



**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 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 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, each 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 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 T-4, T-3 and T-11; 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

1.1.5 Diversity

- The lead university is a Minority Serving Institution and Hispanic Serving Institution. With a current enrollment of approximately 55,000, 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 our goals and objectives.
- The ABC-UTC hosted its first Virtual Symposium on ABCs of ABC on December 4, 2020 with 1051 sites registered.
- In this period all active research projects in Cycles 1, 2, and 3 are ongoing. In addition, the research projects for Cycle 4 were selected. A total of 15 research projects started in March 2021. In the next reporting period, the progress of each project will be reported.
- The ABC-UTC has a total of 71 funded research projects that cover all research areas mentioned in Section 1.1.1.
- Total of nine research projects from Cycles 1 and two research projects from Cycle 2 were completed. 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/>)
- 2020 Research Day 2 was held on November 6, 2020. PIs made a total of 20 online presentations on Cycle 3 projects to the public. The next Research Day will be held on April 29, 2021 and will focus on the recently funded projects in Cycle 4.
- The following Research Seminars were presented during the reporting period, with the number of independent sites attending 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 developed a Memorandum of Understanding with lightweight concrete industry.
- The ABC-UTC developed 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	10/30/2020	ABC and Safety: Work Zone Safety Analysis, Investigating Benefits from ABC on Roadway Safety	Sajad Mokhtarimousavi (Ph.D., FIU)	642
2	1/29/2021	More Choices for Connecting Prefabricated Bridge Deck Elements	Mohamed Abokifa, (Ph.D., UNR)	907

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 are posted

Project #	Project Title	Principal Investigator	Status
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	99% Complete
FIU-2016-1-4	Innovative Foundation Alternative for High-Speed Rail Application (Joint project with UNR)	Seung Jae Lee	Completed. Final Deliverables will be posted in May
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 Deliverables will be posted in May
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
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
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 May
FIU-2016-2-4	Optimization of Advanced Cementitious Material for Bridge Deck Overlays and Upgrade, Including Shotcrete	Islam Mantawy	60% Complete
FIU-2016-2-5	Robotics and Automation in ABC Projects: Exploratory Phase	Islam Mantawy	Completed Final Deliverables will be posted in May
FIU-2016-2-6	Laminated Wood Deck System for Folded Plate Girder	Atorod Azizinamini	25% 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 will be posted in May
FIU-2016-2-8	Complex Networks Perspectives Towards	Arif Mohaimin Sadri	95% Complete

Project #	Project Title	Principal Investigator	Status
	Accelerated Bridge Construction (ABC)		
FIU-2016-3-1	Alternative Materials and Configurations for Prestressed-precast Concrete Pile Splice Connection	Armin Mehrabi	65% Complete
FIU-2016-3-2	Alternative Technical Concepts for Contract Delivery Methods in Accelerated Bridge Construction	Mohamed ElZomor	52% Complete
FIU-2016-3-3	Work Zone Safety Analysis, Investigating Benefits from Accelerated Bridge Construction (ABC) on Roadway Safety	Islam Mantawy	Completed Final Deliverables will be posted in May
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	40% Complete
FIU-2016-3-5	Prefabricated Barrier System Utilizing UHPC Connections	Islam Mantawy	60% Complete
FIU-2016-3-6	Robotic Bridge Construction: Experimental Phase I	Atorod Azizinamini	50% Complete
FIU-2016-3-7	Rapid Repair and Retrofit of Timber Piles Using UHPC	Islam Mantawy	60% Complete
FIU-2016-3-8	Automated MFL System for Corrosion Detection	Atorod Azizinamini	55% Complete
FIU-2016-3-9	UHPC connection for SDCL steel bridge system	Atorod Azizinamini	95% 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	95% Complete
ISU-2016-2-2	Performance of Existing ABC Projects- Inspection Case Studies (Joint project with all partner universities)	Katelyn Freeseaman	65% Complete
ISU-2016-2-3	Synthesis of available contracting methods	Jennifer S. Shane,	99% Complete

