TriDurLE

National Center for Transportation Infrastructure Durability & Life-Extension

USDOT National University Transportation Center
Progress Performance Report #1

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Signature of Submitting Official	

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1. Accomplishments

1.1 What are the major goals and objectives of the program?

The major goals and objectives of the program as outlined in the proposal include the following categories. The partnerships underlying this National UTC are based on the shared vision of "cost-effective innovations and holistic solutions to enhance multimodal infrastructure durability." TriDurLE will conduct multidisciplinary and multimodal research, education and workforce development, and technology transfer related to this vision, and will directly support the USDOT's strategic goal of infrastructure durability and life-extension while providing secondary benefits for other relevant strategic goals such as safety, mobility, and environmental sustainability.

Center Strategic Goals

The National UTC TriDurLE is concerned with the following strategic goals:

1. Facilitating innovations in data modeling/management, analytical tools, and decision-making related to infrastructure durability and life-extension.
2. Enhancing understanding of transportation infrastructure performance and asset management via condition monitoring and remote sensing.
3. Extending the service life of transportation infrastructure and addressing durability issues through new materials and technologies and best practices.
4. Leading the way in education, workforce development, capacity building, and technology transfer.

Research

The research activities of the National UTC TriDurLE will be grouped into six interrelated thrust areas as follows, which will be supplemented by education and technology transfer activities.

1. **Management**: Asset management and performance management for enhanced durability and life-extension of transportation infrastructure.
2. **Monitoring**: Condition monitoring, remote sensing, and the use of GPS for enhanced durability and life-extension of transportation infrastructure.
3. **Addressing corrosion** of transportation infrastructure.
4. **Addressing aging** and other materials-related durability distresses of transportation infrastructure through the use of *new materials, technologies, and construction methodologies*.
5. **Addressing natural hazards and extreme events** that threaten the durability and service life of transportation infrastructure.
6. **Intervention and rehabilitation** of transportation infrastructure through advanced materials, technologies and construction methodologies.

Leadership

The TriDurLE team is nationally and internationally recognized for contributions to the field of infrastructure durability and for its deployment of effective solutions to critical, real world transportation challenges. Through this UTC grant, the Consortium plans to build on its demonstrated experience to support, encourage and mentor future leaders in the field of transportation, with a cross-disciplinary approach to infrastructure durability.

Education and Workforce Development

TriDurLE will provide a range of education and workforce development (E&WD) opportunities

for students and professionals across the nation to contribute to a skilled, diverse, informed and practice-ready transportation workforce. The E&WD program will build on the success of existing programs at the Consortium universities, starting from K-12. The program will promote creative and multidisciplinary problem solving and exposure to a myriad of experiences, serving to attract, educate, and train future and existing transportation professionals with the know-how to undertake and implement innovative projects. The outreach initiatives will particularly focus on recruiting underrepresented minorities into transportation and other STEM fields.

TriDurLE will also support career-building activities that facilitate student transition from school to the workplace by offering enhanced student research opportunities, research seminars, guest speakers, professional conference travel and other professional networking opportunities.

Technology Transfer

TriDurLE will maintain an ongoing technology transfer (T2) program to ensure research results are made available to potential users in a form that can be implemented, utilized, commercialized, or otherwise applied quickly and to the widest possible audience. The goals of T2 activities by TriDurLE will mainly include:

1. Knowledge dissemination, to inform stakeholders in various aspects of transportation infrastructure durability and life-extension, including policy makers, public decision makers, transportation infrastructure professionals, industry partners, researchers and technology developers, and the general public
2. IP implementation, to move the IP from research and development phases towards adoption by practitioners and to spur implementation by industry
3. Brand awareness building, to increase the visibility of TriDurLE researchers, outputs, and outcomes and to broaden the potential impacts of TriDurLE activities

Collaboration

Many of the consortium members have an extensive history of collaborative relationships at a variety of technical, fiscal, and administrative levels. Across all its activities - from conducting pooled fund studies to hosting technology transfer events - TriDurLE will seek to work with partners from all sectors.

Diversity

TriDurLE is committed to an explicit policy and active program of engaging diverse and underrepresented groups, with the goal of increasing their interest and participation in STEM disciplines and awareness of careers in the transportation fields. In order for the transportation workforce to reflect the diversity of the national workforce pool, TriDurLE will continue to pursue the development of innovative programs to encourage new entrants, particularly those from groups currently underrepresented in the field, including women, minorities and those with disabilities.

