



**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, and 5 are moving forward toward completion with final deliverables expected during the next reporting period.
- To date, the ABC-UTC has a total of 86 funded research projects within Cycles 1 through 5 that cover all research areas mentioned in Section 1.1.1.
- Total of 32 research projects were completed to date (including 4 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/>)
- 2022 Research Day 2 was held on November 9, 2022. PIs made a total of 13 online presentations that featured projects from various cycles of our 2016 grant. The next Research Day will be held May 12, 2022, and will present projects from Cycle 5. Presentations will be reported in the next reporting period.
- Two quarterly Research Seminars (see table below) were presented 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 to give exposure of our students to the industry.

	Date	Research Seminar Title	Student(s) Presenter	# sites registered
1	10/28/2022	Alternative Technical Concepts for Contract Delivery Methods in Accelerated Bridge Construction	Piyush Pradhananga, Ph.D. student	349
2	01/27/2023	Robust Methods for UHPC Early-Strength Determination and Quality Control for ABC	Mohammed S. Ibrahim, Ph.D. student	485

- 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 5.
- 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 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	95% Complete
FIU-2016-2-5	Robotics and Automation in ABC Projects: Exploratory Phase	Islam Mantawy	Completed Final report is posted

Project #	Project Title	Principal Investigator	Status
FIU-2016-2-6	Laminated Wood Deck System for Folded Plate Girder	Atorod Azizinamini	95 % Complete
FIU-2016-2-7	Understanding Critical Impacting Factors and Trends on Bridge Design, Construction, and Maintenance for Future Planning	Lu Zhang	Completed 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	90 % Complete
FIU-2016-3-5	Prefabricated Barrier System Utilizing UHPC Connections	Islam Mantawy	95% Complete
FIU-2016-3-6	Robotic Bridge Construction: Experimental Phase I	Atorod Azizinamini	90% Complete
FIU-2016-3-7	Rapid Repair and Retrofit of Timber Piles Using UHPC	Islam Mantawy	90% Complete
FIU-2016-3-8	Automated MFL System for Corrosion Detection	Atorod Azizinamini	90% Complete
FIU-2016-3-9	UHPC connection for SDCL steel bridge system	Atorod Azizinamini	Completed Final Deliverables will be posted in next reporting period
FIU-2016-4-1	Developing ABC Success Index to Support Contractors During Pre-Project Planning	Mohamed ElZomor	80% Complete
FIU-2016-4-2	Use of All Lightweight Concrete in Conjunction with UHPC Connection for Prefabricated Barrier System	Atorod Azizinamini	90% Complete

Project #	Project Title	Principal Investigator	Status
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	50% Complete
FIU-2016-5-1	Development of Rapid In-Situ Testing for Concrete Deck Durability	Amer Awwad	10% Complete
FIU-2016-5-2	A Comprehensive Decision Support Tool for Accelerated Bridge Construction Considering Social Equity	Ali Ebrahimian	0% Complete
FIU-2016-5-3	Development of Accelerated Bridge Construction Handbook (ABC Handbook)	Atorod Azizinamini	10% Complete
FIU-2016-5-4	Use of Canines as a Corrosion Detection Device	Kenneth Furton	10% Complete
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	90% 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	Justin Dahlberg	Completed

Project #	Project Title	Principal Investigator	Status
	Implementation in Accelerated Bridge Construction Projects – Phase I		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	60% 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	0% Complete
ISU-2016-5-2	Accelerated Construction of the Highway Steel Overhead Sign Truss (SOST) through the Implementation of U-Bolt Connections	Zhengyu Liu	0% Complete
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	50% Complete
UNR-2016-3-1	Quantitative assessment of soil-structure interaction	Elnaz Seylabi	85% Complete

Project #	Project Title	Principal Investigator	Status
	effects on seismic performance of bridges with ABC connections		
UNR-2016-3-2	Investigating the Potential Applications of Elastomeric Polymers (Such As Polyuria and Polyurethane) For Accelerated Bridge Construction And Retrofit	Hamed Ebrahimian	85% 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	90% Complete
UNR-2016-4-2	Towards Autonomous Drone-Based Dynamic and Seismic Response Monitoring of Bridges	Mohamed Moustafa	70% 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	0% Complete
UNR-2016-5-2	Shake Table Testing of Precast UHPC Bridge Column with ABC Seismic Connection	Mohamed Moustafa	0% 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	Shima Mohebbi	Completed

