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ACCOMPLISHMENTS

What are the major goals and objectives of the program?

The broad goals and objectives of the Tier I 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 ABC knowledge to the profession; develop a next-generation ABC workforce; 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 design, repair and construction of the nation's aging bridge infrastructure in line with U.S. DOT's strategic focus on State of Good Repair.

Specific goals and objectives of the ABC-UTC can be broken into three general categories:

Research

- Extend principles of ABC to the repair, replacement and preservation of bridges, including multi-hazards and seismic issues.
- Enhance the service life of bridges constructed using principles of ABC by emphasizing design for service life (at the design stage), preservation, and timely maintenance.
- In collaboration with other UTCs develop traffic safety systems specifically for modular bridge construction for all traffic levels.
- Develop next generation bridge systems that are best suited for ABC applications.
- Building on existing knowledge, develop the next generation of decision-making tools for better communication among stakeholders, which should assess the merits of various construction processes and visualize the entire life span of bridges in a seamless manner from birth to recycling.
- Develop new and innovative ideas and applications for use of advanced materials, such as Ultra High-Performance Concrete in ABC.
- Investigate use of robotics in bridge construction
- Facilitate adaptation of high-speed rails, by developing ABC solutions specific to high speed rails
- Investigate ABC solutions for addressing challenges imposed by climate change
- Develop new knowledge to extend the application of ABC in seismic areas.

Education and Workforce Development

- Become the educational focal point for advancing principles of ABC.
- Develop and nationally distribute K-12 educational materials related to bridge engineering, and ABC in particular, for educating and attracting future generations of transportation and sustainability engineers.
- Develop educational materials that could be used in academia at both undergraduate and graduate levels for explaining fundamental and advanced topics in ABC.
- Develop and deliver continuing education opportunities on ABC for practicing engineers across the country.

- Train graduate students knowledgeable in implementation of ABC in practice
- Train high school teachers by providing them with tools that they can incorporate into their curriculum to teach bridge engineering with an especial focus on ABC.

Technology Transfer

- Become a national repository and focal point for assisting federal, state, and local agencies on matters related to ABC.
- Educate the current and next generation of engineers on when and how to effectively use ABC technologies.
- Lower the cost of utilizing ABC technologies by conducting outreach activities at the local, regional, and national levels that include the dissemination of research results.
- Develop implementable tools that follow the form and function of AASHTO-type publications.
- Conduct webinar and national conferences.

What was accomplished under these goals?

Meetings among the partner universities were held during the reporting period to track progress in different tasks, using a matrix that included a list of planned tasks. Progress in different tasks related to research, education and workforce development, and technology transfer was discussed during these meetings between ABC-UTC directors, associate directors, graduate students and key researchers.

Following is a description of various tasks by three main categories that are research, workforce development, and technology transfer.

Research

ABC-UTC aims to carry out research in close association with federal and state agencies and bridge industry. During the reporting period, technical advisory committee (TAC) was established for research projects that were selected based on input of ABC-UTC steering committee, AASHTO T-4 and AASHTO T-3 Committees. The technical advisory committee consists of professionals from FHWA, state DOT and industry. These professionals were carefully selected for each research projects based on their experience that was closely related to the ABC-UTC research projects. Meetings were held with TAC to discuss ABC-UTC research projects.

Following table provides a list of research projects, technical advisory committee members for each project and progress made in the project during the reporting period.

Project #	Research Project Title	TAC Members	Progress (Apr-2016 Sept-2016)
FIU-1	Compilation of all ABC research that is ongoing and completed Recommended by AASHTO T-4	Ahmad Abu-Hawash, Iowa DOT Ben Beerman, FHWA	The research database is functioning and online. The researchers are beginning to expand it and advertise it for others to use. The research and project databases will be part of an ABC workshop at TRB in January 2017.

Project #	Research Project Title	TAC Members	Progress (Apr-2016 Sept-2016)
FIU-2	Compilation of ABC solutions	Ahmad Abu-Hawash, Iowa DOT Ben Beerman, FHWA	The researchers continue to communicate with bridge owners and other parties involved in ABC to further expand the database. The research and project databases will be part of an ABC workshop at TRB in January 2017.
FIU-3	Extending the application of simple for dead continuous for live load (SDCL) to seismic regions- Part 1: Numerical Study	Tom Ostrom, Caltrans Reza Farimani, Thornton Tomasetti BijanKhaleghi, Washington DOT Elmer Marx, Alaska DOT Bruce Johnson and Hormoz Seraj, Oregon Department of Transportation, Ben Beerman, FHWA	Phase I one the investigation is completed and Phase II is initiated. Phase I included the development of suitable detail for connecting steel girders over middle supports and applicable to moderate to high seismic regions.
FIU-4	Estimating total cost of bridge construction using ABC and conventional methods of construction (Phase I)	Ben Beerman, FHWA Mary Lou Ralls Newman, Ralls Newman, LLC	This project has been completed.
FIU-5	Development of Manual for Enhanced Service Life of ABC Bridges	Bruce Johnson, Oregon DOT Ali Maher, Rutgers University Hamid Ghasemi, FHWA Carlos Duart, CDR Maguire	Recent work on this manual has concentrated on developing complete arrays of reinforcement for closure pours. In order to achieve this goal, the following steps have been undertaken: A study of the ABC project database was conducted, and all possible types of closure pour for ABC projects were categorized. From a structural standpoint, there are concerns about the performance of cast-in-place closure pour connections in ABC projects, in particular durability and integrity. To address these concerns, an