Project #	Project Title	Principal Investigator	Status
ISU-2016-2-4	Development of Link Slabs: A Short Course Module	Behrouz Shafei	92% Complete
ISU-2016-3-1	Investigation of The Efficacy Of Helical Pile Foundation Implementation In Accelerated Bridge Construction Projects – Phase I	Justin Dahlberg	80% Complete
ISU-2016-3-1	Multi-Span Lateral Slide Laboratory Investigation: Phase 1	Katelyn Freeseaman	45% 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	80% Complete
UNR-2016-1-3	More Choices for Connecting Prefabricated Bridge Elements and Systems (PBES)	Mohamed Moustafa	Completed Final Deliverables will be posted in May
UNR-2016-2-1	Development of Non-Proprietary UHPC Mix - Application to Deck Panel Joints (Joint project with all partner universities)	Mohamed Moustafa	90% complete
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	30% Complete
UNR-2016-3-1	Quantitative assessment of soil-structure interaction effects on seismic performance of bridges with ABC connections	Elnaz Seylabi	40% 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	20% Complete
UNR-2016-3-3	Application of Methacrylate Polymers for Seismic ABC Connections	Mohamed Moustafa	75% Complete
OU-2016-1-1	Development of Guide For Selection of Substructure For	Musharraf Zaman (Joint project with FIU)	Completed

Project #	Project Title	Principal Investigator	Status
	ABC Projects (Joint project with all partner universities)		Final Deliverables are posted
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	98% Completed
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	45% Complete
OU-2016-3-2	Development of User-friendly Tools and Decision-making Algorithms for Service Life Design of ABC Bridges	Shima Mohebbi	50% Complete
UW-2017-1-1	Performance Evaluation of Structural Systems for High-Speed Rail In Seismic Regions	John Stanton	85% Complete
UW-2017-1-2	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	98% Complete
UW-2016-2-2	Development of ABC Course Module- Seismic Connections	John Stanton	35% Complete
UW-2016-2-3	Development of ABC Course Module - Design of CFST Components and Connections for Transportation Structures	Dawn Lehman	95% Complete
UW-2016-2-4	Performance of Existing ABC Projects - Inspection Case Studies (Joint project with all partner universities)	John Stanton	65% Complete
UW-2016-2-5	Tsunami Design Forces for ABC Retrofit	Marc Eberhard	30% Complete

Project #	Project Title	Principal Investigator	Status
UW-2016-3-1	Design Guidelines for ABC Column-to-Drilled-Shaft Foundation Connections in High Seismic Zones	Marc Eberhard	40% Complete
UW-2016-3-2	Economic Pier-to-Pile Connections for Permanently Cased Shaft (CFST) Piles	Dawn Lehman	45% Complete

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, 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).
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. Director of Research, Florida International University
David Garber-FIU	Assistant Professor, Civil and Environmental Engineering Department at Florida International University (FIU) and Director of Workforce Development, Florida International University
Islam Mantawy-FIU	Research Assistant Professor, Civil and Environmental Engineering Department at Florida International University (FIU) and Assistant Director for Research QA/QC
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	Assistant 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	10/1/20 to 3/31/21
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.	49 (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.	11 (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.	5 journal articles submitted, 5 journal articles published, (submitted, accepted, or published)
		Due to Covid-19, there were no in-person conference presentations (presented); 6 presentations were made virtually
WD-4	Travel Scholarships: Each ABC-UTC consortium member is expected to support students who travel to conferences to present their work.	7 students received support (registration fee only) to present their work virtually in the January 2021 TRB Annual Meeting.
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 as part of the ABC-UTC technology transfer activities.	Total of 2 students presented in 2 research seminars
		1549 sites registered for the seminars

In addition to these core Education and Workforce Development activities, the following activities are being planned:

