



**UTC Semi Annual Progress Report  
University Transportation Centers**

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University Transportation Center)

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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 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; TRB ABC Joint Subcommittee; 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 goals and objectives.
- During the reporting period all active research projects in Cycles 1, 2, 3 and 4 are moving forward toward completion with final deliverables expected during the next reporting period
- To date, the ABC-UTC has a total of 70 funded research projects within Cycles 1 through 4 that cover all research areas mentioned in Section 1.1.1.
- Total of 26 research projects were completed to date (including 5 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/>)
- 2021 Research Day 2 was held on November 4, 2021. PIs made a total of 14 online presentations that featured projects from Cycle 4 of our 2016 grant. Research Day 1 for April 2022 will be reported in the next reporting period. The next Research Day will be held November 2022 and will introduce projects from Cycle 5.
- 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.
- The ABC-UTC maintains a Memorandum of Understanding with the lightweight concrete industry.
- During this period 19 idea proposals were submitted for review by ABC-UTC Research Advisory Board (RAB). Thirteen idea proposals received positive feedback and were asked by RAB to proceed with preparation of final proposals. PIs from all participating university have since, submitted the final proposals (13 proposals) for Cycle 5. These Thirteen projects are scheduled to start during summer of 2022.
- The ABC-UTC developed 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).

	Date	Research Seminar Title	Student(s) Presenter	# sites registered
1	10/29/2021	Service Life Design Guidance for UHPC Link Slabs	Clay Reed (M.S.C.E, OU)	680
2	01/28/2022	Critical Impacting Factors/Trends on Bridge Design, Construction, and Operation for Future Planning	Maruf Muhaimin, (M.S.C.E, FIU)	499

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 Deliverables will be posted in May 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	75% Complete
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	90 % Complete



Project #	Project Title	Principal Investigator	Status
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	95% Complete
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	75% 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	80% 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	50% Complete
FIU-2016-4-2	Use of All Lightweight Concrete in Conjunction with UHPC Connection for Prefabricated Barrier System	Atorod Azizinamini	30% Complete
FIU-2016-4-3	Life-Cycle Cost Analysis of Ultra High-Performance Concrete (UHPC) in	Carlos M. Chang	70% Complete

Project #	Project Title	Principal Investigator	Status
	Retrofitting Techniques For ABC Project		
FIU-2016-4-4	Integrated Flood and Socio-Environmental Risk Analysis for Prioritizing ABC Activities	Ali Ebrahimian	60% Complete
FIU-2016-4-5	Construction of Three Large-Scale Robots Capable of Constructing UHPC Shell, Repair of Culvert and Automated MFL	Anthony Abrahao	45% 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	100% Complete Final Report Posted
ISU-2016-2-2	Performance of Existing ABC Projects- Inspection Case Studies (Joint project with all partner universities)	Katelyn Freeseaman	85% 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
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	Mohamed Moustafa	98% Complete Completed Final Deliverables will be posted in

Project #	Project Title	Principal Investigator	Status
	Risk Elimination and Mitigation Strategies		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	Final report under review and revision
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	35% Complete
UNR-2016-3-1	Quantitative assessment of soil-structure interaction effects on seismic performance of bridges with ABC connections	Elnaz Seylabi	50% Complete
UNR-2016-3-2	Investigating the Potential Applications of Elastomeric Polymers (Such As Polyuria And Polyurethane) For Accelerated Bridge Construction And Retrofit	Hamed Ebrahimian	80% Complete
UNR-2016-3-3	Application of Methacrylate Polymers for Seismic ABC Connections	Mohamed Moustafa	Final report under review and revision
UNR-2016-4-1	Robust Methods for UHPC Early-Strength Determination and Quality Control for ABC	Mohamed Moustafa	85% Complete
UNR-2016-4-2	Towards Autonomous Drone-Based Dynamic and Seismic Response Monitoring of Bridges	Mohamed Moustafa	50% 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

Project #	Project Title	Principal Investigator	Status
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	95% 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	60% Complete
OU-2016-4-2	Project Management Plans to Support Successful Delivery of Accelerated Bridge Construction Projects	Matthew Reyes	70% Complete
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	50% Complete
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	40% 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	85% Complete
UW-2016-3-1	Design Guidelines for ABC Column-to-Drilled-Shaft Foundation Connections in High Seismic Zones	Marc Eberhard	Final report under review and revision
UW-2016-3-2	Economic Pier-to-Pile Connections for Permanently Cased Shaft (CFST) Piles	Dawn Lehman	Final report under review and revision
UW-2016-4-1	Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction Applications	Travis Thonstad	50% 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