1.2 What was accomplished under these goals?

Research

Based on the research thrusts and list of “early-winner” elements identified and outlined in the proposal, the TriDurLE executive committee worked together to develop a “Year one” Request for Proposals. The RFP was distributed by the TriDurLE Site Directors to their faculty members, typically those made actual contributions to the original Center proposal and some new faculty members. The RFP solicited project ideas from researchers at all consortium member universities, with the due date of February 28, 2020. Exception was granted by the Center

Director, in a few limited cases, in the effort of securing more desirable cost-share from local DOTs or private sector.

Each project proposal was reviewed by typically three peers identified by the Managing Director; sometimes two peers if a 3rd one was not available. The rigorous peer review process was single-blind, with the peer reviewers being anonymous to the proposal PI(s). The selection of reviewers considered diverse representation of expertise and background, availability, etc. and Advisory Board members were recruited where suitable. The vast majority of the projects in the first round (i.e., in the year of 2019-2020) have completed the peer review process by April 15, 2020, with the review comments being addressed by the proposal PIs and the revised proposal being accepted (or denied).

The appendix contains the list of the selected projects for funding, with respect to each member university; even though the official sub-awards from WSU to Consortium universities is on hold due to delays caused by the COVID-19 lockdowns. These projects will be completed within one year and the Final Reports will be submitted within two months after the completion of each project. No-cost time extension may be needed for some of the projects, in light of the delays caused by the limited access to laboratory facilities and potential difficulties in student recruitment.

Leadership

Two kickoff meetings were conducted during this period. The first meeting was the official kickoff meeting and site visit by three USDOT OST-R administrators in October 2019. The meeting was focused on the planning and conduct of the new National UTC grant including how this new consortium will work together to achieve success, in accordance with your UTC grant application. The participants from OST-R included Caesar Singh (Director, University Grants Office), Robin Kline (the OST-R Grant Manager assigned to this grant), and Amy Stearns (one additional Grant Manager). In addition to the TriDurLE Director Dr. Xianming Shi, the participants from WSU included Dr. Mary Rezac (Dean of Voiland College of Engineering and Architecture at WSU), Dr. Geeta A. Dutta (Assistant Vice President, WSU Research Advancement and Partnerships), Dr. Balasingam Muhuhthan (Chair, Civil & Environmental Engineering Department), and staff members from the WSU VP Research Office and from the CEE Department. The site visit included tours of relevant laboratory facilities at WSU. The meeting was very successful.

The second meeting was the unofficial kickoff meeting organized by the Center Director Dr. Xianming Shi where he communicated with the Site Directors of TriDurLE on the progress thus far on the Center operations as well as the plans, immediate tasks and expectations for the National UTC grant.

TriDurLE has been establishing a consistent process for the overall management and oversight of its activities. During the reporting period, we have created an Advisory Board of 11 members, primarily of representatives from state DOTs and private sector. The Board has been designed to be geographically and specialty diverse to ensure each research thrust and region of the U.S. is fairly represented. The Board will provide guidance and serve as champions of Center activities through annual meetings.

The Center Director worked on creating the TriDurLE Outreach Coordinator job position, and eventually recruited Ms. Cheryl Reed for the position after an extensive process of advertising and interviews. Assisted by other members of the TriDurLE executive committee, he also prepared the Data Management Plan (DMP) and the Technology Transfer (T2) Plan for TriDurLE. The DMP received some comments from OST-R and its revised version has been submitted to OST-R for further review; whereas the T2 plan has been approved by OST-R.

Dr. Shi also attended the UTC Grantees' Meetings at the Transportation Research Board Annual Meeting held in Washington, D.C., in January 2020.

TriDurLE has started some initial meetings with the Native American Program at WSU, to plan our efforts on recruiting and supporting minorities' future leaders.

Collaboration

TriDurLE is in the early stages of developing a diverse collaboration network with different state and local government agencies, private sector, and some through the TriDurLE Advisory Board members. We have initiated some collaboration with the Journal of Infrastructure Preservation & Resilience (JIPR) by Springer Nature and Bridge Engineering Institute (BEI).

For the first round of projects selection, the RFP clarifies that the preference will be given to proposed projects that involve collaboration across different campuses, thrust areas, or disciplines. Also, the proposal PIs are encouraged to engage stakeholders to ensure innovation and accelerate implementation.
Dr. Shi has given one invited presentation to the Idaho Transportation Department in Oct. 2019 to initiate potential collaboration between TriDurLE and ITD. He also has given one presentation to two administrators of the Washington State Transportation Improvement Board in Oct. 2019 to initiate potential collaboration between TriDurLE and WATIB.

Education and Workforce Development

Nothing to report; other than we have started some initial discussions with the Native Americans program at WSU.

Diversity

Nothing to report; other than we have started some initial discussions with the Native Americans program at WSU.