- Engineering First Teachers Workshop – The University of Nevada, Reno, University of Washington, and University of Oklahoma are currently planning a teacher’s workshop in collaboration with Iowa State University for content and FIU for coordination. This workshop will include 2 days: online day and on-site in-person training day for K-5 teachers to introduce bridge engineering module. The workshop will take place in July and August across all the sites.
- ABC Coloring Book – We are in the initial stages of developing an ABC-related coloring book to help introduce children to basic ABC concepts.
- Workforce Development Webinar Series – We are in the planning stage for a WD-related webinar series. We plan to have the first webinar in Summer/Fall 2021.
- 3D Printing Model Development – partnering with Miami Beach Urban Studios on 3D printing and model development.
- Public Library Outreach – the ABC-UTC is continuing discussions with the public library system (MDPLS) to explore future opportunities for collaboration.

We continue to evaluate future 2021 WD based on the current situation with COVID-19. 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, planning continued for the 2021 International Accelerated Bridge Construction Conference. Another web meeting was held with state Department of Transportation non-financial co-sponsors of past ABC-UTC Accelerated Bridge Construction Conferences during this period to receive additional stakeholder input. As a result of those discussions, the decision was made to hold the 2021 Conference virtually with international presentations and no awards program, followed by the typical in-person Conference in 2022. The 2021 Conference details were posted on the ABC-UTC website. The Call for Abstracts for international presentations was announced, with submission deadline of July 23, 2021.

The half-day regional Contractor/Owner Collaboration on ABC Programs Workshop to be held in Nebraska in 2021 continued on hold during this reporting period due to the state DOT continuing travel restrictions because of the pandemic.

The one-day virtual Symposium on ABCs of ABC was held on December 4, 2020. Over a dozen presentations were given by state DOT, FHWA, industry, and ABC-UTC representatives on the latest essential information that bridge professionals need to know to effectively put ABC into practice.

The ABC-UTC Director attended the virtual 2021 American Association of State Highway and Transportation Officials (AASHTO) Technical Committee for Construction (T-4) Mid-Year Meeting in March 2021 and presented an update on ABC-UTC activities per their request.

Six Monthly Webinars were conducted during the reporting period. For these free webinars, the number of registered sites ranged from 869 to 1,283 although the web room software limit is 1,000 participants. Four presentations were given by bridge owners (Alabama DOT, Connecticut DOT, Georgia DOT, and the City of New Braunfels-Texas) 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. Two presentations on rapid railroad bridge construction projects were given by industry representatives.

Planning for the 2021 In-Depth Web Training, to be held in September 2021, was begun during this period. The Connecticut DOT accepted the ABC-UTC's invitation to feature their programmatic implementation of ABC in the State of Connecticut. The 4-hour training will consist of six 40-minute modules, each with a 30-minute presentation and 10-minute Q&A session.

The ABC-UTC website (<https://abc-utc.fiu.edu/>) was updated with the latest ABC-UTC research and workforce development activities. Also posted were the Monthly Webinar, Research Seminar, Research Day, and In-Depth Web Training recordings and other documents. Also, work continued on data entry of completed ABC construction projects in the ABC Project Database, working with bridge owners to complete these submissions for posting on the open web. In addition, various other ABC events, news items, and details were posted.

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.

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 11 students, 3 females and 8 males.

1.2.7 How have the results been disseminated?

- Research Day 2 was held on 11/06/2020 where the progress of each 2016 Cycle 3 research project was presented by PI's to a general audience (comprising of State DOTs, Industry, FHWA, and other affiliates).
- Quarterly Progress Reports posted on the website.
- Publications
- Presentations
- Conference Proceedings
- Webinars, Research Seminars, In-depth Web Training

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:

- Conducting meetings with more than 30 state bridge engineers and to discuss the research needs in the area of accelerated bridge construction
- Completion of 20 additional research projects currently near completion
- Implementation of Education and Workforce Development activities pending COVID-19
- Planning of the Summer 2023 CUTC Meeting
- The planning of the next ABC-UTC Conference to be held in December 2021. The deadline for submitting abstracts is July 23, 2021
- Monthly Webinars and other related technology transfer activities
- Quarterly Research Seminars will take place on April 30 and July 30, 2021
- Semi-annual 2021 Research Day One will take place on April 29, 2021
- Continuation of research projects and other activities.
- Working with bridge owners to implement the results of research projects developed by ABC-UTC
- 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 a cooperative working relationship with US Forest Service
- 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	10/1/20-3/31/21
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	2 (see 1.2.1 research table)
	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	5 (see 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	11 (see 3.1.3)

Research	Goals	Research Performance Measures	10/1/20-3/31/21
	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 working on developing 4 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)	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
Muhaimin, A.M.M., Zhang, L., Dhakal, S., Lv, X., Pradhananga, N., Kalasapudi, V.S., Azizinamini, A. "Identification and Analysis of Factors Affecting the Future of Bridge Design, Construction, and Operation". <i>Journal of Management in Engineering</i> , Submitted Nov, 2020	Yes
Sosa Cardenas, C., Mantawy, I. M., & Azizinamini, A. <i>Repair of Timber Piles Using Ultra-High-Performance Concrete</i> . <i>Transportation Research Record (TRR)</i> , February, 2021	Yes
Rehmat, S., Sadeghnejad, A., Mantawy, I. M., & Azizinamini, A. <i>Ultra-High Performance Concrete Based Connections for Concrete Filled Steel Tubes for Accelerated Bridge Construction Applications</i> , February, 2021	Yes
Sadeghnejad, A., & Azizinamini, A. Simple for Dead Load and Continuous for Live Load Connection Detail Using UHPC for Steel Bridges in Non-Seismic Areas" <i>Structures</i> , February, 2021	Yes
Zhao M, Lehman D and Roeder C. (2021) "Analytical Investigation of a New Direct Column-to-Cased Shaft Connection" <i>Engineering Structures</i> , January 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
Khedmatgozar Dolati, S. S., and Mehrabi, A.B. "Review of Mechanical Bar Couplers for Splicing Precast Concrete Members." <i>Sci J Research & Rev.</i> 3(1):2021. SJRR.MS.ID.000551. DOI: 10.33552/SJRR.2021.03.000551.	Yes
Khedmatgozar Dolati, S. S., and Mehrabi, A.B. "Review of aAvailable Systems and Materials for Splicing Prestressed-precast Concrete Piles." <i>Structures</i> 2021; 30:850-65 doi:10.1016/j.istruc.2021.01.029.	Yes
Abokifa, M., M.A. Moustafa, "Experimental Behavior of Poly Methyl Methacrylate Polymer Concrete for Bridge Deck Bulb Tee Girders Longitudinal Field Joints",	Yes