### 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.

<b>Atorod Azizinami-FIU</b>	Vasant H. Surti Professor of Civil Engineering; Director, Moss School of Construction, Infrastructure and Sustainability; Director, Accelerated Bridge Construction University Transportation Center (ABC-UTC); Director, Preeminent Institute for Resilient and Sustainable Coastal Infrastructure (InteRaCt).
<b>Mary Lou Ralls Newman</b>	Principal of Ralls Newman, LLC; ABC-UTC Director of Technology Transfer
<b>Armin Mehrabi- FIU</b>	Associate Professor in the Civil and Environmental Engineering Department of the College of Engineering and Computing. Director of Research, Florida International University
<b>David Garber-FIU</b>	Associate Professor and Interim Chair, Civil and Environmental Engineering Department at Florida International University (FIU) and Director of Workforce Development, Florida International University
<b>Islam Mantawy-FIU</b>	Research Assistant Professor, Civil and Environmental Engineering Department at Florida International University (FIU) and Assistant Director for Research QA/QC
<b>Terry Wipf- ISU</b>	Professor, Civil Engineering Department Co-Director, Iowa State University
<b>Brent Phares- ISU</b>	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
<b>Mohamed Moustafa- UNR</b>	Associate Professor, Civil and Environmental Engineering Department, University of Nevada, Reno
<b>John Stanton-UW</b>	Professor, Civil and Environmental Engineering, University of Washington.
<b>Marc Eberhard- UW</b>	Professor, Civil and Environmental Engineering, University of Washington

<b>Musharraf Zaman- OU</b>	David Ross Boyd Professor and Aaron Alexander Professor of Civil Engineering; Alumni Chair Professor of Petroleum and Geological Engineering; Director, Southern Plains Transportation Center
<b>K.K. Muralee Muraleetharan-OU</b>	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	10/01/21- 3/31/22
WD-1	<b>Student Education and Research Assistantships:</b> 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.	53 (FIU, UNR, ISU, OU, UW) MS/Ph.D. students have been supported
WD-2	<b>Undergraduate Internships:</b> Each ABC-UTC consortium member is expected to support undergraduate students on research projects.	9 (FIU, UNR, ISU, OU) Undergraduate students have been supported
WD-3	<b>Student Publications:</b> Each ABC-UTC consortium member is expected to support students to publish and present their work.	2 journal articles submitted, 8 journal articles published
WD-4	<b>Travel Scholarships:</b> Each ABC-UTC consortium member is expected to support students who travel to conferences to present their work.	1 travel scholarship was provided during this period. We anticipate more scholarships will be reported in the next report.
WD-5	<b>Quarterly Research Seminars:</b> 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. 1179 sites registered for the seminars

In the current reporting period there were no Education and Workforce Development activities conducted. The most recent activities can be found in report number 9: <https://abc-utc.fiu.edu/wp-content/uploads/sites/52/2021/10/UTC-Semi-Annual-Progress-Report-9.pdf>

The following Education and Workforce Development activities are being planned:

- OU Engineering Days - One-day summer camp for high school students interested in civil engineering with several hands-on activities focused on bridge construction and ABC. The Summer camp will take place June 23, 2022.
- OU Seminar: Dr. Ellie Fini, an Associate Professor at Arizona State University, will conduct a seminar to discuss about the key criteria in moving towards a carbon negative built environment. The seminar will take place on April 1, 2022.
- Additional sessions for the Professors' Workshop Series are being planned based on feedback from the initial series.



- ABC Coloring Book – We are in the initial stages of developing an ABC-related coloring book to help introduce children to basic ABC concepts.
- Public Library Outreach – the ABC-UTC is continuing discussions with the public library system (MDPLS) to explore future opportunities for collaboration.

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 virtual 2021 International Accelerated Bridge Construction Conference: With Emphasis on International Experiences. Keynote speakers were confirmed, and the draft program was finalized and published. Award nominations were received in three categories – Best International ABC Projects Constructed Outside U.S.; Most Innovative ABC Bridge System Developed Outside U.S.; and Most Influential International ABC Person of the Year Outside U.S. – and award winners were selected. The Conference was held December 8-10, 2021. It included 18 keynote presentations, 30 technical presentations, and an innovative hybrid virtual workshop on non-proprietary Ultra-High Performance Concrete (UHPC) that was held the evenings of December 9-10.