Project #	Research Project Title	TAC Members	Progress (Apr-2016 Sept-2016)
			<p>experimental program was conducted in FIU. A test program was developed to investigate the optimal lap splice length and staggering space on existing ABC bridge closure pours. At the first phase, Laboratory test specimens were constructed with twelve different lap splice length and 2-inch staggering space of closure pours using hooked bar. Twelve specimens constructed, each was 8-foot long, 1-foot wide and 8-inch thickness. The closure pour specimens constructed in two stages.</p> <p>The testing of the first 12 specimens are completed. Data to date indicates that for number 4 reinforcement very short overlap is needed, while additional tests need to be conducted to establish lap splice length for number 6 bars and larger.</p> <p>Another component of the development of customized manual for design of ABC bridges for service life consists of the development of a methodology for rapidly repairing substandard bridges in need of repair. To this end a novel idea of UHPC Shell is developed. FIU has submitted a provisional patent on the idea. To evaluate the merit of the method developed a total of 8 test specimens are completed. Results indicated great potential of repairing existing substandard bridges in an accelerated manner without interrupting traffic.</p>
FIU-6	Alternative ABC Connections Utilizing UHPC		<p>A scaled connection between a precast column and a cap beam was constructed and tested at Florida International University (FIU) under combined axial compression and reversed cyclic loading to form the plastic hinge and failure. The results show an acceptable behavior of the connection. This phase of the study was a feasibility study using large-scale test. Results indicate that ABC-UTC alternative connection developed has great merits.</p> <p>To develop practical design and detailing recommendations, additional tests specimens are under construction.</p> <p>This investigation addresses both seismic and non-seismic applications.</p>

Project #	Research Project Title	TAC Members	Progress (Apr-2016 Sept-2016)
FIU-7	Extending Application of SDCL to ABC (Phase II – Experimental):		Following completion of Phase I of the study, Phase II of the investigation was initiated. A third scale test specimen, incorporating the SDCL seismic connection developed at FIU, is near completion. The test specimen is meant to evaluate experimentally the merits of the connection detail developed before deploying it in the shake table test that is scheduled to be carried out at University of Nevada-Reno.
FIU-8	Estimating total cost of bridge construction using ABC and conventional methods of construction (Phase II)		<p>During the reporting period, both transportation system and construction data were collected for a case study for the everglades port in Broward Country, FL. This subarea network was imported to DTAlite (dynamic traffic assignment tool). First, the mobility estimation based on multi-level of traffic analysis tools were compared, including Q-DAT, FREEVAL_WZ, QuickZone and DTAlite. Through the comparison, data requirements and outputs were identified for each tool. Secondly, both days to day learning method and conventional traffic assignment method in DTAlite were utilized to compare the mobility impacts due to construction activities. It can be found a day to day learning method is able to capture the daily driving behavior changes. In addition, the modeling process in the demand forecasting model may need to be reinitiated at the trip generation and trip distribution steps to assess the business and freight impacts.</p> <p>For the final evaluation of total costs, including construction and user costs, TOPSIS will be utilized in the assessment of total costs of bridge construction projects. The fuzzy evaluation method is able to take user’s preference into consideration in the alternative selection of bridge construction projects. Also, the fuzzy evaluation method was built based on spreadsheet tool.</p>
FIU-9	Demolition Requirements for Bridge Construction		During the reporting period, a survey was developed with the help of the Research Advisory Panel (RAP) and was distributed to bridge owners across the US. Results of the survey were summarized in a final

Project #	Research Project Title	TAC Members	Progress (Apr-2016 Sept-2016)
	Projects – Best Practices Guideline		report for the first phase of the research. This report is being used to communicate the state of practice for bridge demolition to members of AASHTO T-4 and TRB ABC Subcommittee. Feedback from these committees will determine the direction and scope for future phases of the project.
ISU-1	Development of Crash-Tested Prefabricated Bridge Railings Recommended by AASHTO T-4	Ahmad Abu-Hawash, Iowa DOT Tim Fields, Connecticut DOT	The laboratory crashing-test was finished during this period. The Conclusions drawn from this study are as follows. The two precast barrier systems did not have any construction challenges in the assembly. The barrier system connections were assembled as planned without any challenges. The construction of the inclined connection required minimal access to install the connection reinforcement. The u-bar connection required access from under the bridge overhang to install the u-shaped connection reinforcement.
ISU-2	Extending the Application of ABC to Bridge Rehabilitation (synthesis first then developmental)	Ahmad Abu-Hawash, Iowa DOT Ben Beerman, FHWA	This project has been completed. Please see the final report at http://www.intrans.iastate.edu/research/documents/research-reports/ABC_for_rehab_synthesis_w_cvr.pdf
ISU-3	Durability and strength of grouted sleeve couplers	Ahmad Abu-Hawash, Iowa DOT Elmer Marx, Alaska DOT	This project has been completed and the final report is posted.
ISU-4	Material Design and Structural Configuration of Link Slabs for ABC Applications		A comprehensive study on a range of material choices that can be considered for a link slab was completed by the research team. It was found that the selected materials must demonstrate high durability, enough flexibility (to be further quantified), low modulus of elasticity, high strain capacity, no (or micro) cracking under service loads, and corrosion resistivity to maintain the long-term performance. For this purpose, various cement matrices and fiber types that can be added to the mix were explored through an intense review of the existing literature. The research team works to finalize a select set of materials that will be subjected to a set of experimental tests at the

