



Program Progress Performance Report University Transportation Centers

Submitted to	U.S. Department of Transportation Research and Innovative Technology Administration
Federal Grant Number	DTRT13-G-UTC41
Project Title	ABC-UTC (Accelerated Bridge Construction - University Transportation Center)
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Submission Date	October 31, 2017
DUNS and EIN Numbers	DUNS: 07-129-8814, EIN: 237047106
Recipient Organization	Florida International University; 11200 SW 8th St, Miami, FL 33174
Account Number	800002954
Grant Period	September 30, 2013 to September 30, 2018
Reporting Period Start Date	April 1, 2017
Reporting Period End Date	September 30, 2017 (PPPR # 8)
Report Frequency	Semi-annual

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October 31, 2017

 Date

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 and correspondences 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 Advisory 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 (April 1, 2017 – September 30, 2017)
FIU-1	Compilation of all ABC research that is ongoing and completed	Ahmad Abu-Hawash, Iowa DOT	The ABC Research Database continues to be populated and advertised.

Project #	Research Project Title	TAC Members	Progress (April 1, 2017 – September 30, 2017)
	Recommended by AASHTO T-4	Ben Beerman, FHWA	
FIU-2	Compilation of ABC solutions	Ahmad Abu-Hawash, Iowa DOT Ben Beerman, FHWA	The ABC Project Database continues to be populated and advertised.
FIU-4	Estimating total cost of bridge construction using ABC and conventional methods of construction	Ben Beerman, FHWA Mary Lou Ralls Newman, Ralls Newman, LLC	Completed and final report is currently being worked on.
FIU-5	Development of Manual for Enhanced Service Life of ABC Bridges	Bruce Johnson, Oregon DOT Ali Maher, Rutgers University Hamid Ghasemi, FHWA Carlos Duarte, CDR Maguire	The structural conditions of a closure joint was replicated under a flexure test for a unit width. 12 beam specimens were cast and tested to failure. Observations were recorded. 24 more specimens are currently under construction for future testing.
FIU-6	Alternative ABC Connections Utilizing UHPC	Bruce Johnson, Oregon Department of Transportation, Bijan Khaleghi, Washington DOT, Tom Ostrom, Caltrans, Elmer Marx,	The experimental program was carried out to evaluate the performance and structural behavior of the proposed connection. The results show that non-seismic detail, with a seismic design consideration can be an alternative detail even for seismic regions.

Project #	Research Project Title	TAC Members	Progress (April 1, 2017 – September 30, 2017)
		Alaska DOT	
FIU-7	Extending Application of SDCL to ABC (Phase II – Experimental):	Bruce Johnson, Oregon Department of Transportation, Bijan Khaleghi, Washington DOT, Tom Ostrom, Caltrans, Elmer Marx, Alaska DOT	The component testing of a one third scale of the connection was completed and showed promising results. The damaged specimen was repaired with ultra-high performance concrete using new techniques. The repaired specimen is currently being prepared for testing.
ISU-1	Development of Crash-Tested Prefabricated Bridge Railings Recommended by AASHTO T-4	Ahmad Abu-Hawash, Iowa DOT Tim Fields, Connecticut DOT	During the period April 1, 2017 to September 30, 2017, the research project "Development of Prefabricated Concrete Bridge Railings" has progressed with further analysis of the testing results. The force distribution during the barrier-to-barrier tests has been examined and investigated. This was done to determine the strength of the connection and the input from the two barrier-to-deck interface connections. Progress also includes the analysis of the results observed when testing the systems to failure. These observations and results were used to determine the strengths and weaknesses of the barrier-to-deck connections and to determine the ease of replacement and repair of the barrier segments and connections.
ISU-4	Material Design and Structural Configuration of	Ahmad Abu-Hawash	Testing of four different types of concrete fibers for their effect on rheological properties in the fresh state as well as pre and post crack