In addition, the ABC-UTC hosted the hybrid virtual American Association of State Highway and Transportation Officials (AASHTO) Technical Committee for Construction (T-4) 2021 Mid-Year Meeting on December 6, and sponsored the hybrid virtual ABC-UTC Advisory Committee Annual Meeting on December 7, both in Miami, Florida in conjunction with the virtual 2021 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 712 to 950 for these free webinars. Four featured presentations were given by State Department of Transportation (DOT) representatives (Arkansas, Montana, New Hampshire, and Washington State) 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. In addition, a presentation was given by the Massachusetts Bay Transportation Authority on one of their recent weekend railroad bridge replacement projects, and a presentation featured a privately-owned fiber-reinforced polymer (FRP) pedestrian bridge on the island of Bermuda.

During this period, planning began for the 2022 annual In-Depth Web Training. Non-proprietary Ultra-High Performance Concrete (UHPC) was selected as the focus of the training, to be held during the next reporting period on Tuesday, September 6, 2022. 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.

During this reporting period, planning also began for the face-to-face 2022 International Accelerated Bridge Construction Conference: Including Advanced Bridge Technologies, to be held December 7-9, 2022 in Miami, Florida. The Conference Planning Committee met, the Call for Papers was issued, development was begun on the slate of keynote speakers, program overviews for the four half-day pre-conference workshops to be held on December 7 were developed by the workshop coordinators, and the Conference web page was posted with details as developed.

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 virtual 2021 International ABC Conference Archives; the upcoming face-to-face 2022 International ABC Conference; 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 to a more robust and secure platform was substantially 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 worked closely with the 2022 Conference Planning Committee to identify keynote speakers for the December 2022 International ABC Conference in Miami. The Advisory Committee has been active in supporting with research areas and review of Cycle 5 research proposals from the 2016 grant. As another example, Dr. Zaman worked closely with the Oklahoma DOT to assist in sending a survey to different state DOTs as part of an on-going project.

### **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 recent period we graduated a total of four male students.

### **1.2.7 How have the results been disseminated?**

- Research Day 2 was held on 11/04/2021 where the progress of each 2016 Cycle 4 research project was presented by PIs to a general audience (comprising of State DOTs, Industry, FHWA, and other affiliates)
- Quarterly Progress Reports posted on the website
- Publications
- Presentations
- Conference Proceedings
- 6 Monthly Webinars, 2 quarterly Research Seminars, planning for 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
- Planning of the Summer 2023 CUTC Meeting
- Sponsor and host the 2022 International ABC Conference that will be held December 7-9, 2022. This Conference (<https://abc-utc.fiu.edu/conference/>) will also include four workshops (<https://abc-utc.fiu.edu/workshops/>), keynote talks and technical presentations on Advanced Technologies that are transforming bridge engineering in general and ABC specifically.
- Review of abstracts submitted to the 2022 International ABC Conference by Conference Planning Committee, and finalization of technical program