Project #	Research Project Title	TAC Members	Progress (Apr-2016 Sept-2016)
			material level to verify that the expected performance characteristics are met.
ISU-5	Investigation of Macro-Defect Free Concrete for ABC including Robotic Construction		To date, we have worked with the material manufacturer to perform an initial series of compression and tensile tests to investigate how fabrication impacts these engineering parameters. Following initial test result analysis, a second iteration of the mix matrix was developed. Although there were several motivations for this, the primary motivation was to increase the ductility of the matrix.
ISU-6	An Integrated Project to Enterprise-Level Decision Making Framework for Prioritization of Accelerated Bridge Construction		A metric used by the World Bank to prioritize funding for aid in developing countries: social return on investment (SROI) is implemented to estimate the value of investment in ABC techniques to reduce social, economic, and environmental impacts to the road network users. The Missouri Department of Transportation (MoDOT) completed the replacement of more than 500 bridges as part of the "safe and sound" project using the ABC techniques. Five counties mostly in the agricultural part of Missouri were used as the case study and estimated the benefits/costs of the utilization of ABC. The results showed that using holistic metrics such as SROI that consider a socioeconomic perspective of project impact can be effectively used as a prioritization tool for future projects.
UNR-1	Behavior and design of precast bridge cap beams with pocket connections	Bijan Khaleghi, Washington DOT Elmer Marx, Alaska DOT Tom Ostrom, Caltrans	This project has been completed and the final report is posted.
UNR-2	Evaluation of Seismic Performance of Bridge Columns w/ Couplers and Development of Design Guidelines	Ahmad Abu-Hawash, Iowa DOT Bijan Khaleghi, Washington DOT	This project has been completed and the final report is posted.

Project #	Research Project Title	TAC Members	Progress (Apr-2016 Sept-2016)
		Elmer Marx, Alaska DOT Tom Ostrom, Caltrans	
UNR-3	Development and Seismic Evaluation of Pier Systems w/ Pocket Connections and Hollow PT/UHPC Columns	Bijan Khaleghi, Washington DOT Elmer Marx, Alaska DOT Tom Ostrom, Caltrans	Analysis of the data for the single column was completed and analytical studies of the column began. A journal paper for this project has been drafted and is undergoing internal review. Analysis of data for the two-column pier model is nearly completed.
UNR-4	Shake Table Studies of a Bridge System with ABC Connections:		The bridge model has been designed and pretested analytical studies are in progress. Donation of the superstructure steel girders and other components is being handled by NSBA through the effort of FIU. Contracts for construction of the pier model and the precast decks have been issued. Development of instrumentation plan has begun.

Education and Workforce Development

The following table lists different tasks related to workforce development provides a brief description of each task, identifies the lead institution for each task, and states the progress made in each task during the reporting period.

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
WD-1	Student Education: Each ABC-UTC consortium member will be expected to mentor a minimum of one graduate student for each \$50,000 to \$75,000 in project work.	ALL (FIU, ISU, UNR)	In this period, two doctoral students in UNR have been directly funded by ABC-UTC. In total, 24 graduate students are working on ABC-UTC related research projects. Thirteen at FIU, seven at ISU, and four at UNR.
WD-2	Increasing the number of research assistantship opportunities for graduate students.	ALL (FIU, ISU, UNR)	In this period, two more graduate research assistantships have been granted in UNR. Therefore, Research assistantships were increased by two from the previous reporting cycle.
WD-3	Upgrading course content in the areas of structural engineering and construction engineering/management to include modules on the use of ABC topics.	UNR	In this period, audios were added by UNR to two ABC-seismic seminars, one for general public and the other for bridge engineers. These are posted on the UNR-Saiidi YouTube channels.
WD-4	Developing online courses and making progress towards the development of fully online degree programs.	FIU	FIU and ISU have continued to develop materials to move some courses online.
WD-5	Mentorship Program – Development of a mentoring program where students are put in direct contact with industry representatives who are active in the field of accelerated bridge construction.	FIU, ISU, UNR	The following professionals from industry have been mentoring ABC-UTC students on research during this reporting period: <ul style="list-style-type: none"> • Michael LaViolette, HDR • Mike Culmo, CME • Finn Hubbard, Fish & Associates • Dr. Reza Farimani, Thornton Tomasetti • Dr. Francesco Russo, Michael Baker Jr., Inc. • Dr. Jawad Gull, HDR • Dr. Ardalan Sherafati, BlueScope Construction. • Nathan Johnson, Kleinfelder Engineering • Claudia Pulido, Kiewit Infrastructure Engineers • Mark Reno, Quincy Engineering • Ashkan Vosooghi, AECOM

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			All three center partners are actively encouraging productive mentorship relationships between graduate students and former graduate students and professionals.
WD-6	Graduate Student Seminars – Each graduate student will be required to give a technical presentation at the conclusion of their research study. These presentations will be delivered electronically as part of the ABC-UTC technology transfer activities.	ISU	These seminars occur quarterly and feature graduate student speakers who worked on ABC-UTC related research projects. The second and third graduate student seminar was delivered in April and July 2016 respectively and were attended by over 200 sites across the world. It is important to note each site usually have several attendees. These seminars are recorded and archived on the ABC-UTC website for future viewing.
WD-7	Encourage one-on-one interaction with industry.	ISU Lead; ALL (FIU, ISU, UNR)	Opportunities for graduate and undergraduate students is being encouraged through the mentorship program, the internship program, and the graduate student seminar program. Additionally, all project technical advisory committees include numerous members of the technical community.
WD-8	Internship Program- All three consortium members will develop an undergraduate research internship program.	UNR Lead; ALL (FIU, ISU, UNR)	All three partner universities have hired undergraduate students as interns on ABC-UTC research projects. Fourteen undergraduate students are supported through internships and are actively involved in research during the past reporting period.
WD-9	Educational Modules- Develop three educational modules, in the form of print and videos, for K-12 with focus on developing age-appropriate programs.	UNR	An ABC-seismic module was prepared and presented at three middle-school summer camps that were held at UNR in June 2016. The PowerPoint presentation has been posted on the project website.
WD-10	Summer Teacher Program- Each consortium member will develop a two-day-long summer camp for elementary, middle and high school teachers to familiarize them with basics of transportation engineering in general and principles of bridge engineering and ABC in particular.	FIU, ISU, UNR	The Summer Transportation Camp held in FIU was a two-week summer camp that included the exploration of both the transportation and structural engineering sides of transportation. The camp includes: <ul style="list-style-type: none"> • Multiple field trips (to local bridge construction sites, infrastructure hotspots, and the world-class laboratory facilities at FIU)