Construction and Building Materials, 2021	
Zhao M, Lehman D and Roeder C. (2021) "Modeling Recommendations for RC and CFST Sections in LS-Dyna including Bond Slip" Engineering Structures, February 2021.	Yes
Aboukifa, M., M.A. Moustafa, "Experimental Seismic Behavior of Ultra-High Performance Concrete Columns with High Strength Steel Reinforcement", Engineering Structures, 2021	Yes
Javed, A., Mantawy, I. M., & Azizinamini, A. (2021). "3D-Printing of Ultra-High-Performance Concrete for Robotic Bridge Construction", Transportation Research Record (TRR). Accepted, 2021	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"
Student Symposium-Southeast Region UTC Conference, November, 2020	Seyed Saman Khedmatgozar Dolati- Alternative Materials and Configurations for Prestressed-Precast Concrete Pile Splices
ABC-UTC Research Day 2, Virtual, November 2020	20 key researchers presented: https://abc-utc.fiu.edu/mc-events/2020-research-day-2/?mc_id=606
100th TRB Annual Meeting, Virtual, January 2021	Lu Zhang, Information Systems in Construction Management Subcommittee, The Transportation Research Board (TRB) 99th Annual Meeting, Washington D.C., Jan 2021
100th TRB Annual Meeting, Virtual, January 2021	Construction Management Committee AFH10, The Transportation Research Board (TRB) 99th Annual Meeting, Washington D.C., Jan 2021
Transportation Research Board Annual Meeting, Washington D.C. Virtual, January 2021	Ahmed, M.A., Sadri, A.M., Mehrabi, A., Azizinamini, A. "Complex Networks Perspectives towards Accelerated Bridge Construction.", 2021 Transportation Research Board Annual Meeting.
100th TRB Annual Meeting, Virtual, January 2021	Sosa Cardenas, C., Mantawy, I. M., & Azizinamini, A. (2021). Repair of Timber Piles Using Ultra-High-Performance Concrete (No. TRBAM-21-03084).
100th TRB Annual Meeting, Virtual, January 2021	Javed, A., Mantawy, I. M., & Azizinamini, A. (2021). 3D-Printing of Ultra-High-Performance Concrete for Robotic Bridge Construction (No. TRBAM-21-03768).
100th TRB Annual Meeting, Virtual, January 2021	Mokhtarimousavi, S., Hadi, M., Sadeghvaziri, E., & Azizinamini, A. (2021). Evolutionary Training Approaches for Machine Learning Models for Analyzing Classification Imbalanced Crash Datasets (No. TRBAM-21-03834).
100th TRB Annual Meeting, Virtual, January 2021	Valikhani, A., Jaber, A., & Azizinamini, A. (2021). An Investigation of Reinforced Concrete Beams Retrofitted with Ultra-High Performance Concrete (No. TRBAM-21-03744).
100th TRB Annual Meeting, Virtual, January 2021	Khodayari, A., Mantawy, I. M., & Azizinamini, A. (2021). Introducing a New Connection Detail for Connecting Prefabricated Barrier to Concrete Deck Using UHPC (No. TRBAM-21-03857).

100th TRB Annual Meeting, Virtual, January 2021	Sheharyar Rehmat, Amir Sadeghnejad, & Atorod Azizinamini (2021). Connection Details for Concrete Filled Tubes using UHPC for Resilient Bridge Substructure
AISC TC5, Virtual Meeting, November 2020	Committee Member, Dawn Lehman
ACI Convention, Virtual, March 2021	Committee Member, John Stanton

3.1.4 Conference Proceedings (TT Plan Output)

Nothing to report

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

- We have initiated preliminary work to develop the next frontier in bridge engineering, specifically the application of automation in bridge construction inspection with an emphasis on accelerated field procedures.

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	10/1/20-3/31/21
Outcomes	Separate Financial Contributions for Research Projects or Follow-on Research Projects – The impact of the research projects will be assessed by the level of interest expressed by state DOTs and/or industry	Number of separate financial contributions for research projects or follow-on research projects	10
	Activities Requested by Stakeholders – Presentations, workshops, etc. Number of activities conducted	Number of activities conducted	5
	Use in ABC Projects – Output(s) used in an ABC construction project	Number of times research outputs are incorporated in bridge construction projects, as identified by the PIs in collaboration with the bridge owners	1

Outcomes descriptions for current period (10/01/2020 – 3/01/2021)

#	Title	Outcomes (Separate Financial Contributions for Research Projects, or Follow-on Research Projects)
2016-C4-FIU02	Use of All Lightweight Concrete in Conjunction with UHPC Connection for Prefabricated Barrier System	Lightweight concrete industry will be actively participating in this project and has provided \$15,000 funds plus in-kind materials
2016-C3-FIU08	Automated MFL System for Corrosion Detection	Florida DOT Districts 1 and 6 have strongly recommended supporting additional research by FDOT to expand the technology for rapid inspection of external tendons
2016-C2-FIU02	Performance of Existing ABC Projects: Inspection Case Studies	Florida DOT District 6 provided boat, operator, and technician for inspections
		University of Miami invited FIU to join their research team to evaluate ABC bridge on UM campus
		Work on University of Miami bridge set the foundation for proposing the concept to FHWA; FHWA invited FIU to submit a full research proposal for the concept
2016-C3-ISU01	Investigation of The Efficacy of Helical Pile Foundation Implementation In ABC Projects – Phase 1	Iowa DOT expressed strong interest in continuing the project into Phase 2 due to outputs from this Phase 1 project
2016-C3-ISU02	Multi-Span Lateral Slide Laboratory Investigation: Phase 1	Iowa DOT expressed strong interest in continuing the project into Phase 2 due to outputs from this Phase 1 project
2016-C3-UNR02	Investigating the Potential Applications of Elastomeric Polymers (such as Polyuria and Polyurethane) for Accelerated Bridge Construction and Retrofit	In-kind donation from Bridge Preservation LLC