Project #	Project Title	Principal Investigator	Status
	Algorithms for Service Life Design of ABC Bridges		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 Development of Hazard-Based Assessment Framework, Research Needs, and Benefits of Accelerated Construction	Islam Mantawy-FIU Musharraf Zaman-OU Mohamed Moustafa-UNR	99% Complete
OU-2016-5-1	Innovative Multi-Hazard-Resistant Bridge Columns for ABC	Jeffery Volz	0% Completed
OU-2016-5-2	Adoption and Implementation of Project Management Plans (PMPs) for ABC Projects: Benefits and Challenges	Matthew Reyes & Somik Ghosh	0% Completed
OU-2016-5-3	Bond Behavior of Nano-Enhanced Polymer Concrete for Bridge Deck Overlays	Shreya Vemuganti	0% 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	50% Complete
UW-2016-2-3	Development of ABC Course Module - Design of CFST Components and Connections for Transportation Structures	Dawn Lehman	99% Complete

Project #	Project Title	Principal Investigator	Status
UW-2016-2-4	Performance of Existing ABC Projects - Inspection Case Studies (Joint project with all partner universities)	John Stanton	75% Complete
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	Final report under review and revision
UW-2016-5-1	Exploring the Combined Use of Distributed Fiber and Deformed Bar Reinforcement to Resist Shear Forces	Travis Thonstad	0% Completed
UW-2016-5-2	Developing Prestressed Concrete Girder Cross-Sections for Longer Spans and New Materials	Richard Wiebe	0% 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	10/01/22-3/31/23
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: Oklahoma Transportation Research Day (OTRD) 2022 - A major workforce development and tech transfer event, which was co-organized by the Southern Plains Transportation Center (SPTC), Accelerated Bridge Construction University Transportation Center (ABC-UTC) and the Oklahoma Department of Transportation (ODOT). The OTRD

was held on October 18, 2022, at National Cowboy & Western Heritage Museum, Oklahoma City, Oklahoma. Approximately 250 people attended this one-day event. Attending this FREE event gave participants the opportunity to receive up to five (5) Professional Development Hours (PDHs). This event included keynote and technical sessions with domain experts and poster sessions by students. The student poster competition is an annual highlight of OTRD, giving participants the opportunity to highlight their research. A total of 36 posters were submitted for the student poster competition at 2022 OTRD. After a rigorous judging process the Poster Judge Panel selected five posters for the best student poster awards. Several demos were also presented.

- OU Webinar: On November 16, 2022, the SPTC, ODOT, and ABC-UTC hosted a webinar by Prof. Soheil Nazarian on 'Building Better Foundations for Roads Using Emerging Technologies'. Dr. Soheil Nazarian is the McIntosh Murchison Chair Professor of Civil Engineering at The University of Texas at El Paso (UTEP) where he has served as the Director of the Center for Transportation Infrastructure Systems (CTIS) and the Campus Director of the newly-established Engineering Research Center entitled "Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE)," funded by the National Science Foundation. Nearly 70 people attended the webinar. One PDH was provided for the attendees.
- OU Short Course: A one-day short course on 'Alternative Dispute Resolution for Engineers' was held on December 7, 2022 at the ODOT Training Center in Oklahoma City. It was organized jointly by SPTC, ABC-UTC and ODOT. The course was instructed by Dr. Nils J. Gransberg, vice president, Gransberg & Associates, Inc. and adjunct professor at Gallogly College of Engineering, the University of Oklahoma. A total of 45 people attended the short course.
- OU Webinar: On March 7, 2023, the SPTC, ODOT, and ABC-UTC hosted a webinar by Dr. Rouzbeh Ghabchi on 'Sustainable Asphalt Mixes Containing Plant-Based Nanofibers'. Nearly 55 people attended the webinar. One PDH was provided for the attendees.