Project #	Research Project Title	TAC Members	Progress (April 1, 2017 – September 30, 2017)
	Link Slabs for ABC Applications	Peter Taylor Sean Perfetti	flexural properties was carried out. Fresh properties were evaluated using the Vibrating Kelly Ball test, which was originally developed for slip form paving applications and is gaining attention for other concrete applications. Flexural performance of the FRC mixtures were assessed using the ASTM C1609 standard (2). The standard tests 4"x4"x14" beams under third point bending and evaluates flexural strength as well as post crack residual strength and toughness. It was found that as a trend for all fibers, increasing the volume fraction increased the post crack performance. The same trend was noticed for pre crack strength (Modulus of Rupture), but there were some exceptions for PVA and HSPE likely due to fiber clumps producing weak spots in the cross section.
ISU-5	Investigation of Macro-Defect Free Concrete for ABC including Robotic Construction	Ahmad Abu-Hawash Peter Taylor Sean Perfetti	The research group continued to explore the applicability of macro defect free concrete for ABC applications. This included post-processing and analyzing of material testing data, with comparisons made between the MDF material and traditional concrete. Test data included split tensile test, compression test, and subjection of the specimen to freeze thaw cycles. The results showed that the MDF concrete performed well in compression and tensile strength tests, but had low toughness and durability. Brainstorming of applications for the material continued, with discussions made possible via presentations at the 2017 Western Bridge Engineers' Seminar in Portland, OR and the 2017 University Transportation Centers Spotlight conference in Washington DC. The limitations of the utilization of the material continue to center around the lack of toughness and expense of manufacturing.

Project #	Research Project Title	TAC Members	Progress (April 1, 2017 – September 30, 2017)
ISU-6	An Integrated Project to Enterprise-Level Decision Making Framework for Prioritization of Accelerated Bridge Construction	Ahmad Abu-Hawash, IOWA DOT	A stochastic approach is used to optimize the cost and mean-risk objective of the system loss considering both pre- and post-disruption actions. A multi-objective and two-stage programming model to enhance the system resilience is generated. Meanwhile, to account for the effects of different improvement strategies, an original transportation network is tested under various disruption scenarios with their different occurrence probabilities. The enhancing effectiveness of each scenario is measured by the risk and costs during the entire process. The pre-event scenarios represent any retrofitting or planning activities that could contribute to increasing the robustness or redundancy of the network system. The post-event scenarios include the enhancing effects caused by pre-disruption activities and the rapid recovery behaviors at present scenario.
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	Three journal articles were submitted, one has been accepted and published, one has been accepted and is awaiting publication, and one is under final review.
UNR-4	Shake Table Studies of a Bridge System with ABC Connections:	Bijan Khaleghi, Washington DOT Elmer Marx, Alaska DOT	Bids for precast deck panels were obtained and the panels were constructed. The block for the abutment support system were constructed. Steel girders for the superstructure were received and the girders and their braces were assembled. Extensive nonlinear dynamic analysis of the bridge was conducted and a conference article presenting the study was prepared.

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, a total of 19 graduate students are working on ABC-UTC related research projects. Ten at FIU, four at ISU and five at UNR.
WD-2	Increasing the number of research assistantship opportunities for graduate students.	ALL (FIU, ISU, UNR)	In this period, a total of five graduate research assistants worked on different aspects of seismic design of ABC bridges. ISU added one student and FIU had 2 additional students in this reporting period.
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, ABC seminars previously posted and the related video clips were maintained.
WD-4	Developing online courses and making progress towards the development of fully online degree programs.	FIU	FIU and ISU continue 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

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			<ul style="list-style-type: none"> Ashkan Vosooghi, AECOM <p>All three center partners are actively encouraging productive mentorship relationships between graduate students and former graduate students and professionals.</p>
WD-6	<p>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.</p>	ISU	<p>These seminars continue to be offered quarterly as “Research Seminars”. Seminars were delivered in April 2017 and August 2017 and were attended by over 490 sites each from across the world (with multiple attendees at many sites).</p> <p>These seminars are recorded and archived on the ABC-UTC website for future viewing.</p> <p>These seminars are recorded and archived on the ABC-UTC website for future viewing.</p>
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	<p>Internship Program- All three consortium members will develop an undergraduate research internship program.</p>	UNR Lead; ALL (FIU, ISU, UNR)	All three partner universities have hired undergraduate students as interns on ABC-UTC research projects. Twenty undergraduate students are supported through internships and are actively involved in research during the past reporting period.
WD-9	<p>Educational Modules- Develop three educational modules, in the form of print and videos, for K-12 with focus on developing age-appropriate programs.</p>	UNR	An ABC seismic module was presented at three middle-school summer camps at UNR in June 2017. The PowerPoint presentation has been posted on the project website.
WD-10	<p>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</p>	FIU, ISU, UNR	A parent-child bridge engineering camp was conducted in June 2017 in Miami. The camp introduced around 30 low-socio economic families to bridge engineering and ABC. Details of the camp are available on the ABC-UTC website.