Technology Transfer

Developed a website (https://TriDurLE.wsu.edu/) and provided information on Center activities. Organized/hosted two monthly webinars with nearly 100 attended. Periodically posted announcements (e.g., academic conference) and news items (e.g., new publications or presentations).
Explored the possibility of leveraging the newly launched journal: *Journal of Infrastructure Preservation & Resilience* by Springer Nature for partnership opportunities.

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

The monthly webinars have been promoted via multiple channels to the professional groups likely interested in transportation infrastructure preservation and life-extension. These are open to the general public, particularly of value to the local and state transportation agencies, as well as to industry practitioners and researchers. We have hosted two of such monthly webinars as follows:

March 19, 2020, "Best Practices to Evaluate, Rehabilitate, and Repair Local Road Bridges," By Dr. Mostafa Tazarv of South Dakota State University. Attendance: 32

April 19, 2020, “Functional Aspects of Concrete Pavement Durability,” by Dr. Dan Zollinger of Texas A&M University. Attendance: 63

1.4 How have the results been disseminated?

Dr. Shi has given four invited research seminars relevant to TriDurLE, by the School of Civil Engineering, Sun Yet-Sen University; South China University of Technology; the first Sino-US Symposium on Advances in Civil Infrastructure Intelligence and Sustainability and the fourth International Conference on Transportation Infrastructure & Materials (ICTIM), respectively.

During the reporting period, Dr. Shi and his graduate students also have given a total of eight research presentations relevant to TriDurLE, at a variety of professional events such as the 99th Transportation Research Board Annual Meeting (Jan. 2020), the 10th IACIP (International Association of Chinese Infrastructure Professionals) Annual Workshop (Jan. 2020), and the ACI (American Concrete Institute) Fall Convention (Oct. 2019).

The Missouri University of Science and Technology team gave more than 10 presentations at the annual TRB meeting in January, covering a wide range of topics on transportation infrastructure. Drs. Jenny Liu, Xiong Zhang and their research groups’ presentations showcased their substantial effort on advancing innovative sustainable materials for transportation infrastructure use in cold regions. Also, the Office of the Vice Chancellor of Research at Missouri S&T organized the Beyond NSF workshop about writing proposals to DOT, DOE, DOD, DARPA, and NASA on February 28. As one of the invited panelists, Dr. Jenny Liu shared her experience and thoughts on working with U.S. and state DOTs. Dr. Xiong Zhang, Associate Professor in Geotechnical Engineering at Missouri S&T, was invited to give a keynote speech on “Use of Wicking Fabric to Dehydrate Road Embankment under Unsaturated Conditions” at GEO-Omaha 2020, 37th Annual Geotechnical Conference, organized by American Society of Civil Engineers, Nebraska Section – Geotechnical Group and Geo-Institute Nebraska Chapter in Omaha, NE on Friday, February 21, 2020.

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

The following tasks are planned in order to accomplish the goals and objectives of TriDurLE.

(1) Issue contracts (sub-awards) to Consortium universities

(2) Hold monthly Zoom Meetings w/ the executive committee (Site Directors); and hold quarterly Zoom Meetings w/ fiscal staff members and outreach coordinator

(3) Develop the TriDurLE Project Information Forms, likely including information such as project title, university, principle investigator, PI contact information, funding source(s) and amounts provided (by each agency or organization), total project cost, agency ID or contract number, start and end dates, brief description of research project, (anticipated) implementation of research outcomes, and (anticipated) impacts/benefits of implementation. The project information will be posted on the TriDurLE website as required by OST-R.

(4) Project summaries will be posted and updated on the TriDurLE website aswell as on TRB RiP once all projects have been selected.

(5) Continue the efforts in research, leadership, education, workforce development, diversity, and technology transfer, on behalf of the National UTC TriDurLE.

(6) Continue to explore opportunities of collaboration so as to pool resources and expand the scope of previous success. Develop a diverse collaboration network with different state and local government agencies, private sector, educational and professional organizations (and their student chapters), other university transportation centers (UTCs), FHWA offices, and universities in the U.S. and abroad. Expand our collaboration with the Journal of Infrastructure Preservation & Resilience (JIPR) and Bridge Engineering Institute (BEI).

(7) Maintain a robust website and publish a quarterly e-newsletter

(8) Work with partners to pursue commercialization and licensing opportunities
Continue to update the website, Facebook and YouTube pages, particularly those related to publications, presentations, monthly webinars, collaborations, and events/activities related to diversity, leadership, collaboration, education, workforce development, or technology transfer.

2. Participants & Collaborating Organizations

2.1 Who has worked on the program?

TriDurLE led by Washington State University is one of seven National University Transportation Centers (UTCs) sponsored by the U.S. Department of Transportation (DOT). TriDurLE was selected in the recent nationwide competition under the FAST Act. We serve as the only National UTC with a focus on the USDOT strategic priority of "**Improving the Durability and Extending the Life of Transportation Infrastructure**."