#	Title	Outcomes (Separate Financial Contributions for Research Projects, or Follow-on Research Projects)
2016-C4-OU01	Design Guidance for UHPC Connections of Precast Girders Made Continuous for Live Load	Follow-on research implementation (field) project from the Oklahoma DOT (see also C2-OU01)
2016-C2-OU01	Development of Non-Proprietary UHPC Mix	Follow-on research implementation (field) project from the Oklahoma DOT

#	Title	Outcomes (Activities Requested by Stakeholders)
2016-C3-FIU01	Alternative Materials and Configurations for Prestressed-Precast Concrete Pile Splice Connection	Florida DOT and Louisiana DOTD have expressed interested in outputs including specifications
2016-C2-FIU01	Development of Non-Proprietary UHPC Mix	As requested by Oklahoma DOT, Atorod Azizinamini gave a presentation ("UHPC-based Bridge Engineering Solutions") during Oklahoma Transportation Research Day (OTRD) on October 20, 2020
2016-C2-FIU05	Robotics and Automation in ABC Projects: Exploratory Phase	Based on Atorod' s presentation during Nov-19 TRB 1st International Conference on 3D Printing and Transportation, Army Corps of Engineers contacted ABC-UTC to submit an idea proposal for use of this technology for military construction
2016-C2-UNR01	Development of Non-Proprietary UHPC Mix – Application to Deck Panel Joints	Invited presentation given to Global Sealer Technologies (GST International) internal group, Oct 2020
2016-C2-OU01	Development of Non-Proprietary UHPC Mix	As requested by Oklahoma DOT, Royce Floyd gave a presentation ("Non-Proprietary UHPC for Transportation Structures") during Oklahoma Transportation Research Day (OTRD) on October 20, 2020
2016-C4-UW01	Exploring Fiber-Reinforced Polymer Concrete for Accelerated Bridge Construction Applications	Invited presentation given to WSDOT Bridge Technical Committee, Jan 27, 2021

#	Title	Outcomes (Use in ABC Projects)
2016-C3-FIU08	Automated MFL System for Corrosion Detection	Florida DOT, following June 2020 closure of the Roosevelt Bridge in Stuart, FL, contacted ABC-UTC to use this output

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	10/1/20-3/31/21
Impacts	<i>Influence on Standard Practice</i>	Number of changes that are made to the standard way an outside entity is doing business, as a result of research outputs	9
	<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>Standard Use of Outputs in ABC Projects</i>	Number of states using the outputs in their bridge construction as a standard practice, as identified by the PIs in collaboration with the bridge owners	2

Impact descriptions for Current period (10/01/2020– 03/31/2021)