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	of transportation engineering in general and principles of bridge engineering and ABC in particular.		
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	One article was published during this reporting period: Can’t Stop the Traffic! (http://go-explore-trans.org/post.cfm?ID=19022)
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 11 th Annual UTC Spotlight Conference, and the Western Bridge Engineering conferences during this reporting period.
WD-13	Make presentations on transportation careers at major minority institutions and conferences.	All (FIU, ISU, UNR)	Video presentations were prepared featuring UNR faculty and graduate students working on ABC projects. The videos were completed and are being used for recruitment of students to the bridge engineering program.

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	<p>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.</p>	All (FIU, ISU, UNR)	The 2017 AASHTO SCOBS meeting was held in Spokane, Washington and attended by ABC-UTC Director. He briefed the committee on research findings by giving technical presentation.
T2-2	<p>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.</p>	All	The director attended and was a Speaker at a Panel Presentation on, "UTC Operations" and also attended the 2017 UTC Spotlight Conference: Rebuilding and Retrofitting the Transportation Infrastructure (TRB) and was a speaker on ABC: National Perspective and ABC-UTC activities.
T2-3	<p>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.</p>	All	<p>The following papers were submitted. Two have been accepted and one is under review:</p> <p>--Mohebbi, A., M. Saiidi, and A. Itani, "Shake Table Studies and Analysis of a PT/UHPC Bridge Column with Pocket Connection," Journal of Structural Engineering, ASCE, Accepted.</p> <p>--Mohebbi, A., M. Saiidi, and A. Itani, "Shake Table Studies and Analysis of a Precast Two-Column Bent with Advanced Materials and Pocket Connections," Journal of Bridge Engineering, ASCE, Submitted.</p> <p>--Mohebbi, A., M. Saiidi, and A. Itani, "Seismic Design of Precast Piers with Pocket Connections, CFRP Tendons, and ECC/UHPC Columns," International Journal of Bridge Engineering, Special Issue:</p>

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			<p>Experimental and Analytical Investigations with Emerging Bridge Design Methods, October 2017, pp. 99-123.</p> <p>D. Z. Hossain*, <u>K. Lau</u>, and D. Garber. "An Approach to Detect Steel Corrosion in Concrete Using Global Strain Measurement." NACE Corrosion/2017. Paper No. 9302. 13pp.</p> <p>S. Permeh*, C. Reid*, M, Echeverría*, B. Tansel, <u>K. Lau</u>, M. Duncan, and I. Lasa. "Microbiological Influenced Corrosion in Florida Marine Environment: A Case Study." NACE Corrosion/2017. Paper No. 9536. 12pp.</p> <p>S. F. Fancy*, Md. A. Sabbir*, <u>K. Lau</u>, and D. DeFord. "Corrosion Performance of Nano-Particle Enriched Epoxy Primer for Marine Highway Bridge Application." NACE Corrosion/2017. Paper No. 9539. 12pp.</p> <p>Md. A. Sabbir*, S. F. Fancy*, <u>K. Lau</u>, and D. DeFord. "Update on Corrosion Performance of CBPC Coatings in Aggressive Bridge Environments." NACE Corrosion/2017. Paper No. 9593. 12pp.</p> <p>D. Z. Hossain*, <u>K. Lau</u>, and D. Garber. Presentation at 72nd NACE Corrosion Conference. Paper No. 9302. New Orleans, LA. NACE Int., Houston, TX. March 2017.</p> <p>S. Permeh*, C. Reid*, M, Echeverría, B. Tansel, <u>K. Lau</u>, M. Duncan, and I. Lasa. Presentation at 72nd NACE Corrosion Conference. Paper No. 9536. New Orleans, LA. NACE Int., Houston, TX. March 2017.</p> <p>S. F. Fancy*, Md. A. Sabbir*, <u>K. Lau</u>, and D. DeFord. Presentation at 72nd NACE Corrosion Conference.</p>