- Award nominations deadline in June 2022 for the 2022 International ABC Conference
- Monthly Webinars and other related technology transfer activities
- Quarterly Research Seminars will take place in April 2022 and July 2022
- Annual In-Depth Web Training will take place in September 2022
- Planning for semi-annual 2022 Research Day Two, which will take place November 2022
- Continuation of research projects and other activities.
- Start of Cycle 5 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	10/01/21-3/31/22
Outputs	<b>ABC-UTC Guides documents</b> – 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
	<b>Research Seminar</b> – 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)
	<b>Publications</b> – Peer-reviewed publications on research products	Number of peer-reviewed publications on research products	2 journal articles submitted, 8 journal articles published. (see 3.1.1, 3.1.2)
	<b>Presentations</b> – Research projects presented at conferences and other events	Number and quality of conferences and events during which results of the research are presented	39 (see 3.1.3, includes 14 Research Day presentations)
	<b>Development of Educational Materials</b> – Continuing education courses, web-based training, part of conference workshops, or modules for college courses	Number of developed educational materials <b>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)</b>	1 (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
Acharya, P., H. Ebrahimian, M.A. Moustafa. "Behavior Study of Commercial Polyurea under Monotonic, Rate Dependent, Cyclic and Fatigue Tensile Loading for Potential Structural Applications", <i>Polymers</i> (MDPI) Submitted March 2022	Yes
Looney, T., Leggs, M., Volz, J., and Floyd, R. "Durability and Corrosion Resistance of Ultra-High Performance Concretes for Repair," <i>Construction and Building Materials</i> , Submitted November 2021	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
Rani, S., Ghabchi, R., Ali, S. A., Zaman, M., and O'Rear, E. A. "Moisture-induced damage potential of asphalt mixes containing polyphosphoric acid and antistripping agent. <i>Road Materials and Pavement Design</i> , 2021, 1-21.	Yes
Ghos, S., Sumter, C. R., Arevalo, P.C., Ali, S. A., Zaman, M., Hobson, K. R., Kalicki, G., and Metzger, D. " Performance of Asphalt Mixes Containing Post-Consumer Recycled (PCR) Plastic using Balanced Mix Design Approach and Dry Process". Accepted at <i>Transportation Research Record (TRR)</i> , 2022.	Yes
Shahrokhinasab, E., Looney, T., Floyd, R., and Garber, D. (2021) "Effect of Fiber, Cement, and Aggregate Type on Mechanical Properties of UHPC," <i>Civil Engineering Journal</i> , Vol. 7, No. 8, 2021, pp. 1290-1309	Yes
Shahrokhinasab, E. and Garber D. (2022) "Effect of fiber type and content on mechanical properties of non-proprietary UHPC," <i>British Journal of Civil and Architectural Engineering</i> , Vol. 3, Iss. 1.	Yes
Khedmatgozar Dolati, S.S., and Mehrabi, A., "FRP sheet/jacket system as an alternative method for splicing prestressed-precast concrete piles," <i>Case Studies in Construction Materials</i> , Elsevier, June 2022	Yes
Khedmatgozar Dolati, S.S., and Mehrabi, A., "Alternative system and materials for splicing prestressed-precast concrete piles," <i>Transportation Research Records (TRR)</i> of Transportation Research Board (TRB), TRB, November 2021 Sage Publishers.	Yes
Dolati, Seyed Saman Khedmatgozar, and Armin Mehrabi. "FRP Sheet/jacket System as an Alternative Method for Splicing Prestressed-precast Concrete Piles." <i>Case Studies in Construction Materials</i> (2022): e00912.	Yes
Farhangdoust, Saman, Armin Mehrabi, and Steven Nolan. "Design of prestressed precast pile splice using glass fiber reinforced polymer (GFRP) dowels." <i>Engineering Structures</i> 244 (2021): 112806.	Yes

### 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"
TRB Concrete Bridges Committee (AKB30) Annual Meeting, Washington, DC, January 2022	Atorod Azizinamini, "Implementation of 3D Printing in ABC Technology"
UTC Discussion on emerging bridge technologies, Washington, DC January 2022	Atorod Azizinamini, "Emerging Bridge Technologies"