The following Education and Workforce Development activities are being planned:

- Additional sessions for the Professors' Workshop Series are being planned based on feedback from the initial series.
- Public Library Outreach – the ABC-UTC is continuing discussions with the public library system (MDPLS) to explore future opportunities for collaboration.
- UW LSAMP Scientist Program - This program is meant for students with little to no research experience from groups traditionally underrepresented in STEM. Students are paired with mentors and conduct research during the summer quarter, while also attending workshops that focus on research skills including how to write a research report, how to create a poster presentation, and how to effectively communicate expectations. At the end of the program students present their research to the UW community.
- OU Webinar - The SPTC, ABC-UTC and ODOT have organized a discussion on Bridge Engineering, which has gone through significant evolution in recent years. In early 2000, the introduction of Accelerated Bridge Construction (ABC), in the U.S. can be seen as a paradigm shift in the way we design, construct, and maintain bridges. A major development in bridge engineering is related to the development and application of Ultra-High-Performance Concrete (UHPC). One Professional Development Hour (PDH) will be offered for this event.
- OU Workshop: NSF RET Summer Workshop for K-12 Teachers.

With COVID-19 restrictions subsiding, it is expected that ABC-UTC can continue to host more in-person events. 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

During this reporting period, preparations were completed for the 2022 International Accelerated Bridge Construction Conference: Including Advanced Bridge Technologies. The Conference was held December 7-9, 2022 in Miami, Florida. It included six welcome speakers, recognition of travel scholarship contributors, five keynote presentations, 80 technical presentations, and 25 technical breakout sessions. Five Best ABC Project awards were given in the following categories: International, Emergency, Lateral Slide Technology, Self-Propelled Modular Transporter, and Prefabricated Bridge Elements and Systems. Four half-day pre-conference workshops were held on December 7; the workshops focused on Steel Bridge Design, Prestressed Concrete Bridge Design, Composites Bridge Design, and Non-Proprietary ABC-UTC Ultra-High Performance Concrete.

In addition, the ABC-UTC sponsored its Advisory Committee Annual Meeting on December 5 and also hosted the American Association of State Highway and Transportation Officials (AASHTO) Technical Committee for Construction (T-4) 2022 Mid-Year Meeting on December 6, both in Miami, Florida in conjunction with the 2022 International ABC Conference. The ABC-UTC Director presented an update on ABC-UTC activities at the AASHTO T-4 meeting per their request.

Six Monthly Webinars were conducted during this reporting period. Registered sites ranged from 647 to 935 for these free webinars. Four featured presentations were given by State Department of Transportation (DOT) representatives (Alaska, California, New York, Oklahoma) and their industry partners, featuring design and construction details and lessons learned on state-of-the-art ABC technologies incorporated in recently completed highway bridge projects in their states. The Oklahoma presentation featured the field application of an ABC-UTC research output: Ultra-High Performance Concrete connections for accelerated restoration of live load continuity on Oklahoma's U.S. 183/412 Bridge over Wolf Creek. In addition, a presentation was given on the precast substructure details in the AASHTO LRFD Guide Specifications for Accelerated Bridge Construction and the PCINE Guidelines for Precast Substructures used in ABC, 1st Edition, 2022, and a presentation featured international incremental (longitudinal) launching of bridges.

During this period, planning began for the 2023 annual In-Depth Web Training. The focus of the training will be precast substructures, and it will be held during the next reporting period on Tuesday, September 12, 2023. The 4-hour training will consist of six 40-minute modules (each a 30-minute presentation and 10-minute Q&A session), to start at 11:00 a.m. Eastern and end at 3:15 p.m. Eastern, with a 15-minute break after Module 3.

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 for the 2022 International ABC Conference Archives and the Monthly Webinars, quarterly Research Seminars, semi-annual Research Days, and annual In-Depth Web Training and their Archives. Also, the upgrade of the ABC Project and Research Databases was completed. In addition, various other ABC 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. As an example, the ABC-UTC continued working closely with the 2022 Conference Planning Committee on suggestions and the development of the December 2022 International ABC Conference in Miami. The ABC-UTC Advisory Committee has met with the ABC-UTC Center Administration prior to the ABC Conference to discuss future activities and direction.