Research Project		Impacts
#	Title	Influence on Standard Practice
2016-C4-FIU02	Use of All Lightweight Concrete in Conjunction with UHPC Connection for Prefabricated Barrier System	Lightweight concrete industry is looking to the ABC-UTC to partner with industry to expand the use of lightweight concrete in ABC applications (due to effectiveness of ABC-UTC's technology transfer strategies)
2016-C3-FIU03	Work Zone Safety Analysis, Investigating Benefits from ABC on Roadway Safety	Strong interest from bridge owners to develop tools using this research output to quantify the safety provided by ABC
2016-C3-FIU04	Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts - Phase I	Vermont AOT expressed interest in using outputs of this research to address deficiencies of multiple VT culverts that lack upgrade alternatives
2016-C3-FIU05	Prefabricated Barrier System Utilizing UHPC Connections	Research output is viewed by bridge professionals as an excellent alternative to be pursued
2016-C2-FIU02	Performance of Existing ABC Projects: Inspection Case Studies	Florida DOT strongly interested in inspection outputs; ABC-UTC provided report
2016-C3-ISU01	Investigation of The Efficacy of Helical Pile Foundation Implementation in ABC Projects – Phase 1	Willingness of Iowa DOT to support this project is strong indication of their desire to have another option for deep foundations
2016-C3-ISU01	Investigation of The Efficacy of Helical Pile Foundation Implementation in ABC Projects – Phase 1	Iowa DOT has expressed interest in a county-level demonstration project
2016-C3-UNR02	Investigating the Potential Applications of Elastomeric Polymers (such as Polyuria and Polyurethane) for Accelerated Bridge Construction and Retrofit	Bridge Preservation LLC is utilizing UNR for product proof testing

Research Project		Impacts
#	Title	Influence on Standard Practice
2016-C2-OU03	Performance of Existing ABC Projects: Inspection Case Studies	ABC-UTC's activities have partly contributed to Oklahoma DOT's awareness of ABC benefits

Research Project		Impacts
#	Title	Standard Use of Outputs in ABC Projects
2016-C4-OU01	Design Guidance for UHPC Connections of Precast Girders Made Continuous for Live Load	Oklahoma DOT will be incorporating change to allow this output (non-proprietary UHPC) as a standard option (see also C2-OU01)
2016-C2-OU01	Development of Non-Proprietary UHPC Mix	Oklahoma DOT will be incorporating change to allow this output (non-proprietary UHPC) as a standard option (see also C4-OU01)

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

ABC-UTC works closely with stakeholders to enhance the transportation systems with a focus on accelerated bridge construction techniques. For example, ABC-UTC works closely with the lightweight concrete industry to expand the use of lightweight concrete in ABC applications. ABC-UTC works closely with the Vermont AOT to address deficiencies in culverts by repairing them using UHPC through shotcrete. As a respond 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?

ABC-UTC has identified research areas that will help the ABC cause and that falls outside the mission of 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. Iowa DOT has expressed interest in a county level demonstration for the use of helical piles as accelerated foundation option, Oklahoma DOT is considering ABC-UTC non-proprietary UHPC mix as one of their standard options and was included in project bid. For industry, Bridge Preservation LLC is utilizing UNR for proof testing of their polyuria products.

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 was guest editor for the Special Collection on Accelerated Bridge Construction in ASCE Journal of Bridge Engineering with more than 20 articles published on various aspects of ABC in this special collection, including precast concrete segmental columns, seismic design for ABC, pretensioned concrete bent caps,

prefabricated composite box girders, ABC methods such as lateral slide and SPMT, etc (https://ascelibrary.org/page/jbenf2/accelerated_bridge_construction). Dr. Azizinamini was recently invited to serve as guest editor for Materials 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 operation last Fall with limitation 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

ABC-UTC implemented bi-annual meetings among all PIs and Co-PIs to collect all outcomes and impacts for every project. It was noted that some outcomes and impacts were missed to be reported timely to the USDOT during the last report periods. Tables below show the collected outcomes and impacts prior to 10/01/2020.