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			<p>Paper No. 9539. New Orleans, LA. NACE Int., Houston, TX. March 2017.</p> <p>Md. A. Sabbir*, S. F. Fancy*, <u>K. Lau</u>, and D. DeFord. Presentation at 72nd NACE Corrosion Conference. Paper No. 9593. New Orleans, LA. NACE Int., Houston, TX. March 2017</p> <p>Valikhani, Alireza, Azadeh Jaber Jahromi, and Atorod Azizinamini. Retrofitting Damaged Bridge Elements Using Thin Ultra High Performance Shell Elements. Transportation Research Record, No. 17-02047. 2017</p> <p>Sadeghnejad, Amir, Alireza Valikhani, Brian Chunn, Kingsley Lau, and Atorod Azizinamini. Magnetic Flux Leakage Method for Detecting Corrosion in Post Tensioned Segmental Concrete Bridges in Presence of Secondary Reinforcement. TRB, Washington, DC Transportation Research Record, No. 17-05231. 2017.</p> <p>Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "New Connection Detail to Connect Precast Column to Cap Beam Using UHPC in ABC Applications". Journal of the Transportation Research Board July, 2017.</p> <p>Mahsa Farzad, Shafieifar, Mohamadreza, and Atorod Azizinamini. "Accelerated Retrofitting of Bridge Elements Subjected to Predominantly Axial Load Using UHPC Shell". Journal of the Transportation Research Board July, 2017.</p> <p>Mahsa Farzad, Atorod Azizinamini, David Garber, and Kingsley Lua. "Corrosion Macrocell Development In</p>

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			<p>Reinforced Concrete With Repair UHPC". Journal of the International NACE, October 2017.</p> <p>Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "Experimental and numerical study on mechanical properties of Ultra High Performance Concrete (UHPC)." Construction and Building Materials 156 (2017): 402-411.</p> <p>Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "Alternative ABC Connection Utilizing UHPC". TRB 2017, No. 17-03398. 2017.</p> <p>Farzad, Mahsa, Alireza Mohammadi, Mohamadreza Shafieifar, Huy Pham, and Atorod Azizinamini. "Development of Innovative Bridge Systems Utilizing Steel-Concrete-Steel Sandwich System". TRB 2017 No. 17-02229.</p> <p>Zhang, N., Alipour, A., Coronel, L." Application of Novel Recovery Techniques to Enhance the Resilience of Transportation Networks", TRB 2018 Annual Meeting.</p>
T2-4	Outreach: Each ABC-UTC consortium member will be expected to participate in a minimum of two outreach	FIU, ISU and UNR	Researchers gave 6 presentations at different venues in the form of invited presentations, posters, etc.

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
	activities each year. Ideally, one outreach activity would be geared toward a national audience and one would be geared toward regional audiences.		
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 support the use of ABC across the U.S.	All	ABC-UTC key researchers attended the July 11-15 AASHTO Subcommittee on Bridges and Structures Annual Meeting in Spokane, WA and provided an ABC-UTC update to the Technical Committee for Construction (T-4).
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	WA and TX projects were added to the Project Database. Project submissions from several other states are in progress.
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	The Proven Advanced Technologies initiative proposal continues to be evaluated.
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	The ABC-UTC is developing a process where it can provide an independent perspective on Proven Advanced Technologies (PAT), to work in conjunction with the PAT initiative.
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	All	No change

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
	Simulation (NEES).		
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 develop a patent based on research outcomes.	All	No change
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	Papers on ABC were prepared for upcoming conferences and journals. New journal papers were submitted and preparation of other papers began.
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	Nothing new to report.
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	Nothing new to report.

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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	The 2016 Annual Highlights Report has been completed.
T2-15a	Webcasting and video Clips: Selected tests will be webcast, and video clips of critical parts of selected tests will be developed.	All	Nothing to report.
T2-16	Social media: Researchers will actively participate in professional social media such as Facebook, Twitter, and LinkedIn.	All	ABC-UTC have continued using Hootsuite to coordinate and market all webinars, seminars, events, and any other large events hosted by ABC-UTC via Facebook, Instagram, Twitter, and LinkedIn.
T2-17	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.	FIU	In progress.
T2-18	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.	FIU	The 2017 In-Depth Web Training was conducted on September 12. The topic was the Utah DOT's Accelerated Bridge Program. The six 40-minute modules included speakers from the Utah DOT and its consultant and construction industry. Details are available on the In-Depth Web Training Archives at