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 2 was held on 11/09/2022 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, and Research Seminars archived on website

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 16 additional research projects currently near completion
- Implementation of Education and Workforce Development activities pending COVID-19
- Sponsor and host Summer 2023 CUTC Meeting
- Planning the 2023 Summer CUTC Meeting that will be held June 2023. This meeting (<https://abc-utc.fiu.edu/2023-cutc-summer-meeting/>) will include 4 US DOT presentations and 6 Host Session Topics addressing climate change and infrastructure resiliency
- Plan to send out call for abstracts for the 2024 International ABC Conference
- Monthly Webinars and other related technology transfer activities
- Quarterly Research Seminars will take place in April 2023 and July 2023
- Planning for semi-annual 2023 Research Day Two, which will take place November 2023
- Planning for the next Annual In-Depth Web Training
- Continuation of research projects and other activities.
- Start 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

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	04/01/22-9/30/22
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

Research	Goals	Research Performance Measures	04/01/22-9/30/22
			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 We are currently finalizing the development of four short courses, work currently in progress. (See Research Section, project #'s FIU-2016-2-3; ISU-2016-2-4; UW-2016-2-2; UW-2016-2-3)	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?
Author(s). "Article Title". <i>Journal Title</i> , Submitted <Month>, <year>.	Yes or No
Galik, WD, Wiebe, R, Stanton, JF. "Lateral-Torsional-Roll Response of Long Precast Girders: Uncracked Buckling Load". PCI Jo., submitted Mar 2023.	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
Khodayari, A., Mantawy, I. M., & Azizinamini, A. (2023). Experimental and Numerical Investigation of Prefabricated Concrete Barrier Systems Using Ultra-High-Performance Concrete. <i>Transportation Research Record</i> , 0(0). https://doi.org/10.1177/03611981231162591	Yes
Caluk, N., & Azizinamini, A. (2023). Introduction to the concept of modular blocks for lunar infrastructure. <i>Acta Astronautica</i> , 207, 153-166.	Yes
Caluk, N., & Azizinamini, A. (2022). A Summary of Technical Requirements, Environmental Factors, and Loading for Lunar Infrastructure. In <i>Earth and Space 2022</i> (pp. 701-716).	Yes
Looney, T., Mesigh, M., Volz, J., and Floyd, R. "Repair of Damaged Continuity Joints Using Ultra-High Performance, Fiber Reinforced Self-Consolidating, and Magnesium-Aluminum-	Yes

Liquid-Phosphate Concretes,” Applied Sciences, Vol. 12, No. 24, 12775, 2022, https://doi.org/10.3390/app122412775	
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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”
2022 Oklahoma Transportation Research Day (OTRD), Oklahoma City, Oklahoma, October 2022	Mendez Larrain, M. M., Ali, S. A., Hobson, K. R., Zaman, M. “Enhancement of Data Analysis Procedure of Traffic Speed Deflection Device for Pavement Structural Evaluation”
2022 Oklahoma Transportation Research Day (OTRD), Oklahoma City, Oklahoma, October 2022	Ghosh, S., Ali, S. A., Hobson, K. R. and Zaman, M. (2022). “Evaluating the Impact of Various Asphalt Rejuvenating Agents on the Performance of Asphalt Binders.”
2022 Oklahoma Transportation Research Day (OTRD), Oklahoma City, Oklahoma, October 2022	Arevalo, P. F. C., Ali, S. A., Zaman, M., and Hobson, K. R. “Laboratory Evaluation of Strength, Permeability and Durability of Recycled Concrete Aggregate (RCA) for Pavement Base Construction.”
2022 Oklahoma Transportation Research Day (OTRD), Oklahoma City, Oklahoma, October 2022	Barrios, L. U., Khalife, R., Mendez Larrain, M. M., Zaman, M., and Razzaghi, T. “Mitigation of Swelling Soil-Induced Problems in Oklahoma Using Chemical Injections.”
ACI Concrete Convention, Dallas, TX, October 2022	Gaston, J.P., Thonstad, T., and Calvi, P. M. "Shear Behavior of Macro-Synthetic Fiber-Reinforced Concrete."
ABC-UTC Research Day 2, Virtual, November 2022	Awwad, A., “Development of Rapid In-Situ Testing for Concrete Deck Durability”
ABC-UTC Research Day 2, Virtual, November 2022	Ebrahimian, A., “A Comprehensive Decision Support Tool for Accelerated Bridge Construction Considering Social Equity”
ABC-UTC Research Day 2, Virtual, November 2022	Azizinamini, A., “Development of Accelerated Bridge Construction Handbook (ABC Handbook)”
ABC-UTC Research Day 2, Virtual, November 2022	Furton, K., “Use of Canines as a Corrosion Detection Device”
ABC-UTC Research Day 2, Virtual, November 2022	Volz, J., “Innovative Multi-Hazard-Resistant Bridge Columns for ABC”
ABC-UTC Research Day 2, Virtual, November 2022	Ghosh, S., Reyes, M., “Adoption and Implementation of Project Management Plans (PMPs) for ABC Projects: Benefits and Challenges”
ABC-UTC Research Day 2, Virtual, November 2022	Vemuganti, S., “Bond Behavior of Nano-Enhanced Polymer Concrete for Bridge Deck Overlays”
ABC-UTC Research Day 2, Virtual, November 2022	Petrone, F., “Numerical Investigation of the Impact of Vertical Ground Motions on ABC Girder-to-Cap Connections in the Near-Field”
ABC-UTC Research Day 2, Virtual, November 2022	Moustafa, M., “Shake Table Testing of Precast UHPC Bridge Column with ABC Seismic Connection”