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			<ul style="list-style-type: none"> • Lectures and presentations by experts in various transportation and structure related fields • Team jeopardy trivia event • Balsa wood bridge competition involving moving loads and natural disasters <p>One of the focal points of the camp was Accelerated Bridge Construction (ABC). Students were introduced to ABC techniques through a series of lessons and then were given the opportunity to explore their use in the balsa wood bridge project. Student teams were required to prefabricate their bridges in three pieces and transport them to the bridge site. They then had 30 minutes to construct their final bridge.</p> <p>The inaugural camp was attended by 18 Miami-area high school students ranging from sophomore to seniors.</p> <p>Also, UNR prepared an ABC-seismic module which was presented at three middle-school summer camps.</p>
WD-11	Online e-Zine Go- ISU will publish quarterly articles in the online “e-zine Go!” related to the ABC-UTC’s mission.	ISU	Two articles were published during this reporting period: <ul style="list-style-type: none"> • “ABC: Fiber diet for bridges” (UNR) • “The rise of 3D printing in ABC” (FIU)
WD-12	Offer travel scholarship with emphasis on traditionally underrepresented students	All (FIU, ISU, UNR)	Travel scholarships were offered for students to attend and present at ACI, ASCE, and International UHPC Symposium.
WD-13	Make presentations on transportation careers at major minority institutions and conferences.	All (FIU, ISU, UNR)	Presentations were made by students at ACI, International UHPC Symposium, ASCE, and 8th International Conference on Bridge Maintenance, Safety, and Management. Many of these presentations were made by students from FIU, which is designated a minority university.

Technology Transfer

The following table lists different tasks related to technology transfer provides a brief description of each task, identifies the lead institution for each task, and states the progress made in each task.

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
T2-1	AASHTO Subcommittee on Bridges and Structures (SCOBS) Meeting: ABC-UTC Director and key research team members will be attending the annual AASHTO meetings and, where needed and possible, will brief the related committees on research findings by giving technical presentations.	All (FIU, ISU, UNR)	2016 SCCBS meeting held in Minnesota June 26–30, was attended by some ABC-UTC key research team members.
T2-2	National Committee Meetings: Each ABC-UTC consortium member will be expected to attend at least 3 meetings of national committees each year (other than annual AASHTO meetings) and give technical presentations.	All	Technical Presentations were given by UNR partners at international conferences in June 2016.
T2-3	Journal Publications: Each ABC-UTC consortium member will be expected to prepare and submit a minimum of two journal publications, in high impact journals, for each research project as lead.	All	Several papers were prepared and submitted by FIU, UNR and IS, based on first and second-year research projects, being carried out, to TRB and other journals.
T2-4	Outreach: Each ABC-UTC consortium member will be expected to participate in a minimum of two outreach activities each year. Ideally, one outreach activity would be geared toward a national audience and one would be geared toward regional audiences.	FIU, ISU and UNR	All universities have been active in outreach and assisting local and national agencies to learn about ABC. Key researchers at all three institutions routinely give presentations at national conferences. Dr. Azizinamini has given several keynote talks on ABC at national gatherings and more are planned.
T2-5	ABC strategic plan: In collaboration with AASHTO T-4 Technical Committee on Construction, a strategic implementation plan will be developed to promote and	All	Nothing new to report.

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
	support the use of ABC across the U.S.		
T2-6	Collaboration with bridge groups: The research team will work with other bridge groups such as the FHWA Long-Term Bridge Performance Program.	All	Nothing new to report.
T2-7	Provide bridge owners with tools to implement ABC as a standard practice: Research team will convene meetings of select practicing engineers and bridge owners to assist them in the implementation of ABC as a standard practice.	FIU	Nothing new to report.
T2-8	Supplier input: Suppliers that specialize in products suitable for making ABC more efficient will be consulted on their products and systems; as appropriate, ABC-UTC will assist suppliers in assembling and/or acting as an independent body that evaluates the products (similar to HITEC).	All	Nothing new to report.
T2-9	Data dissemination through partnership: Several existing resources will be utilized for data dissemination, such as a) DOT/RITA research clusters and b) NEEShub, which is established by the NSF George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES).	All	Nothing new to report. NEES program is completed.
T2-10	Offices of technology transfer: As appropriate, cooperative agreements will be developed with industries for eventual marketing of products developed through research studies conducted by the ABC-UTC. At the request from an individual researcher, industry partner or the ABC-UTC Director, it will be determined if there is a merit to	All	A new concept in the form of thin Ultra High-Performance Concrete (UHPC) in shell form is envisioned for retrofitting bridges in the coastal area, especially as related to sea level rise issues. A provisional patent was prepared for patenting the concept by FIU.