6th Military Additive Manufacturing Summit, Tampa, Florida January 2022	Atorod Azizinamini, attended the Military Additive Manufacturing Summit, Tampa
2022 Bridge Task Force / AASHTO T-14 Meetings, February 2022	Atorod Azizinamini, attended the Bridge Task Force meeting
NASCC: 2022 World Steel Bridge Symposium, 03/2022	Atorod Azizinamini, "Unique Short Span Solutions"
7th UTC Conference for Southeastern Region, Boca Raton, FL, March 2022	Islam Mantawy, "Recent Activities in ABC-UTC to advance American Infrastructure"
	Khedmatgozar Dolati, S.S. and Mehrabi A.B., Alternative system and materials for splicing prestressed-precast concrete piles
	Nasim Mohamadiazar & Ali Ebrahimian. "Risk-Based, Spatial, Multi-Criteria Analysis for Prioritizing Accelerated Bridge Construction Activities"
	Seyed Saman Khedmatgozar Dolati- "Alternative Materials and Configurations for Prestressed-Precast Concrete Pile Splices"
	Carlos M. Chang. "Life-Cycle Cost Analysis of Ultra High-Performance Concrete (UHPC) in Retrofitting Techniques for ABC Projects"
ASCE-EWRI St. Louis Chapter Symposium, Virtual. March 2022	Ali Ebrahimian & Nasim Mohamadiazar. "Integrated Flood and Socio-Environmental Risk Analysis for Prioritizing Bridge Projects Mohamed
Construction Institute and Construction Research Congress Joint conference Arlington, Virginia March 2022	Pradhananga, Piyush, "Leveraging Alternative Technical Concept for Contract Delivery of Accelerated Bridge Construction."
ABC-UTC Research Day 21, Virtual, November 2021	14 key researchers presented: <a href="https://abc-utc.fiu.edu/mc-events/2021-research-day-1/?mc_id=650">https://abc-utc.fiu.edu/mc-events/2021-research-day-1/?mc_id=650</a> <a href="https://abc-utc.fiu.edu/mc-events/2021-research-day-2/?mc_id=700">https://abc-utc.fiu.edu/mc-events/2021-research-day-2/?mc_id=700</a>
ASCE-EWRI World Environmental & Water Resources Congress, Atlanta, GA, March 2022	Nasim Mohamadiazar & Ali Ebrahimian. "Integrated Flood and Socio-Environmental Risk Analysis Using a Spatial Multicriteria Approach"
2021 Virtual Accelerated Bridge Construction Conference	Floyd, R. and Banik, D. "Practical Demonstration of ABC-UTC Non-Proprietary UHPC," Ultra-High Performance Concrete (UHPC) Workshop.
	Floyd, R. (presenter), Volz, J. S., Dyachkova, Y., Roswurm, S., Walker, C., and Starks, J. "Introduction and Basic Properties of UHPC," Ultra-High Performance Concrete (UHPC)
	Atorod Azizinamini, "ASCE-EWRI World Environmental & Water Resources Congress"
	Atorod Azizinamini "3D-Printing of UHPC Shells for Bridge Element using Section Printing"
2021 Oklahoma Transportation Research	Larrain, M.M., Hanlon, B., Razzaghi, T. and Zaman, M. "Prediction of Unconfined Compressive Strength in Oklahoma Clays using Linear Regressions and Random Forest Models,

Day (OTRD), National Cowboy and Western Heritage Museum, Oklahoma City, November 2021	Ghos, S., Sumter, C. R., Arevalo, P.C., Ali, S. A., Zaman, M., Hobson, K. R., Kalicki, G., and Metzger, D. "Performance of Asphalt Mixes Containing Recycled Plastics Incorporated Using the Dry Process and Balanced Mix Design"
	Cancino, P., Ali, S.A., Zaman, M., Garland, G.S. and Romero, M. "Durability and Service Life of Recycled Concrete Aggregate (RCA) for Use in Pavement Base Construction"
101 Annual Meeting-Transportation Research Board, Washington D.C., 9-01/2022.	Ghos, S., Sumter, C.R., Arevalo, P.C., Ali, S.A., Zaman, M., Hobson, K.R. and Kalicki, G., "Performance of Asphalt Mixes Containing Post-Consumer Recycled (PCR) Plastic using Balanced Mix Design Approach and Dry Process".
	Larrain, M.M., Hanlon, B., Zaman, M. and Razzaghi, T., "Prediction of Unconfined Compressive Strength in Oklahoma Clays using Linear Regressions and Random Forest Models."
ACI 239-0E, UHPC Educational Outreach, American Concrete Institute Virtual Spring Convention, March 2022	Floyd, Royce, Committee member, worked on workforce development materials for UHPC certificate program.
ACI 239-0E, UHPC Educational Outreach, American Concrete Institute Virtual Spring Convention, October 2021	Floyd, Royce, Committee member, worked on workforce development materials for UHPC certificate program.
ACI Fall 2021 Convention (online), October 2021	M. A. Moustafa, M. Abokifa. "Non-Proprietary Ultra-High-Performance Concrete for Precast Bridge Decks Field Joints", Special Session – UHPC Hot Topics
ABC-UTC 2021 UHPC Workshop, Virtual, December 2021	M. Moustafa. "Performance of ABC-UTC Non-Proprietary UHPC Deck Panel Joints"