ABC-UTC Research Day 2, Virtual, November 2022	Thonstad, T., "Exploring the Combined Use of Distributed Fiber and Deformed Bar Reinforcement to Resist Shear Forces"
ABC-UTC Research Day 2, Virtual, November 2022	Stanton, J., "Developing Prestressed Concrete Girder CrossSections for Longer Spans and New Materials"
ABC-UTC Research Day 2, Virtual, November 2022	Dahlberg, J., "Accelerated Construction of Pile Foundations by Means of Elimination"
ABC-UTC Research Day 2, Virtual, November 2022	Liu, Z., "Accelerated Construction of the Highway Steel Overhead Sign Truss (SOST) through the Implementation of U-Bolt Connections"
American Geophysical Union (AGU) Fall Meeting, Chicago, IL, December 2022	Ebrahimian, A., Mohamadiazar, N., "Integrated Flood Risk and Social Equity Assessment for the Prioritization of Bridge Rehabilitation Activities Using Spatial, Data-driven, Multi-criteria Decision Analysis"
International Accelerated Bridge Construction Conference, Miami, FL, December 2022	Ebrahimian, A., Mohamadiazar, N., "Risk-based, spatial, multi-criteria analysis for prioritizing accelerated bridge construction activities"
International Accelerated Bridge Construction Conference, Miami, FL, December 2022	Khodayari, A., Mantawy, I. M., and Azizinamini, A. (2022). Development of Prefabricated Barrier System utilizing UHPC Connection for ABC Applications
International Accelerated Bridge Construction Conference, Miami, FL, December 2022	Caluk, N., Azizinamini, A. (2022) "ABC Out of This World"
International Accelerated Bridge Construction Conference, Miami, FL, December 2022	Sosa Cardenas, C., & Azizinamini, A. (2022). Upgrading Timber Piles Using Ultra-High-Performance Concrete
International Accelerated Bridge Construction Conference, Miami, FL, December 2022	Donohoe, C. and Thonstad, T. "Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction Applications."
ABC-UTC Monthly Webinar, Virtual, December 2022	Peters, W., Floyd, R. W., and Looney, T. J., "UHPC Connections for Accelerated Restoration of Live Load Continuity – Oklahoma's U.S. 183/412 Bridge over Wolf Creek,"
Transportation Research Board (TRB) Annual Meeting, Washington, DC, January 2023	Ebrahimian, A., Mohamadiazar, N., "Integrated Flood and Socio-environmental Risk Analysis for Prioritizing Accelerated Bridge Construction Activities" (poster)
Transportation Research Board (TRB) Annual Meeting, Washington, DC, January 2023	Khodayari, A., Mantawy, I. M., and Azizinamini, A. (2023). Experimental and Numerical Investigation of Prefabricated Concrete Barrier Systems Using Ultra-High-Performance Concrete. Transportation Research Record, 0(0). https://doi.org/10.1177/03611981231162591
Transportation Research Board (TRB) Annual Meeting, Washington, DC, January 2023	Caluk, N., Azizinamini, A. (2023) "Potential Impact of Future Lunar Infrastructure and Space Exploration on Terrestrial Infrastructure and Sustainability"
Transportation Research Board (TRB) Annual	Dickenson R., Afzal M.F.U.D, Mantawy I, Azizinamini A. (2023). pneumatic Spray of Ultra-High-Performance Concrete for Bridge Repair Applications. Transportation Research Record.