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
	develop a patent based on research outcomes.		
T2-11	Three forms of publication: ABC-UTC publications will be of three forms, each serving a different purpose: (1) journal articles, (2) conference papers; and (3) research reports.	All	Conference papers on ABC were prepared for upcoming conferences and journals.
T2-12	Technical briefs: Every ABC research project will have a one-page (front and back) technical brief of the pertinent details that will be sent out via e-news to a larger transportation community.	All	Description of each ABC-UTC research project has been posted on ABC-UTC website. www.abc-utc.fiu.edu
T2-13	Dedicated website: Currently the FIU ABC Center has a website (www.abc.fiu.edu). With enhancements, this website will become the official site of the ABC-UTC.	All	The dedicated ABC-UTC website (http://www.abc-utc.fiu.edu) continues to be improved and refined.
T2-14	Periodic e-newsletter (ABC Talk): An online newsletter (ABC Talk) will be published to present the highlights of ABC-UTC activities. The availability of the newsletter will be communicated through resources available to AASHTO, FHWA, and TRB.	All	The 2015 Highlights Report summarizing the ABC-UTC's work during 2015 was published online on ABC-UTC website and is now accessible using the following link: https://abc-utc.fiu.edu/wp-content/uploads/sites/52/2016/02/ABC-UTC_2016_Highlights_v5-website.pdf
T2-15	Printed newsletter: Annually, a hard copy version of the select articles from e-newsletter (ABC Talk), summarizing the highlights of ABC-UTC activities, will be published	All	A limited number of hard copy version of the 2015 Highlights Report summarizing the ABC-UTC's work during 2015 was also published.
T2-15a	Webcasting and video Clips: Selected tests will be webcast, and video clips of critical parts of selected tests will be developed.	All	The UNR shake table testing of April 2016 was webcast. Select videos of the shake table tests were posted on the project website.
T2-16	Social media: Researchers will actively participate in professional social media such as Facebook, Twitter, and LinkedIn.	All	FIU continue activities in social media, promoting ABC-UTC activities. The Youtube channel has been prepared and

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			many video clips of shake table tests conducted at UNR have been posted.
T2-17	<p>Statewide or region-wide continuing education courses: Three short courses, each four hours long, will be developed: a short course on basic principles of ABC and overview (FIU), a short course on issues related to seismic (UNR), and a short course on use of principles of ABC in small communities (ISU). The materials for each course will be developed for presentation on the web to DOTs and consulting engineers across the country. The course materials will be archived for future use.</p>	FIU	FIU, ISU and UNR gave number of presentations at various gathering
T2-18	<p>In-depth web conference training: Specific featured presentation topics from the planned monthly webinars will be expanded to 3- to 4-hour in-depth web conference training to assist practitioners in developing a better understanding of the specific topics.</p>	FIU	An In-Depth web training was conducted on October 4, 2016. Similar to the 2014 and 2015 inaugural training, the 2015 in-depth web training was four hours long and consists of six modules, each a 30-minute presentation by an expert in the focus area of the module followed by a 10-minute Q&A session. This year's in-depth web training featured the Tennessee DOT's "Fast Fix 8" Project in Downtown Nashville.
T2-19	<p>Monthly ABC webinars: The current FIU ABC center monthly webinars, attracting 3000 to 5000 participants, will be continued. Webinars will be archived for subsequent viewing.</p>	FIU	FIU has continued to organize and successfully conduct monthly free webinars, without any interruption. These webinars are being attended by about 3000 to 4000 bridge professionals from across the country. Almost all State DOTs listen to these monthly webinars. These monthly webinars have become the most listened bridge webinar in the country.

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
T2-20	Annual national conference: In coordination with FHWA, state DOTs, and industry, a national ABC conference will be organized each year.	FIU	The next conference is scheduled for December 6, 7 and 8, 2017 (www.abc-utc.fiu.edu)
T2-21	Annual workshop: An annual 1.5-day technical workshop on ABC topics of current concern will be held at FIU. FIU held its first such ABC workshop in December 2012 with more than 40 attendees. There will be a registration fee and the event will be self-supporting.	FIU	Ten workshops, covering different ABC topic, were held during 2015 National ABC conference. For details of these nine workshops, please visit https://abc-utc.fiu.edu/conference/2015-national-accelerated-bridge-construction-conference/
T2-23	Assessment and Evaluation Tool: Initially develop the tool, determine the goal of the activity, and identify the criteria. For each activity, populate the tool. See EDC “National and State Implementation Goals” and SHRP2 “Evaluation of Benefits.”	FIU	The progress of different activities is being monitored using evaluation matrices.

What opportunities for training and professional development has the program provided?

Please see the tables above for more details. Following are highlights of information provided in the tables listed above

- 2014 and 2015 National ABC conference
- Educational modules were developed and used in graduate courses to train students.
- Nine, four-hour long, workshops were held in conjunction with 2014 National ABC Conference. Ten, four hour or 8 hour long workshops were held during 2015 National ABC conference
- Monthly webinars were continued
- ABC-UTC web-based graduate student seminars were held in January, April and July 2016.
- In-depth webinar series were initiated and held in November 2014, November 2015 and October 2016
- ABC sessions are organized at several major conferences
- Ph.D. students, post-doctoral fellows, and undergraduate students involved in ABC-UTC projects have been trained on ABC topics.
- Webcasting of shake table tests conducted at UNR.

- UNR YouTube channel for video clips of the tests and posting of general aspects of ABC seismic connections.

How have the results been disseminated?

The results will be disseminated by followings:

- 2014 and 2015 National ABC conference
- Educational modules
- Nine, four-hour long, workshops were held in conjunction with 2014 National ABC Conference. Ten, four hour or 8 hour long workshops were held during 2015 National ABC conference
- Monthly webinars
- In-depth webinars
- Web-based graduate student seminars
- Various presentations to AASHTO, TRB, other national and international conferences, website, and conference publications.