### 3.1.4 Conference Proceedings (TT Plan Output)

Citation for Conference Proceedings	Peer-Reviewed?
Author(s). "Article Title". Conference proceedings, year, pp.	Yes or No
Pradhananga, P., and ElZomor, M. "Leveraging Alternative Technical Concept for Contract Delivery of Accelerated Bridge Construction." Proceedings of Construction Research Congress, March 2022, 902–911	Yes
Ghos, S., Ali, S.A., Zaman, M., Arevalo, P.C., and Hobson, K.R. "Performance of Asphalt Mixes Containing Post-Consumer Recycled (PCR) Plastic using Balanced Mix Design Approach and Dry Process". Accepted at the ASCE International Conference on Transportation & Development, will be held on March 31-June 3, 2022	Yes

### 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

We have initiated joint projects with all partner universities to develop a non-proprietary UHPC mix that will be available at the end of the year, promising low cost and availability to all users.

### 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	10/01/21-3/31/22
Outcomes	<b><i>Separate Contributions for Research Projects, or Follow-on Research Projects</i></b>	Number of separate financial or in-kind contributions for research projects, or follow-on research projects	4
	<b><i>Activities Requested by Outside Entities – Presentations, workshops, etc.</i></b>	Number of activities conducted	6
	<b><i>Use in the Field – Output(s) used in processes or projects</i></b>	Number of times research outputs are incorporated in bridge processes, construction projects, etc.	0

**Outcomes descriptions for current period (10/01/21- 3/31/22)**

#	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-04-04	Integrated Flood and Socio-Environmental Risk Analysis for Prioritizing ABC Activities	2-Invited speaker to make a presentation to St Louis Chapter of virtual ASCE-EWRI 2022 Environmental and Water Resources Symposium/Workshop, March 11, 2022
2016-FIU-03-09	UHPC Connection for SDCL Steel Bridge System	1- Research project sponsored by TxDOT was awarded to Texas A&M University based on previous and on-going ABC-UTC project on simple for dead continuous for live steel bridge system (PI: Matthew Yarnold and funding amount: \$689,995) <a href="https://rip.trb.org/View/1879829">https://rip.trb.org/View/1879829</a>
2016-FIU-02-01	Development of Non-Proprietary UHPC Mix	1-Used results from project in FDOT proposal on UHPC bond, which was awarded to PI in January 2022 for \$250,000
2016-OU-04-02	Project Management Plans to Support Successful Delivery of Accelerated Bridge Construction Projects	2-FHWA has expressed that they would like to encourage State DOTs to implement
2016-OU-03-01	Service Life Design Guidance for UHPC Link Slabs	2-Oklahoma DOT has requested the research team to assist them in seeking funding from USDOT for link slab project implementation
2016-OU-03-02	Development of User-Friendly Tools and Decision-Making Algorithms for Service Life Design of ABC Bridges	2-SHRP2 R19A panel chair has expressed interest in pursuing this type tool for other aspects of service life design
2016-OU-02-01	Development of Non-Proprietary UHPC Mix	2-Two-day workshop at December 2021 ABC Conference was held in partnership with others; hybrid to allow audience to experience mixing UHPC
2016-OU-02-01	Development of Non-Proprietary UHPC Mix	1-An implementation proposal submitted to Oklahoma DOT for FY 2021/2022 on non-proprietary UHPC joint design was funded for Feb 2021-Sept 2022 (\$133,000) [initially reported Apr 21]
2016-UW-02-01	Development of Non-Proprietary UHPC Mix – Evaluation of the Shear Strength of UHPC	2-Invited paper “Shear strength of ultra-high-performance concrete” in Engineering Structures, published March 2022
2016-UW-02-01	Development of Non-Proprietary UHPC Mix – Evaluation of the Shear Strength of UHPC	1- Follow-on funding in form of Mary Gates fellowship for undergraduate student, awarded Jan 22

## 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	10/01/21-3/31/22
Impacts	<i>Influence on Practice</i>	Number of changes that are made to the way an outside entity is doing business, as a result of research outputs	1
	<i>Governing State, Local, and National Specifications</i>	Number of changes, to incorporate products, that 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 (10/01/2021– 3/31/2022)

#	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-04-02	Project Management Plans to Support Successful Delivery of Accelerated Bridge Construction Projects	1- Caltrans has expressed interest to use the framework as a pilot

#### 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. The ABC-UTC works closely with the Vermont AOT to address deficiencies in culverts by repairing them using UHPC through shotcrete. 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](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 operation 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 monitoring the situation continuously to ensure all research projects are 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.