Task #	Brief Description of Task	Lead Institution	Progress (Apr-2016 Sept-2016)
			https://abc-utc.fiu.edu/mc-events/utah-dots-accelerated-bridge-program/?mc_id=308 . A total of 539 sites registered for this 4-hour web training.
T2-19	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.	FIU	The ABC-UTC conducted a monthly webinar with featured presentation in each of the six months of this reporting period, as done since 2011. Viewership continues to be high, with the number of registered sites ranging from 750 to 1,274. Details are available on the Monthly Webinar Archives at https://abc-utc.fiu.edu/events/webinar-archives/ .
T2-20	ABC Conferences: In coordination with FHWA, state DOTs, and industry, a national ABC conference will be organized each year.	FIU	The preliminary program for the 2017 National ABC Conference, to be held December 6-8 in Miami, has been completed. Copies have been printed and given out at several conferences and events to promote the conference. Preliminary program is also posted on the website.
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	Details were developed for a total of 11 half-day workshops to be held on December 6 in Miami prior to the 2017 National ABC Conference. Five workshops will be held in the morning and six workshops will be held in the afternoon.

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

- 2017 National ABC Conference plans are in progress with several pre-conference workshops being planned.

- Educational modules were developed and used in graduate courses to train students.
- Monthly webinars were continued
- ABC-UTC web-based research seminars were held April 2017 and August 2017. All of our past research seminars are archived and available on our website.
- In-depth webinar series were held in September 2017
- 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.
- Travel scholarships offered to students to attend 11th Annual UTC Spotlight Conference in Washington DC and Western Bridge Engineering Seminar in Portland, Oregon.

How have the results been disseminated?

The results will be disseminated by followings:

- Educational modules
- Monthly webinars
- In-depth webinars
- Web-based research seminars
- Various presentations to AASHTO, TRB, other national and international conferences, website, and conference publications.
- Youtube channel for video clips of the tests was maintained and updated.
- Youtube posting of general aspects of ABC seismic connections was maintained and updated.

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 third incremental funding
- Briefing the ABC-UTC steering committee members on the progress of research projects.
- Development of more ABC educational modules
- Continuing with monthly free webinars
- Continue to disseminate research results through various outlets.
- Hosting the 2017 National ABC conference
- Post new video clips of tests and other ABC promotional materials on web..
- Support travel for graduate students to attend and present at the 2017 National ABC Conference in Miami
- Prepare material for middle school summer camp 2018 at UNR
- Give multiple technical presentations at national and international conferences
- Support graduate students working on ABC research projects

PRODUCTS

- Several papers were prepared and submitted to TRB
- ABC-UTC Advisory committee planned for December 4th, 2017
- Several final reports as reported on ABC-UTC website.

Publications, conference papers, and presentations

- Garber D and Ralls M, “Accelerated bridge construction project and research databases,” New York City Bridge Conference, New York, 2017.
- Lee, S. J. (2017). *Towards Simulation-aided Predictive Demolition Planning*, 11th University Transportation Center (UTC) Spotlight Conference: Rebuilding and Retrofitting the Transportation Infrastructure (Organized by Transportation Research Board), Washington, D.C., September 26-27, 2017.
- D. Z. Hossain*, K. Lau, and D. Garber. “An Approach to Detect Steel Corrosion in Concrete Using Global Strain Measurement.” NACE Corrosion/2017. Paper No. 9302. 13pp.
- S. Permech*, C. Reid*, M. Echeverría*, B. Tansel, K. Lau, M. Duncan, and I. Lasa. “Microbiological Influenced Corrosion in Florida Marine Environment: A Case Study.” NACE Corrosion/2017. Paper No. 9536. 12pp.
- S. F. Fancy*, Md. A. Sabbir*, K. Lau, and D. DeFord. “Corrosion Performance of Nano-Particle Enriched Epoxy Primer for Marine Highway Bridge Application.” NACE Corrosion/2017. Paper No. 9539. 12pp.
- Md. A. Sabbir*, S. F. Fancy*, K. Lau, and D. DeFord. “Update on Corrosion Performance of CBPC Coatings in Aggressive Bridge Environments.” NACE Corrosion/2017. Paper No. 9593. 12pp.
- Saiidi, M., “Advanced Materials and construction methods in earthquake-resistant bridges,” Seminar Presentation, Department of Bridge Engineering, Tongji University, Shanghai, April 2017.
- Benjumea, J., Shoushtari, E., Saiidi, M., Itani, A., and Moustafa, M. (2017). “Seismic Design of Large-Scale ABC Bridge Systems for Shake Table Testing.” ASCE Structures Congress 2017, Denver, Colorado.
- Mehrsoroush, A., Saiidi, M. S., and Ryan K. L. (2017). “Development of Earthquake-resistant Precast Pier Systems for ABC in Nevada.” *ASCE Structures Congress 2017*, Denver, Colorado.
- Mohebbi, A. and M. Saiidi, “Development and Seismic Evaluation of Pier Systems w/Pocket Connections and PT/UHPC Columns” Poster Presentation, Conference, Research Council of the Association of Public and Land Grant Universities, University of Nevada, Reno, Nevada, July 2017.
- Mohebbi, A., M. Saiidi, A. Itani and A. Robb, “Seismic Response of an ABC Two-Column Bent Using Advanced Materials” Poster Presentation, Conference, Research Council of the Association of Public and Land Grant Universities, University of Nevada, Reno, Nevada, July 2017.
- Shoushtari, E., M. Saiidi, A. Itani, and M. Moustafa, “Shake Table Studies of A Two-Span Steel Girder Bridge Incorporating ABC Connections,” Poster Presentation,