The TriDurLE consortium includes:

- Alabama A&M University
- Case Western Research University
- Florida Atlantic University
- Missouri University of Science and Technology
- South Dakota State University
- Tennessee State University
- Texas A&M University
- University of Colorado Denver
- University of Mississippi
- University of Utah

Table 1 on page 9 and 10 lists the leadership team members who have worked on the program during this reporting period.

Table 1. TriDurLE Staff Working on the Program

Name	Xianming Shi*	Catherine Armwood-Gordon	Jenny Liu	Chris Pantelides	Mohamad Ashour
Program/ Project Role	Center Director	Assistant Director for Diversity; Site Director at Tennessee State U	Associate Director for Research; Site Director at Missouri U of S&T	Site Director at U of Utah	Site Director at Alabama A&M
Contribution to Program/ Project	Oversees overall operations of the program. Responsible for coordinating with stakeholders and developing and implementing the CAMMSE strategic Plan	Oversees overall diversity activities of the program. Serves as liaison between TriDurLE and TSU.	Oversees overall research activities of the program. Serves as liaison between TriDurLE and M S&T.	Serves as liaison between TriDurLE and UU.	Serves as liaison between TriDurLE and AL A&M.
Funding Support	WSU	TSU	M S&T	UU	AL A&M
Collaborated with Individual(s) in Foreign Country(ies)	Yes	No	Yes	No	Yes
Countries of Foreign Collaborator(s)	China	N/A	China	N/A	China and South Korea
Traveled to Foreign Country	No	No	No	No	No
If traveled to foreign country, duration of stay	N/A	N/A	N/A	N/A	N/A

Table 1 continued

Name	Yail Jimmy Kim	Francisco Presuel-Moreno	Mostafa Tazarv	Waheed Uddin	Xiong (Bill) Yu	Dan Zollinger	Cheryl Reed
Program/Project Role	Site Director at U Colorado Denver	Site Director at Florida Atlantic U	Site Director at SD State U	Site Director at U of Mississippi	Site Director at Case Western Reserve U	Site Director at Texas A&M	Outreach Coordinator
Contribution to Program/Project	Serves as liaison between TriDurLE and UCD .	Serves as liaison between TriDurLE and FAU.	Serves as liaison between TriDurLE and SDSU.	Serves as liaison between TriDurLE and UM .	Serves as liaison between TriDurLE and CWRU.	Serves as liaison between TriDurLE and TAMU	Coordinated. & outreach activities; manage website and social media; etc.
Funding Support	UCD	FAU	SDSU	UM	CWRU	TAMU	WSU
Collaborated with Individual(s) in Foreign Country(ies)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Country(ies) of Foreign Collaborator(s)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Traveled to Foreign Country	No	No	No	No	No	No	No
If traveled to foreign country, duration of stay	N/A	N/A	N/A	N/A	N/A	N/A	N/A

2.2 What organizations have been involved as partners?

Table 2 provides a list of the organizations that have partnerships with TriDurLE.

Table 2. A List of Organizations Creating Partnerships with TriDurLE

Organization Name	Type / Location	Partners Contribution to Project				
		Financial Support	In-kind Support	Facilities	Collaborative Research	Personnel Exchanges
Alabama A&M University	Government /Alabama	X	X	X		
Denver Streets Partnership	Government/Colorado		X		X	
Libyan North American Scholarship Program	Government/Canada		X			
Case Western Reserve University	Government/Ohio		X	X	X	X
Colorado DOT Accelerated Bridge Construction (ABS)	Government /Colorado		X		X	
Florida Atlantic University	Government /FL		X	X		X
Florida DOT	University /TX	X				
Geneva Rock Products	Industry/Utah		X		X	
Illinois DOT Bureau of Materials	University /WA		X			
KeraKoll Group	Industry/Italy		X			X
Kokosing Materials, Inc.	Industry/Ohio		X			
Missouri S&T	Government /Missouri		X	X	X	X
MYKatikrete	Industry/India					
Northeast Forestry University	Government /China	X			X	X
Ruregold SRL	Industry/Italy		X			
SBIR/STTR	Federal					
Sika USA	Industry		X		X	
SNS Dempers	Industry/Utah		X			
South Dakota State University	Government /South Dakota	X	X	X		
Texas A&M University	Government /Texas		X	X	X	
The Polytechnic University of Milan	Government /Italy		X		X	
University of Maryland, College Park	Government /Maryland				X	
University of Mississippi	Government /Mississippi		X	X		

University of Utah	Government /Utah		X	X	X	X
Washington State University	Government /Washington State	X	X	X	X	X
Washington State DOT	Government /Washington	X	X			

The National UTC TriDurLE has established an advisory board which consists of eleven members from a diverse variety of organizations and disciplines. This Advisory Board will continue to be updated, once we secure a few more volunteers from other stakeholder organizations and the private sector.