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

During next reporting period, the following tasks will be emphasized:

- Continuing with conduct of in-progress research projects and research selected for the second incremental funding
- Briefing the ABC-UTC steering committee members on research progress on November 28
- Two-day face to face annual meeting with ABC-UTC steering committee members in Miami to review the ABC-UTC activities and planning the next year activities. This annual meeting will be held on December 8 and 9, 2016 in Miami.
- Conducting 4th graduate student seminar
- Development of more ABC educational modules
- Identifying more workforce development tasks and activities
- Continuing with monthly free webinars
- Continue with the research tasks as envisioned in the proposals. Continue with the training of researchers, outreach to the ABC stakeholders, other engineers, and researchers. Continue to disseminate research results through various outlets.
- Continuing with organization of the 2017 National ABC conference

PRODUCTS

Publications, conference papers, and presentations

❖ FIU

- Garber D (2016), *Compilation of Accelerated Bridge Construction (ABC) Bridges*, Miami: Florida International University.
- Garber D (2016), *Compilation of Results from Bridge Demolition DOT Survey*, Miami: Florida International University.
- Several papers were prepared and submitted to TRB
- Final report for completed projects are posted on ABC-UTC website.
- Organized a special session at 2017 TRB meeting to provide a summary of ABC-UTC research product. The workshop will be held on Sunday and is organized by ABC-UTC and TRB ABC committee.
- Several final reports as reported on ABC-UTC website

❖ ISU

Final reports as reported in ABC-UTC website

❖ UNR

- Mehraein, M., "Seismic Performance of Bridge Column-Pile-Shaft Pin Connections for Application in Accelerated Bridge Construction," ABC-UTC at Florida International University, October 2016.
- Varela, S., "Design for Disassembly: Towards the Resilient and Sustainable ABC of the Future," ABC-UTC at Florida International University, October 2016.
- Mohebby, A., M. Saiidi, and A. Itani, "Self-Centering Bridge Column with CFRP Tendons under Seismic Loads," General Session, Advanced Materials, 8th International Conference on Bridge Maintenance, Safety, and Management, Iguacu, Brazil, June 2016.
- Mohebby, A. and M. Saiidi, "Development and Seismic Evaluation of Pier Systems w/Pocket Connections and PT/UHPC Columns" Poster Presentation, First US-Chile Workshop on Bridge Earthquake Engineering, Reno, Nevada, August 2016.
- Mohebby, A., M. Saiidi, A. Itani and A. Robb, "Seismic Response of an ABC Two-Column Bent Using Advanced Materials" Poster Presentation, First US-Chile Workshop on Bridge Earthquake Engineering, Reno, Nevada, August 2016.
- Shoushtari, E., M. Saiidi, A. Itani and M. Moustafa, "Design of an ABC Two-Span Bridge System with Steel Superstructure for Shake Table Testing," Poster Presentation, First US-Chile Workshop on Bridge Earthquake Engineering, Reno, Nevada, August 2016.

Website(s) or other Internet site(s)

- **ABC-UTC Website (<https://abc-utc.fiu.edu/>):** The ABC-UTC website was redesigned and recreated to create a more functional and user-friendly site to house all ABC-related materials. The website is host to all of the webinars, in-depth web training, student seminars, and short courses that have been hosted by the center. These videos are all available for free to users. The site also has all information, progress reports, final reports, and other resources related to all of the ABC-UTC research projects.
- **ABC Project and Research Database (<http://utcdb.fiu.edu/>):** As part of two separate ABC-UTC research projects, an ABC Project and Research Database website and the online database was created. This database contains information related to ABC-related projects and research. The website interface allows users to easily search and access this information and also gives users the ability to propose enter in new projects and research for consideration in the official database.
- **Technical Training Certificate Delivery System (<https://abc-utccerts.fiu.edu/>):** This site and system allow for the webinar, graduate student seminar, and other technical training event certificates of participation to be created and delivered to attendees and participants. The system also creates an online database of all user certificates, which allows participants to access all past certificates of attendance.
- UNR YouTube channel to host shake table testing of bridges

Technologies or techniques

FIU has envisioned an innovative approach for rapid retrofit of bridges, exhibiting corrosion activities using thin shells of UHPC and robotic construction. A provisional patent is prepared for submission.

Inventions, patent applications, licenses

FIU is working on following innovative ideas for which patent application will be filed:

- Sandwich Folded Girder System
- Innovative connection for ABC Bridges.
- THIN UHPC shell for rapid retrofitting
- Extending the maximum length of Folded Plate Steel bridge System to 110 ft using an innovative connection detail.

Other products

Nothing to Report

PARTICIPANTS & COLLABORATING ORGANIZATIONS

ABC-UTC Participants at FIU

Name	Atorod Azizinamini, Ph.D.
Program/Project Role	ABC-UTC Director
Number of hours worked during the	Approximately 400 hrs.

reporting period	
Contribution to Program/Project	Responsible for oversight and governance of ABC-UTC
Funding Support	FIU, FDOT, UTC
Collaborated with individual in foreign country	N.A.
Country(ies) of foreign collaborator	N.A.
Traveled to foreign country	N.A.
If traveled to foreign country(ies), duration of stay	N.A.

Name	Mary Lou Ralls, P.E.
Program/Project Role	ABC-UTC Technology Transfer Director
Number of hours worked during the reporting period	Approximately 240 hrs.
Contribution to Program/Project	Responsible for oversight of ABC-UTC technology transfer and assistance to ABC-UTC Director as needed
Funding Support	UTC, AASHTO, TTI
Collaborated with individual in foreign country	N.A.
Country(ies) of foreign collaborator	N.A.
Traveled to foreign country	N.A.
If traveled to foreign country(ies), duration of stay	N.A.