Conference, Research Council of the Association of Public and Land Grant Universities, University of Nevada, Reno, Nevada, July 2017.

- M. Echeverría*, K.K. Krishna Vigneshwaran*, S. Permeh*, K. Lau. Presentation at 232nd Electrochemical Society meeting. ECS. C05-800. National Harbor, MD. September 2017.
- S. Permeh*, K.K. Krishna Vigneshwaran*, K. Lau. Poster Presentation at 11th University Transportation Centers Spotlight Conference. TRB. Washington D.C. September 2017.
- S. F. Fancy*, Md. Ahsan Sabbir*, K. Lau. Poster Presentation at 11th University Transportation Centers Spotlight Conference. TRB. Washington D.C. September 2017.
- D. Z. Hossain*, K. Lau, and D. Garber. Presentation at 72nd NACE Corrosion Conference. Paper No. 9302. New Orleans, LA. NACE Int., Houston, TX. March 2017.
- S. Permeh*, C. Reid*, M. Echeverría, B. Tansel, K. Lau, M. Duncan, and I. Lasa. Presentation at 72nd NACE Corrosion Conference. Paper No. 9536. New Orleans, LA. NACE Int., Houston, TX. March 2017.
- S. F. Fancy*, Md. A. Sabbir*, K. Lau, and D. DeFord. Presentation at 72nd NACE Corrosion Conference. Paper No. 9539. New Orleans, LA. NACE Int., Houston, TX. March 2017.
- Md. A. Sabbir*, S. F. Fancy*, K. Lau, and D. DeFord. Presentation at 72nd NACE Corrosion Conference. Paper No. 9593. New Orleans, LA. NACE Int., Houston, TX. March 2017
- Valikhani, Alireza, Azadeh Jaber Jahromi, and Atorod Azizinamini. Retrofitting Damaged Bridge Elements Using Thin Ultra High Performance Shell Elements. Transportation Research Record, No. 17-02047. 2017
- Sadeghnejad, Amir, Alireza Valikhani, Brian Chunn, Kingsley Lau, and Atorod Azizinamini. Magnetic Flux Leakage Method for Detecting Corrosion in Post Tensioned Segmental Concrete Bridges in Presence of Secondary Reinforcement. TRB, Washington, DC Transportation Research Record, No. 17-05231. 2017.
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- Valikhani Alireza, Azadeh jaber jahromi, Atorod Azizinamini, "EXPERIMENTAL INVESTIGATION OF HIGH PERFORMING PROTECTIVE SHELL USED FOR RETROFITTING BRIDGE ELEMENTS" Retrofitting Damaged Bridge Elements Using Thin Ultra High Performance Shell Elements Transportation Research Board. 2017
- Azadeh Jaber Jahromi, Valikhani, Alireza and Atorod Azizinamini. "The best practice for closure joints in ABC projects". Western Bridge Conference, Portland,2017