- Srdj Boskovic, P.E., Branch Manager, Building & Earth Sciences, Inc.
- Anne Freeman, Research & Library Services Program Administrator, Washington State Department of Transportation
- David Goodwin, Ph.D., Research Chemist, National Institute of Standards and Technology (NIST)
- Issam Harik, Ph.D., Professor, University of Kentucky
- Jennifer Harper, P.E., Research Director, Missouri Department of Transportation
- Ivan R. Lasa, CPM, Structural Materials and Corrosion Specialist, Lasa and Associates Corrosion Services
- Steve Nolan, Composite Materials Expert, Florida Department of Transportation
- James Poorbaugh, PE, PMP, MSCE, Asset Management Engineer, Idaho Transportation Department
- Larry Scofield, PE, Director of Pavement Innovation, American Concrete Pavement Association
- William Tucker Stafford, M.S. E.I.T., Mississippi Department of Transportation
- Carmen Swanwick, MS, SE, Bridge Engineer, Utah Department of Transportation

2.3 Have other collaborators or contacts been involved?

The National UTC TriDurLE has been working with the following to develop collaborative relationships:

- Journal of Infrastructure Preservation & Resilience (JIPR, by Springer Nature)
- Bridge Engineering Institute (BEI)
- Washington State Transportation Improvement Board
- Idaho Transportation Department (ITD)
- Harbin Institute of Technology, China

3. Outputs

3.1 Publications, conference papers, and presentations

Publications

1. Nazari, M.H.**, Shihab, M., Havens, E.A.*, Shi, X. Mechanism of Corrosion Protection in Chloride Solution by an Apple-Based Green Inhibitor: Experimental and Theoretical Studies. Journal of Infrastructure Preservation and Resilience, 2020, in review.
2. He, J.**, Shi, X. Laboratory Assessment of a Self-healing System for Improving the Durability Characteristics of Cementitious Composites. ASCE Journal of Materials in Civil Engineering, 2020, in review.
3. Du, S.**, Ge, Y., Shi, X. High Volume Fly Ash Composites: A Review of Recent Advances. Cement and Concrete Composites, 2020, in review.
4. Xu, G.**, Li, Z.**, Shi, X. Reactivity of Coal Fly Ash Used in Cementitious Binder Systems: An Overview.

Cement and Concrete Composites, 2020, in review.
5. Cong, X., Lu, S., Tang, Z., Wang, C., Wang, L., Shi, X. Effect of Rice Husk Ash Surface Modification by Silane Coupling Agents on Damping Capacity of Cement-based Pastes. Materials and Structures, 2020, in review.
6. He, J.**, Shi, X. Accelerated Laboratory Assessment of Discrete Sacrificial Anodes for Rehabilitation of Salt Contaminated Reinforced Concrete, ASCE Journal of Materials in Civil Engineering, 2020, in press.
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** graduate student; __ corresponding author
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36. Wu, R.-Y., and Pantelides, C.P. (2020). “Seismic Evaluation of Repaired Bridge Bent Using Dynamic Analysis.” Structures Congress 2020, ASCE, 144-161.
37. Wu, R.-Y., and Pantelides, C.P. (2020). “Seismic Experiments and Analysis of Repaired Bridge Columns Using CFRP Donut.” ACI Special Publication 333, SP-333: Advances in Concrete Bridges: Design, Construction, Evaluation, and Rehabilitation, eds. Y.J. Kim, J.J. Myers, and A. Nanni, 80-95.
38. Murphy, C., Pantelides, C.P., Blomgren, H.-E., and Rammer, D.R. (2019). “Development of timber buckling-restrained braces for mass timber braced frames.” INTER Meeting 52, Tacoma, Washington, Aug. 26-29, Paper 52-15-3.
39. Kunwar, B., McEntee, V., Pantelides, C.P., and Alkhrdaji, T. (2019). “Seismic retrofit of reinforced concrete bridge pier walls.” 7th International Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, COMPDYN 2019, Crete, Greece, Jun. 24-26, paper C 18595.
40. McEntee, V., Kunwar, B., and Pantelides, C.P. (2019). “Seismic retrofit of reinforced concrete wall piers using various carbon fiber geometric forms.” ASCE Engineering Mechanics Institute Conference 2019, Pasadena, California, Jun. 18-21.

