
Impacts	<i>Influence on Practice</i>	Number of changes that are made to the way an outside entity is doing business, because of research outputs	3
	<i>Governing State, Local, and National Specifications</i>	Number of changes, to incorporate products, which are made to state, local, or national (e.g., AASHTO) bridge design and/or construction specifications or guidelines	0
	<i>Use of ABC-UTC Activities in Practice</i>	Number of uses of ABC-UTC activities in practice	0

Impact descriptions for Current period (04/01/23- 9/30/23)

#	Title	Research Performance Measures (1-Influence on Practice; 2-Governing State, Local, and National Specifications; 3-Use of ABC-UTC Activities in Practice)
2016-OU-05-01	Innovative Multi-Hazard-Resistant Bridge Columns for ABC	1- Contacted by Missouri DOT to potentially do an implementation project
2016-UW-06-01	High-Early Strength Concrete for Rapid Bridge Deck Repair and Rehabilitation	1-WSDOT has expressed interest in incorporating the calcium sulfoaluminate cements in their bridge decks and pavements
2016-UW-04-01	Exploring Fiber-Reinforced Polymer Concrete for ABC Applications	1-WSDOT has expressed interest in using this product (basalt fiber-reinforced polymer concrete) on a bridge

5.1 WHAT IS THE IMPACT ON THE EFFECTIVENESS OF THE TRANSPORTATION SYSTEM?

The ABC-UTC works closely with stakeholders to enhance the transportation systems with a focus on accelerated bridge construction techniques. For example, the ABC-UTC works closely with the lightweight concrete industry to expand the use of lightweight concrete in ABC

applications. As a response to the bridge industry expressing the lack of prefabricated barriers, the ABC-UTC is also developing UHPC connections for prefabricated barriers.

5.2 WHAT IS THE IMPACT OF TECHNOLOGY TRANSFER ON INDUSTRY AND GOVERNMENT ENTITIES, ON THE ADOPTION OF NEW PRACTICES, OR ON RESEARCH OUTCOMES WHICH HAVE LED TO INITIATING A START-UP COMPANY?

The ABC-UTC has identified research areas that will help the ABC cause and that may fall outside the mission of the ABC-UTC. Bridge engineering is a multi-disciplinary field, and ABC-UTC research activities are having an influence on several other disciplines, such as robotics, automation, computer science and development of the new field in damage assessment that is related to service life design of bridges. As listed in Section 5, DOTs are interested in implementing research outputs.

5.3 WHAT IS THE IMPACT ON THE BODY OF SCIENTIFIC KNOWLEDGE?

ABC-UTC researchers contribute to the body of scientific knowledge by publishing journal articles in top engineering journals such as Construction and Building Materials, Journal of Bridge Engineering, Engineering Structures, among others. Dr. Azizinamini is the guest editor for MDPI-Materials Journal on the recent advances in UHPC (https://www.mdpi.com/journal/materials/special_issues/ultrahigh_performanceconcrete).

5.4 WHAT IS THE IMPACT ON TRANSPORTATION WORKFORCE DEVELOPMENT?

ABC technologies are increasingly being specified on bridge replacement and new construction projects as state DOTs and other bridge owners and their partners gain understanding and expertise in ABC. The ABC knowledge is expanding in part due to the large number of participants in the ABC-UTC conferences and the various ABC-UTC web activities, in addition to stakeholders' use of resources on the ABC-UTC website. Also, the close involvement of state DOT, FHWA, and industry partners in the ABC-UTC's Advisory Committee, Research Advisory Board, Workforce Development Advisory Board, and Technology Transfer Advisory Board is providing the exposure needed to understand the benefits of implementing ABC in their projects.

6. CHANGES/PROBLEMS

6.1 CHANGES IN APPROACH AND REASONS FOR CHANGE

Nothing to report.

6.2 ACTUAL OR ANTICIPATED PROBLEMS OR DELAYS AND ACTIONS OR PLANS TO RESOLVE THEM.

Nothing to report.

6.3 CHANGES THAT HAVE A SIGNIFICANT IMPACT ON EXPENDITURES

Nothing to report.

6.4 SIGNIFICANT CHANGES IN USE OR CARE OF HUMAN SUBJECTS, VERTEBRATE ANIMALS, AND/OR BIOHAZARDS

Nothing to report.

6.5 CHANGE OF PRIMARY PERFORMANCE SITE LOCATION FROM THAT ORIGINALLY PROPOSED

Nothing to report.

7. Additional information regarding Products and Impacts

Nothing to report.