- Azadeh Jaber Jahromi, Valikhani, Alireza and Atorod Azizinamini. "Assessing Structural Integrity of Closure Pours in ABC Projects" Transportation Research Record. 2017
- Amir Sadeghnejad, Atorod Azizinamini. "Seismic Performance of Simple for Dead Load and Continuous for Live Load (SDCL) Steel Bridge System", UTC Spotlight, Washington DC, 2017.
- Amir Sadeghnejad, Atorod Azizinamini. "Seismic Performance of Simple for Dead Load and Continuous for Live Load (SDCL) Steel Bridge System", Western Bridge Conference, Portland, 2017.
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- Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "New Connection Detail to Connect Precast Column to Cap Beam Using UHPC in ABC Applications". Journal of the Transportation Research Board July, 2017.
- Mahsa Farzad, Shafieifar, Mohamadreza, and Atorod Azizinamini. "Accelerated Retrofitting of Bridge Elements Subjected to Predominantly Axial Load Using UHPC Shell". Journal of the Transportation Research Board July, 2017.
- Mahsa Farzad, Atorod Azizinamini, David Garber, and Kingsley Lua. "Corrosion Macrocell Development In Reinforced Concrete With Repair UHPC". Journal of the International NACE, October 2017.
- Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "Experimental and numerical study on mechanical properties of Ultra High Performance Concrete (UHPC)." Construction and Building Materials 156 (2017): 402-411.
- Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "Alternative ABC Connection Utilizing UHPC". TRB 2017, Washington, D.C., 2017.
- Farzad, Mahsa, Alireza Mohammadi, Mohamadreza Shafieifar, Huy Pham, and Atorod Azizinamini. "Development of Innovative Bridge Systems Utilizing Steel-Concrete-Steel Sandwich System". TRB 2017, Washington, D.C., 2017.
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- Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "Alternative ABC Connection Using UHPC". Western Bridge Engineers 2017, Oregon, 2017.
- Shafieifar, Mohamadreza and Atorod Azizinamini. "Innovative ABC solutions using UHPC". 2015 National Accelerated Bridge Construction Conference, Miami, 2017.
- Shafieifar, Mohamadreza, Mahsa Farzad, and Atorod Azizinamini. "Alternative ABC Connection Utilizing UHPC". TRB 2017, No. 17-03398. 2017.
- Farzad, Mahsa, Alireza Mohammadi, Mohamadreza Shafieifar, Huy Pham, and Atorod Azizinamini. "Development of Innovative Bridge Systems Utilizing Steel-Concrete-Steel Sandwich System".TRB 2017 No. 17-02229.

- Zhang, N., Alipour, A., Coronel, L.” Application of Novel Recovery Techniques to Enhance the Resilience of Transportation Networks”, TRB 2018 Annual Meeting.
- Freeseaman, K., Phares, B. (2017). “Investigation of Macro-Defect Free Concrete for Accelerated Bridge Construction, including Robotic Construction.” 2017 University Transportation Centers Spotlight Conference, September 26-27, Washington, DC.
- Freeseaman, K., Phares, B. (2017). “Investigation of Macro-Defect Free Concrete for Accelerated Bridge Construction, including Robotic Construction.” 2017 Western Bridge Engineers’ Seminar (WBES), September 6-8, Portland, OR.
- Hosteng, T., Phares, B. Shafei B., (2017). “Integral Abutment Details for ABC Projects – Phase II.” 2017 University Transportation Centers Spotlight Conference, September 26-27, Washington, DC.
- Shafei B., Phares, B., Dopko, M., Hajilar, S., (2017). “Design and Configuration of Jointless Bridges for ABC Applications.” 2017 Western Bridge Engineers’ Seminar (WBES), September 6-8, Portland, OR.

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

UNR prepared promotional video clips for engineering recruitment events.

PARTICIPANTS & COLLABORATING ORGANIZATIONS

What organizations have been involved as partners?

- Atorod Azizinamini, Florida International University
- Saidi Saiidi, University of Nevada, Reno
- Brent Phares, Iowa State
- Terry Wipf, Iowa State University

Industry Partners and Collaborators

ABC-UTC Advisory Committee Members

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. The members of the Advisory board can be found by visiting <https://abc-utc.fiu.edu/about-us/advisory-members/>

IMPACT

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

The ABC-UTC has now become the focal point for ABC at national level. 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 have sponsored the 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 joined 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 States. 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