Presentations

1. Shi, X. National Center for Transportation Infrastructure Durability & Life-Extension: Collaboration Opportunities. University of Idaho – Idaho Transportation Department Research Progress Meeting, Moscow, ID. Oct. 25, 2019.
2. Shi, X. Innovative Materials Contributing to Life-Cycle Sustainability of Transportation Infrastructure. Presentation invited by the School of Civil Engineering, Sun Yet-Sen University, Zhuhai, China. July 8, 2019.
3. Shi, X. Innovative Materials Contributing to Life-Cycle Sustainability of Transportation Infrastructure. Presentation invited by the School of Civil Engineering and Transportation, South China University of

Technology, Guangzhou, China. July 5, 2019.

4. Shi, X. Innovative Materials Contributing to Sustainable Transportation Infrastructure. Presentation invited by the 1st Sino-US Symposium on Advances in Civil Infrastructure Intelligence and Sustainability, Jinan, China. July 4, 2019.
5. Shi, X. Innovative Materials Contributing to Life-Cycle Sustainability of Transportation Infrastructure. Presentation invited by the 4th International Conference on Transportation Infrastructure & Materials (ICTIM), Jinan, China. July 3, 2019.
6. Li, Z., Shi, X. Graphene Oxide Modified Cementitious Paste with Principally Alkali-Activated Fly Ash. A presentation at the 99th TRB Annual Meeting, Jan. 15, 2020, Washington, D.C.
7. Zhang, Y., Du, S., Shi, X. Sustainable Anti-icing Asphalt Pavement Incorporating $CaCl_2$-Zeolite Coated with Microporous Epoxy. A poster presentation at the TRB Resource Conservation and Recovery Committee, 99th TRB Annual Meeting, Jan. 15, 2020, Washington, D.C.
8. Li, Z., Zhao, C., Deng, K., Shi, X. Experimental Investigation on the Cyclic Performance of Perfobond Rib Shear Connectors. A presentation at the 99th TRB Annual Meeting, Jan. 15, 2020, Washington, D.C.
9. Du, S., Ge, Y., Shi, X. Improving the Freeze-Thaw Durability of High-Volume Fly Ash Concrete through Nanotechnology and Chemical Admixtures. A presentation at the TRB Resource Conservation and Recovery Committee, 99th TRB Annual Meeting, Jan. 14, 2020, Washington, D.C.
10. He, J., Shi, X. Laboratory Assessment of a Self-Healing System for Mitigating Early-Age Shrinkage of Cementitious Composites. A poster presentation at the TRB Resource Conservation and Recovery Committee, 99th TRB Annual Meeting, Jan. 14, 2020, Washington, D.C.
11. Shi, X., He, J., Mesarovic, S. Durability of Highly Flowable Self-Healing Concrete under Freeze-Thaw Actions. A presentation at the 10th IACIP Annual Workshop: Advancing Intelligent Transportation Infrastructure, International Association of Chinese Infrastructure Professionals (IACIP), Jan. 12, 2020, Washington, D.C.
12. Zhang, Y., Shi, X. Laboratory Evaluation of a Sustainable Additive for Anti-icing Asphalt. A poster presentation at the 10th IACIP Annual Workshop: Advancing Intelligent Transportation Infrastructure, Jan. 12, 2020, Washington, D.C. (Best Poster Award, 3rd Place).Du, S., Shi, X. Four-Phase Sphere Model of High-Volume Fly Ash Self-Consolidating Concrete for Predicting Dynamic Elastic Modulus. A podium presentation at the American Concrete Institute (ACI) Fall Convention, Cincinnati, OH. October 21, 2019.
13. Shi, X. National Center for Transportation Infrastructure Durability & Life-Extension (TriDurLE): Collaboration Opportunities. Presentation for the Washington State Transportation Improvement Board, Pullman, WA. Oct. 2, 2019.
14. Wu, R.-Y., and Pantelides, C.P. (2020). “Seismic Evaluation of Repaired Bridge Bent Using Dynamic Analysis.” Structures Congress 2020, ASCE, 144-161.
15. Kunwar, B., McEntee, V., Pantelides, C.P., and Alkhrdaji, T. (2019). “Seismic retrofit of reinforced concrete bridge pier walls.” *7th International Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, COMPDYN 2019,* Crete, Greece, Jun. 24-26, paper C 18595.
16. McEntee, V., Kunwar, B., and Pantelides, C.P. (2019). “Seismic retrofit of reinforced concrete wall piers using various carbon fiber geometric forms.” *ASCE Engineering Mechanics Institute Conference 2019,* Pasadena, California, Jun. 18-21.
17. Sultana, Salma, Rulian Barros, and W. Uddin. Geospatial Analysis of Landsat-8 Satellite Imagery to Classify Terrain and Built Infrastructure for Assessing Coastal Disaster Impacts. The 99th Annual Meeting of Transportation Research Board (TRB), The National Academies, Washington DC, January 12-15, 2020.
18. Uddin, W. Smart City Opportunities and Challenges Related to Connected Infrastructure, Disaster Resilience, and Climate Adaptation. the 2019 International International Conference on Smart Cities, Seoul, South Korea, July 17-19, 2019.
19. CWRU team delivered 8 Presentations at 99th TRB annual conference and presented 4 poster presentations at the International Association of Chinese Infrastructure Professionals.
20. CWRU team delivered 1 Presentation at the 2020 Ohio Transportation Engineering Conference
21. Mogawer, W., Austerman, A., Stuart, K., Zhou, F., and Romero, P.: “*Balanced Mix Design Sensitivity to Production Tolerance Limits and Binder Source.*” Walter J. Emmons Award for the best paper presented at the 2019 Annual Meeting of the Association of Asphalt Paving Technologist