Name	Ali Mostafavi
Program/Project Role	ABC-UTC – Co-PI on a research project
Number of hours worked during the reporting period	Approximately 120 hours
Contribution to Program/Project	Co-PI on the Public Cost Estimation Project
Funding Support	ABC-UTC
Collaborated with individual in foreign country	N.A
Country(ies) of foreign collaborator	N.A
Traveled to foreign country	N.A
If traveled to foreign country(ies), duration of stay	N.A

Name	Mohammad Hadi
Program/Project Role	ABC-UTC – Co-PI on a research project
Number of hours worked during the reporting period	Approximately 80 hours
Contribution to Program/Project	PI on the Public Cost Estimation Project (FIU-4)
Funding Support	ABC-UTC
Collaborated with individual in foreign country	N.A
Country(ies) of foreign collaborator	N.A

Traveled to foreign country	N.A
If traveled to foreign country(ies), duration of stay	N.A

Name	Wallied Orabi
Program/Project Role	ABC-UTC – Co-PI on a research project
Number of hours worked during the reporting period	Approximately 110 hours
Contribution to Program/Project	Co-PI on the Public Cost Estimation Project
Funding Support	ABC-UTC
Collaborated with individual in foreign country	N.A
Country(ies) of foreign collaborator	N.A
Traveled to foreign country	N.A
If traveled to foreign country(ies), duration of stay	N.A

Name	David Garber
Program/Project Role	ABC-UTC Co-Director of WD activities and PI on research projects
Number of hours worked during the reporting period	Approximately 500 hours
Contribution to Program/Project	Responsible for Project #FIU-1, #FIU-2, ABC-UTC website, technology training certificate delivery, and assisting with other center activities.
Funding Support	ABC-UTC and FIU
Collaborated with individual in foreign country	N.A
Country(ies) of foreign collaborator	N.A
Traveled to foreign country	N.A
If traveled to foreign country(ies), duration of stay	N.A

ABC-UTC Participants at ISU

Name	Brent Phares
Program/Project Role	ABC-UTC Co-Director
Number of hours worked during the reporting period	350 hours
Contribution to Program/Project	Overall leadership
Funding Support	-
Collaborated with individual in foreign country	No
Country(ies) of foreign collaborator	NA
Traveled to foreign country	No

If traveled to foreign country(ies), duration of stay	NA
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ABC-UTC Participants at UNR

Name	M. Saiid Saiidi
Program/Project Role	ABC-UTC Co-Director
Number of hours worked during the reporting period	200 hours
Contribution to Program/Project	Management of ABC-UTC-Seismic projects and workforce development/outreach at UNR.
Funding Support	ABC-UTC, Caltrans, WashDOT
Collaborated with individual in foreign country	No
Country(ies) of foreign collaborator	NA
Traveled to foreign country	Yes, but not w/ ABC-UTC funding
If traveled to foreign country(ies), duration of stay	NA

Name	Ahmad Itani
Program/Project Role	ABC-UTC-Seismic Co-PI at UNR
Number of hours worked during the reporting period	130 hours
Contribution to Program/Project	Help manage ABC-UTC-Seismic projects and workforce development/outreach at UNR.
Funding Support	ABC-UTC, Caltrans
Collaborated with individual in foreign country	No
Country(ies) of foreign collaborator	NA
Traveled to foreign country	No
If traveled to foreign country(ies), duration of stay	NA

Industry Partners and Collaborators

ABC Center Executive Board

- Atorod Azizinamini, Florida International University
- Mary Lou Ralls, Ralls Newman, LLC, Former State Bridge Engineer, State of Texas
- Kevin Thompson, URS, Former State Bridge Engineer California
- Jugesh Kapur, Burns & McDonnell, Former State Bridge Engineer, Washington State
- Ben Beerman, Federal Highway Administration
- Paul Liles, Former State Bridge Engineer, Georgia

ABC-UTC Steering Committee Members

- Atorod Azizinamini, Florida International University
- Mary Lou Ralls, Ralls Newman, LLC, Former State Bridge Engineer, State of Texas
- Kevin Thompson, URS, Former State Bridge Engineer California
- Jugesh Kapur, Burns & McDonnell, Former State Bridge Engineer, Washington State
- Ben Beerman, Federal Highway Administration
- Carmen Swanwick, AASHTO SCOBS T-4, Chair, Utah DOT
- Paul Liles, AASHTO SCOBS T-4 Vice Chair, Georgia DOT
- Ahmad Abu-Hawash, Iowa DOT
- Nancy Daubenberger, Minnesota DOT
- Shoukry Elnahal, Delaware River & Bay Authority
- Bruce Johnson, Oregon DOT
- Bijan Khaleghi, Washington State DOT
- Elmer Marx, Alaska DOT&PF
- Tom Ostrom, California DOT
- Robert Robertson, Florida DOT **(New)**
- Monica Starnes, Transportation Research Board
- Wayne Symonds, Vermont Agency of Transportation

Federal Highway Administration

- Ben Beerman, Resource Center
- Phil Yen, Office of Infrastructure

Industrial and Government partners

- John Busel, American Composites Manufacturers Association (ACMA)
- Reid Castrodale, Lightweight concrete rep.
- Randy Cox, American Segmental Bridge Institute (ASBI)
- Jerry DiMaggio, Applied Research Associates, Inc.
- Bill Duguay, Associated General Contractors of America (AGC), rep.; J.D. Abrams, LP
- Mike Engestrom, Small Span Steel Bridge Alliance (SSSBA)
- Mal Kerley, NXL Construction Services, Inc.
- Danielle Kleinhans, National Concrete Bridge Council (NCBC), rep.
- Bill McEleney, National Steel Bridge Alliance (NSBA)
- William Nickas, Precast/Prestressed Concrete Institute (PCI)
- Eliza Partington, FIGG