Meeting, Washington, DC, January 2023	
Transportation Research Board (TRB) Annual Meeting, Washington, DC, January 2023	Ghos, S., Ali, S. A., Zaman, M. and Hobson, K. R. "Comparative Evaluation of Fracture Tests for Characterizing Fatigue Cracking Resistance of Asphalt Mixes."
Transportation Research Board (TRB) Annual Meeting, Washington, DC, January 2023	Ghos, S., Ali, S. A., Zaman, M. and Hobson, K. R. "Comparative Evaluation of Fracture Tests for Characterizing Fatigue Cracking Resistance of Asphalt Mixes."
Doctoral Student Research Forum of Asphalt Materials, 2023 Annual Meeting of Transportation Research Board (TRB), National Academy of Science, Engineering and Medicine, Washington DC, 01/2023	Ghos, S., and Zaman, M. (2023). Performance of Asphalt Mixes Containing Post-Consumer Recycled (PCR) Plastics: Balanced Mix Design (BMD) Approach.
PCI Sub-Committee on Girder Stability, PCI Committee Days, 29 Feb 2023	Knight, H., Stanton, S., and Wiebe, R. "Lateral-Torsional-Roll Buckling (LTRB) of Long-Span Girders"
New Mexico Department of Transportation Research Bureau and Bridge Division, March 2023, Albuquerque, NM	Moustafa, MA. "Polymer Concrete and Non-Proprietary Ultra-High Performance Concrete for Prefabricated Bridge Decks Field Joints"

3.1.4 Conference Proceedings (TT Plan Output)

Citation for Conference Proceedings	Related ABC-UTC Project(s)
Author(s). "Article Title". Conference proceedings, year, pp.	Project Title(s)
Khodayari, A., Mantawy, I. M., & Azizinamini, A. (2023). Experimental and Numerical Investigation of Prefabricated Concrete Barrier Systems Using Ultra-High-Performance Concrete. Transportation Research Record, 0(0). https://doi.org/10.1177/03611981231162591	Prefabricated Barrier System Utilizing UHPC Connections
Donohoe, C. and Thonstad, T. (2022) "Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction Applications." Proceedings, Accelerated Bridge Construction Conference, Miami, FL	Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction Applications.
Donohoe, C. and Thonstad, T. (2022) "Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction	Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction Applications

Applications." Proceedings, International Bridge Conference, Pittsburgh, PA.	
Rani, S., Ghabchi, R., Zaman, M., & Ali, S. A. "Evaluation of Strain Recovery and Stress Sensitivity of Asphalt Binders Containing Warm-Mix Asphalt Additive and Anti-stripping Agent." In International Conference of the International Association for Computer Methods and Advances in Geomechanics, 2022, pp. 11-18, Springer.	Evaluation of Strain Recovery and Stress Sensitivity of Asphalt Binders Containing Warm-Mix Asphalt Additive and Anti-stripping Agent.
Ghos, S., Ali, S. A., Zaman, M., Arevalo, P. F. C., & Hobson, K. R. Evaluation of Stiffness and Fatigue Cracking Resistance of Post-Consumer Recycled (PCR) Plastic-Modified Asphalt Mixes. In International Conference on Transportation and Development, 2022, pp. 201-211.	Evaluation of Stiffness and Fatigue Cracking Resistance of Post-Consumer Recycled (PCR) Plastic-Modified Asphalt Mixes.
Huang, E., Rahman, A. K. F., Ghos, S., Zaman, M., Huang, L. Computational and Fourier-Transform Infrared Spectroscopy Study of Chemical Composition and Its Effect on Asphalt Aging. Submitted in 2022 AIChE Annual Meeting (Engineering Sciences and Fundamentals, 2023.	Computational and Fourier-Transform Infrared Spectroscopy Study of Chemical Composition and Its Effect on Asphalt Aging
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." Accepted for podium presentation at International Airfield and Highway Pavements Conference, 2023.	Repair Evaluations of Depressed Transverse Cracks in Asphalt Pavements.
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." Accepted for podium presentation at International Airfield and Highway Pavements Conference, 2023.	Estimating Optimum Rejuvenator Rate for Asphalt Recycling Based on Binder Rheological Properties.
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. Accepted for podium presentation at International Airfield and Highway Pavements Conference, 2023.	Subsurface Investigation using Traffic Speed Deflection Device (TSDD) in Oklahoma
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." Accepted for podium presentation at International Airfield and Highway Pavements Conference, 2023.	Assessment of Durability and Strength of Recycled Concrete Aggregate (RCA) for Use in Pavement Base Construction.
Nasim Mohamadiazar & Ali Ebrahimian. "Risk-based, spatial, multi-criteria analysis for prioritizing accelerated bridge construction	Integrated Flood and Socio-Environmental Risk Analysis for Prioritizing ABC Activities

activities". International Accelerated Bridge Construction Conference, 2022	
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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	10/01/22-3/31/23
Outcomes	Separate Contributions for Research Projects, or Follow-on Research Projects	Number of separate financial or in-kind contributions for research projects, or follow-on research projects	12
	Activities Requested by Outside Entities – 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