22. Zhang, X. (2020). “Use of Wicking Fabric to Dehydrate Road Embankment under Unsaturated Conditions.” **Keynote Lecture**, GEO-Omaha 2020, *37th Annual Geotechnical Conference*, Omaha, NE, USA.
23. Tang, Q., Cheng, Y., Hu, X., Chen, C., and Song, Y. (2020). “Field Testing and Evaluation of Leader-Follower Autonomous Truck Mounted Attenuator Vehicle System for Work Zone Maintenance.” *99th Transportation Research Board Annual Meeting*, January 12-16, 2020, Washington, D. C., USA.
24. Chen, G. (2020). “Empowering and Rejuvenating Civil Engineering Profession with Informatics, Automation and Actuation.” **Keynote Lecture**, *the 10th International Association of Chinese Infrastructure Professionals (IACIP) Annual Meeting*, Washington, D. C., USA.
25. Fayek, S., Xia, X., Li, L., and Zhang, X. (2020). “A Photogrammetry-based Method to Determine the Absolute Volume of Soil Specimen during Triaxial Testing.” *99th Transportation Research Board Annual Meeting*, January 12-16, 2020, Washington, D. C., USA.
26. Riad, B., and Zhang, X. (2020). “Using Modified State Surface Approach to study the hydro-mechanical behavior of unsaturated soils.” Minneapolis, MN, USA.
27. Xia, X., Zhang, X. (2020). “Deep Learning Aided Target Recognition and 3D Reconstruction for Measuring Volume Changes of Unsaturated Soils in Triaxial Tests.” Guiyang, Guizhou. China.
28. Galinmoghadam, J., Zhang, X., Lin, C., and Guo, Y. (2020). “Pumping Mitigation in Pavement Shoulder Using Wicking Geotextile: An Experimental Study.” *99th Transportation Research Board Annual Meeting*, January 12-16, 2020, Washington, D. C., USA.
29. Li, L., Liu, J., Zhang, X., Saboundjian, S., and Li, P. (2020). “Characterizing Influence of Water Access Condition during Freezing on Resilient Behavior of Base Course Materials.” *99th Transportation Research Board Annual Meeting*, January 12-16, 2020, Washington, D. C., USA.
30. Liu, J. “Working with DOT.” Beyond NSF Workshop, Missouri S&T, February 2020.
31. Wu, H., Zhao, H., and Liu, J. (2019). “In Situ Experimental Study of FFT-based Bridge Weigh-in-motion System on a Continuous Box Girder Bridge.” *The 9th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-9)*, August 4-7, 2019, St. Louis, MO, USA.
32. Liu, J., and Wu, H. (2019). “Improved Ground Penetrating Radar Data Processing Method for Railroad Ballast Inspection.” *The 9th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-9)*, August 4-7, 2019, St. Louis, MO, USA.
33. Zhang, X. (2019). “Rapid Characterization of Stress-Strain Behavior for Unsaturated Soils using Simple Equipment.” **Keynote Lecture**, *the 7th Asia-Pacific Conference on Unsaturated Soils*, August 23~25, 2019, Nagoya Japan.
34. Zhang, X. (2019). “A simple device to measure soil water retention curve.” *The 7th Asia-Pacific Conference on Unsaturated Soils*, August 23~25, 2019, Nagoya Japan.
35. Zhang, X. (2019). “A coupled thermal-hydraulic-mechanical model for frost heave with integration of modern unsaturated soil mechanics.” *The 7th Asia-Pacific Conference on Unsaturated Soils*, August 23~25, 2019, Nagoya Japan.
36. Liu, J., Liu, J., and Saboundjian, S. (2020). “Evaluation of cracking susceptibility of Alaskan polymer modified asphalt binders using chemical and rheological indices.” *99th Transportation Research Board Annual Meeting*, January 12-16, 2020, Washington, D. C., USA.
37. Wu, H., Liu, J., and Zhang, X. (2020). “Feasibility Study on Use of Cellular Concrete for Air Convection Embankment on Permafrost Foundations.” *The 10th International Association of Chinese Infrastructure Professionals (IACIP) Annual Meeting*, Washington, D. C., USA.
38. Fayek, S., and Zhang, X. (2020). “A New Method to Determine the Absolute Volume of Saturated and Unsaturated Soil During Triaxial Testing.” *Geo-Congress 2020*, Minneapolis, MN, USA.
39. Fayek, S., and Zhang, X. (2020). “A Least Square Optimization Approach for Determining the Soil Boundary and Absolute Volume of Unsaturated Soils.” *The 10th International Association of Chinese Infrastructure Professionals (IACIP) Annual Meeting*, Washington, D. C., USA.
40. Xia, X., Fayek, S., and Zhang, X. (2020). “Deep Learning Aided Target Recognition for Volume-Change Measurement of Unsaturated Soils.” *99th Transportation Research Board Annual Meeting*, January 12-16, 2020, Washington, D. C., USA.
41. Riad, B. and Zhang, X. (2020). “Analysis of the Oedometer Test Results Using a New Method.” *Geo-Congress 2020*, Minneapolis, MN, USA.
42. Riad, B. and Zhang, X. (2020). “A Surface Approach for Calibrating Parameters in the Barcelona Basic Model.” *Geo-Congress 2020*, Minneapolis, MN, USA.