Collaborators from Partner Universities

- SaiidSaiid, University of Nevada, Reno
- Brent Phares, Iowa State
- Ahmad Itani, University of Nevada, Reno
- Terry Wipf, Iowa State University

Faculty and Staff at Florida International University

- Mohammad Hadi, Associate Professor
- Seung Jae Lee, Assistant Professor
- David Garber, Assistant Professor
- Xia Jin, Assistant professor
- Hesham Ali, Professor of Practice
- Ali Mostafavi, Assistant Professor
- Wallied Orabi, Assistant Professor
- Alireza Mohammadi, Graduate Student
- Huy Pham, Graduate Student
- Ramin Taghinezhad, Graduate Student
- Alireza Valikhani, Graduate Student
- Azade Jaberi, Graduate Student
- Mahsa Farzad, Graduate Student
- Mohamadreza Shafieifar, Graduate Student
- Taek-RyongSeong, RIST - South Korea
- Chan-Hee Park, RIST - South Korea

IMPACT

What is the impact on the development of the principal discipline(s) of the program?

The ABC-UTC is fast becoming the focal point for ABC. Many designers are contacting ABC-UTC for help and getting started in use of ABC. ABC-UTC is continuing providing an excellent service to bridge profession and assisting U.S. DOT through its research, education and workforce development and technology transfer activities. ABC-UTC is taking a national lead in ABC area and has established a very good working relation with FHWA and AASHTO T-4 that is responsible for developing the national roadmap for State DOTs for implementing ABC. The Director of ABC-UTC was also elected to be liaison between the TRB ABC committee and ABC-UTC. These connections and activities are allowing ABC-UTC to better fill the knowledge gap, especially in the research, technology transfer and workforce development areas. ABC-UTC has also made major accomplishments in developing a close working relationship with State DOTs. Twenty-six States have Co-sponsored the 2014 National ABC Conference. Thirty State DOTs are sponsoring 2015 National ABC Conference and to date 31 state DOTs have co-sponsored the 2017 National ABC Conference to be held on December of 2017 at Hyatt Regency Hotel in Miami, FL. The State DOT engineers of sponsoring State DOTs work very closely with ABC-UTC director to develop the conference program. The connection created with State DOT bridge engineers will greatly facilitate the implementation of ABC-UTC work.

About 25% of the 607,000 bridges in our inventory are substandard and need repair or replacement. This fact continues to elevate the impact ABC-UTC is having on bridge profession.

What is the impact on other disciplines?

Delivering transportation programs in a safe and economical manner is at the heart of any public agencies' mission. ABC-UTC's activities go beyond just building bridges that are constructed quickly. The introduction of time element into construction activities result in significantly enhancing the public and worker safety. It enhances the mobility and therefore help save energy and be environmentally responsible. Assisting the U.S. DOT, ABC-UTC is playing a role in helping to deliver a high quality transportation program to society.

What is the impact on physical, institutional, and information resources at the university or other partner institutions?

The establishment of ABC-UTC has allowed obtaining many additional resources for the faculties, active in ABC areas at FIU and partner universities. In 2015, FIU's Provost provided ABC-UTC a faculty line. As a result ABC-UTC hired Dr. Armin Mehrabi, who is a specialist in long span bridges. He will join the ABC-UTC on January pf 2017. More importantly, on October 13, 2016, President and Provost at FIU, after a yearlong intensive evaluation of all major research activities at FIU, selected five research areas within FIU to be designated as preeminent programs. It is with great pleasure to state that Bridge Engineering and ABC-

UTC was selected as one of the five research preeminent areas. Greater resources will be available to ABC-UTC as a result of being named preeminent program.

In summary, the establishment of ABC-UTC at FIU by U.S. DOT has provided this great institution with an excellent platform to better educate our students and help the profession while working shoulder to shoulder with U.S. DOT.

What is the impact on technology transfer?

The ABC-UTC monthly webinars are proving to be the most effective means of transferring the knowledge to the profession. Having 3000 to 4000 bridge professional participate in each monthly webinars are unparalleled. The 2014 National ABC conference was co-sponsored by 26 states who actively participated in this event. The 2015 National ABC Conference was Co-Sponsored by 30 State. ABC-UTC was successful in developing major travel scholarship program that allowed more than 200 state bridge engineers to attend each National ABC Conferences (2014 and 2015). These activities are providing opportunities for effective communications with State DOTs and bridge professionals, making the task of Technology transfer much easier.

Many State DOTs seek our help in organizing a workshop that is aimed at educating consultants and contractors in their areas about ABC.

What is the impact on society beyond science and technology?

Increasing safety, enhancing mobility, being environmentally responsible, building bridges that are resilient and sustainable are important consequences of using ABC. The major goal of ABC-UTC is to make the ABC the method of choice for bridge replacement and retrofit and in future to call it BC. This, in turn, will improve the mobility and save the society in many different ways. One of the most important contributions of ABC to society is reducing the number of accidents and therefore significantly enhancing the safety. A single accident could cost taxpayers millions in litigation and legal expenses.

CHANGES/PROBLEMS

Changes that have a significant impact on expenditures

No changes

Actual or anticipated problems or delays and actions or plans to resolve them

No changes

Changes that have a significant impact on expenditures

No changes

Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

No changes

Change of primary performance site location from that originally proposed

No changes

SPECIAL REPORTING REQUIREMENTS

Financial report and documents will be sent by Department of Research at Florida International University

Completed by:

Florida International University: Atorod Azizinamini

Iowa State University: Brent Phares, Terry Wipf

University of Nevada, Reno: Saiid Saiidi, A. Itani