Outcomes descriptions for current period (10/1/23- 3/21/23)

#	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-03-04	Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts - Phase I	1- In August 2022, awarded \$100,000 follow-on research project funded by Florida Building Commission, part of which relates to protection of columns against corrosion using UHPC wrap
2016-FIU-03-04	Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts - Phase I	1-In December 2022, received award of \$3.32M grant to develop UHPC mix using local materials for 3D printing
2016-FIU-03-04	Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts - Phase I	2-In March 2023, invited presentation given at FHWA EDC-6 webinar on international UHPC pumping and spraying (Switzerland, France, USA)
2016-FIU-03-05	Prefabricated Barrier System Utilizing UHPC Connections	1-In October 2022, research team awarded NCHRP 22-56 project on development of additional barrier systems for ABC
2016-FIU-03-06	Robotic Bridge Construction: Experimental Phase I	1-In December 2022 received award of \$3.32M grant to develop UHPC mix using local materials for 3D printing
2016-FIU-02-04	Optimization of Advanced Cementitious Material for Bridge Deck Overlays and Upgrade, Including Shotcrete	2-In March 2023, invited presentation given at FHWA EDC-6 webinar on international UHPC pumping and spraying (Switzerland, France, USA)
2016-FIU-02-06	Laminated Wood Deck System for Folded Plate Girder	2-At the request of industry, in March 2023 submitted \$120K proposal to industry to use new precast polymer concrete deck on folded plate girders; this project also has other components unrelated to folded plate girders
2016-ISU-05-02	Accelerated Construction of the Highway Steel Overhead Sign Truss (SOST) through the Implementation of U-Bolt Connections	3-The output of this research will provide guidance on selection, design, and implementation of the U-bolt connection, which is commonly used on SOST to accelerate the onsite construction (assemble) of the truss frame and reduce the field labor cost.
2016-UNR-05-02	Shake Table Testing of Precast UHPC Bridge Column with ABC Seismic Connection	1-In-kind donation from ConFab for UHPC columns
2016-UNR-05-02	Shake Table Testing of Precast UHPC Bridge Column with ABC Seismic Connection	1-Small grant from PCI-West Chapter

#	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-UNR-03-03	Application of Methacrylate Polymers for Seismic ABC Connections	2-Invited presentation given in early March 2023 to NMDOT on research outputs, for potential future implementation of polymer concrete for ABC connections in New Mexico
2016-UNR-01-03	More Choices for Connecting Prefabricated Bridge Elements and Systems (PBES)	1-Receiving a new research grant from NMDOT for \$260K to further explore polymer concrete for ABC connections
2016-OU-05-01	Innovative Multi-Hazard-Resistant Bridge Columns for ABC	1-This research extends an Oklahoma DOT-sponsored research project by leading additional related tasks
2016-OU-02-01	Development of Non-Proprietary UHPC Mix	2-Based on interest by others, a half-day workshop on non-proprietary UHPC was held on December 7, 2022, in conjunction with International ABC Conference in Miami; large attendance, with 86 participants
2016-UW-05-01	Exploring the Combined Use of Distributed Fiber and Deformed Bar Reinforcement to Resist Shear Forces	2-Invited presentation at ACI Convention in October 2022
2016-UW-05-01	Exploring the Combined Use of Distributed Fiber and Deformed Bar Reinforcement to Resist Shear Forces	1-GCP Applied Technologies, LaFarge Cement, and Cal-Portland provided in-kind materials for the research project
2016-UW-05-01	Exploring the Combined Use of Distributed Fiber and Deformed Bar Reinforcement to Resist Shear Forces	1-GCP provided technical support throughout the project
2016-UW-05-01	Exploring the Combined Use of Distributed Fiber and Deformed Bar Reinforcement to Resist Shear Forces	1-Research project is using Louis Stokes Minority Students to assist on the project
2016-UW-04-01	Exploring Fiber-Reinforced Polymer Concrete for ABC Applications	2-Invited presentation at July 2022 International Bridge Conference in Pittsburgh
2016-UW-04-01	Exploring Fiber-Reinforced Polymer Concrete for ABC Applications	1-KWIK Bond Polymers has provided all polymers for the project, and technical support throughout the project