#	Title	Outcomes (Separate Financial Contributions for Research Projects, or Follow-on Research Projects)
2016-C3-ISU02	Multi-Span Lateral Slide Laboratory Investigation: Phase 1	Match funds from Iowa DOT
2016-C2-ISU01	Development of Non-Proprietary UHPC Mix	Match funds from Iowa DOT
2016-C3-UNR03	Application of Methacrylate Polymers for Seismic ABC Connections	Transpo Industries provided polymer concrete for research project
2016-C1-UNR03	More Choices for Connecting Prefabricated Bridge Elements and Systems (PBES)	Transpo Industries provided polymer concrete for research project
2016-C2-OU01	Development of Nonproprietary UHPC Mix	Matching funds from Oklahoma DOT
2016-C1-OW01	Performance Evaluation of Structural Systems for High Speed Rail in Seismic Regions	Match funds from Pacific Earthquake Engineering Research Center (PEER)
2016-C1-ISU01	Contracting Methods for ABC Projects: Case Studies and Consensus Building	Match funds from Kiewit
2016-C1-ISU02	Bidding of ABC Projects: Case Studies and Consensus Building	Match funds from Kiewit

#	Title	Outcomes (Activities Requested by Stakeholders)
2016-C2-UNR02	Synthesis of Available Methods for Repair of Reinforced Concrete and Prestressed Concrete Girders	In August 2020, a design firm (Quiroga Pfeiffer Engineering Corporation) requested research project outputs to assist with a bridge girder project that they were engaged in for a State DOT; relevant references were provided
2016-C1-UNR03	More Choices for Connecting Prefabricated Bridge Elements and Systems (PBES)	Research project results on use of polymer concrete were provided per request of east coast bridge owner
2016-C2-FIU01	Development of Non-Proprietary UHPC Mix	Collaboration between FIU, UNR, and OU invited to present a full-day non-proprietary UHPC mix workshop, held in Miami on 12-11-2019
2016-C2-UNR01	Development of Non-Proprietary UHPC Mix – Application to Deck Panel Joints	As reported under 2016-C2-FIU01, collaboration between FIU, UNR, and OU invited to present a full-day non-proprietary UHPC mix workshop, held in Miami on 12- 11-2019
2016-C2-OU01	Development of Non-Proprietary UHPC Mix	As reported under 2016-C2-FIU01, collaboration between FIU, UNR, and OU invited to present a full-day non-proprietary UHPC mix workshop, held in Miami on 12- 11-2019
2016-C2-OU01	Development of Non-Proprietary UHPC Mix	On 03/20/2020 Royce Floyd responded to phone request from Alabama DOT Miscellaneous Structures & Bridge Design engineer for input on similar non-proprietary UHPC efforts in Alabama

#	Title	Outcomes (Activities Requested by Stakeholders)
2016-C2-OU02	Development of ABC Course Module – The Risk Due to Induced Earthquakes and Accelerated Solutions	Texas DOT, with similar issue, approached research team for advice, May 2020 (see also C1-OU02)
2016-C3-UW01	Design Guidelines for ABC Column-to-Drilled-Shaft Foundation Connections in High Seismic Zones	Invited presentation at 2020 Pacific Earthquake Engineering Research Center (PEER) Annual Meeting on January 17, 2020; speaker was John Stanton

Research Project		Impacts
#	Title	Influence on Standard Practice
2016-C3-FIU05	Robotic Bridge Construction: Experimental Phase I	Approached by NASA to be part of research project for Artemis (<i>originally reported as outcome; subsequently moved to impact</i>)
2016-C2-FIU05	Robotics and Automation in ABC Projects: Exploratory Phase	Approached by NASA to be part of research project for Artemis (<i>originally reported as outcome; subsequently moved to impact</i>)
2016-C2-ISU01	Development of Non-Proprietary UHPC Mix	February 2020 PBS News Hour's Breakthrough series interview with ISU PIs on non-proprietary UHPC research (https://www.pbs.org/newshour/show/this-super-strong-concrete-could-repair-aging-bridges-heres-whats-standing-in-the-way)
2016-C1-OU02	Rapid Retrofitting Techniques for Induced Earthquakes - Phase I	Texas DOT, with issues related to manmade earthquakes, approached research team for advice, May 2020

Research Project		Impacts
#	Title	Governing State, Local, and National Specifications
2016-C2-OU01	Development of Non-Proprietary UHPC Mix	Non-proprietary UHPC mix was included as an option in bid documents for traditional UHPC projects, which says they now have that option for subsequent projects