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	04/01/22-9/30/22

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	11
	<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	2

Impact descriptions for Current period (04/01/22- 9/30/22)

#	Title	Research Performance Measures (1-Influence on Practice; 2-Governing State, Local, and National Specifications; 3-Use of ABC-UTC Activities in Practice)
2016-FIU-04-05	Construction of Three Large-Scale Robots Capable of Constructing UHPC Shell, Repair of Culvert and Automated MFL	1-Several large industry groups have expressed interest in collaboration on automation
2016-FIU-04-05	Construction of Three Large-Scale Robots Capable of Constructing UHPC Shell, Repair of Culvert and Automated MFL	1-Interest expressed by industry to purchase column printers
2016-FIU-04-05	Construction of Three Large-Scale Robots Capable of Constructing UHPC Shell, Repair of Culvert and Automated MFL	1-One consultant has listed FIU's MFL technology as a technology to be used to inspect corrosion of post-tensioned internal tendons in concrete segmental bridges, in a proposal submitted to state DOT in January 2023
2016-FIU-03-01	Alternative Materials and Configurations for Prestressed-Precast Concrete Pile Splice Connection	1-Industry (Holcim, Cemex, Owens Corning) have expressed interest in research outputs
2016-FIU-03-04	Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts - Phase I	1-Miami-Dade County has expressed interest in use of spray with UHPC
2016-FIU-03-08	Automated MFL System for Corrosion Detection	3-This MFL technology is now a tool in the FDOT toolbox for inspection of corrosion in their bridges
2016-FIU-01-02	Field Demonstration-Instrumentation and Monitoring of Accelerated Repair Using UHPC Shell	1-Miami-Dade County is attempting to identify columns to repair using UHPC shell versus conventional concrete
2016-ISU-05-02	Accelerated Construction of the Highway Steel Overhead Sign Truss (SOST) through the Implementation of U-Bolt Connections	3-The research results will assist contractors in effectively and efficiently designing SOST structures without concern for the capacity and safety of the U-bolt connections. This research will also help to verify the safety of existing overhead sign support structures and ensure that the U-bolt connections are structurally

#	Title	Research Performance Measures (1-Influence on Practice; 2-Governing State, Local, and National Specifications; 3-Use of ABC-UTC Activities in Practice)
		adequate for future trusses that will support larger signs at greater span lengths.
2016-UNR-05-02	Robust Methods for UHPC Early-Strength Determination and Quality Control for ABC	1-Steelike and Cortuf (local UHPC vendors) indicated interest in using outputs (cubes) for quality control
2016-UNR-01-03	More Choices for Connecting Prefabricated Bridge Elements and Systems (PBES)	1-NMDOT will identify a pilot project to implement polymer concrete for bridge deck connections
2016-OU-02-01	Development of Non-Proprietary UHPC Mix	1-Interest expressed by contractors bidding on UHPC projects, for using non-proprietary UHPC
2016-OU-05-02	Developing Prestressed Concrete Girder Cross-Sections for Longer Spans and New Materials	1-Gave invited presentation to PCI Girders Stability Committee on 02/09/2023; Committee is interested in research and may change PCI specifications as result of research
2016-OU-04-01	Exploring Fiber-Reinforced Polymer Concrete for ABC Applications	1-PI discussing polymer concrete outputs with WSDOT; WSDOT has expressed interest

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. The Oklahoma DOT has requested the research team to assist them in seeking funding from the USDOT for link slab project implementation. An implementation proposal was submitted to the Oklahoma DOT for FY 2021/2022 on non-proprietary UHPC joint design.

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.

Most of the laboratories at FIU and partner universities resumed normal operations Spring 2021 with some backlog in conducting experiments in their laboratories due to lab closures or lab limitation during the lockdown due to COVID 19 Pandemic. We are continuing to monitor the situation continuously to ensure all research projects remain on-track.

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.