43. Wu, H., Zhao, H., and Liu, J. (2019). “FFT-based Portable Bridge Weigh-in-motion (BWIM) System for Highway Transportation Management.” *The 9th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-9)*, August 4-7, 2019, St. Louis, MO, USA.

3.2 Website(s) or other internet site(s)

The TriDurLE website is located at https://TriDurLE.wsu.edu/ (including links to the TriDurLE Facebook and YouTube pages). This website has been and will continue to be used to disseminate any information related to the program.

4. Outcomes

4.1 Increased understanding of transportation issues

As seen in the publications and presentations section, TriDurLE researchers have been actively involved in increasing knowledge and helping develop an educated workforce. In addition, through our webinar series, we have also reached a growing audience of students and researchers who are pursuing the field of transportation engineering and will continue to grow this audience.

TriDurLE researchers or their studies have been reported in the national media, increasing the awareness of transportation issues and contributing to the body of knowledge. Some examples are provided as follows:

- USA Today: Heavy road salt use in winter is a growing concern, scientists say Get the Full Story>>
- The Philadelphia Inquirer: Highway agencies look to grapes, cheese, and vodka as alternatives to salt Get the Full Story>>
- New Atlas: Grape skins used to create an eco-friendlier de-icer Get the Full Story>>
- Q13 Fox (TV): Move over, salt! A new co-friendly deicer that uses fruit is in the works Get the Full Story>>
- FAST Co: Throwing fermented grape skins on icy roads could help cut down our salt use Get the Full Story>> Also reported by: Yale Environment 360, AG Daily, Traffic Technology Today, Good News Network, etc.
- Sustainability Times: Fly ash waste can now be reused to make concrete Get the Full Story>>
- DW.com: Carbon-intensive cement industry feeling the heat Get the Full Story>>
- Transportation Today: WSU to lead (National) University Transportation Center with focus on strengthening infrastructure Get the Full Story>>
- Traffic Technology Today: Washington State University to address USA’s failing transportation infrastructure Get the Full Story>>
- The Spokesman Review: WSU to research crumbling roads and bridges with $7.5 million federal grant Get the Full Story>>

5. Impacts

Nothing to Report

6. Changes/Problems

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

The COVID-19 pandemic and associated lockdowns starting March 2020 have caused some delays

in preparing the contract paperwork between WSU and USDOT OST-R, mainly due to the fact that most staff members of WSU and OST-R had to work from home and temporarily lost access to their physical offices. Such delays will propagate to cause delays in WSU's process of issuing sub-awards to Consortium universities.

We also anticipate potential problems to arise, such as difficulties in recruiting students and postdoctoral associates (especially those who need visa to join the research groups of our Center), temporary loss of access to laboratory facilities or campuses (in some cases), and cancellation of conferences and other professional events originally planned to occur in summer 2020.

Our plans to resolve aforementioned problems will be to catch up some lost time once the lockdowns are lifted and if necessary, to approve potential requests of no-cost time extension for some of the research projects, and to conduct more outreach activities online where suitable.

7. Special Reporting Requirements

(1) **Website:** Newly-designed website launched July 2019:
https://tridurle.wsu.edu/

(2) **Directory of Advisory Board:** Available on the program website:
https://tridurle.wsu.edu/advisory-board/

(3) **Directory of Key Personnel:** Available on the program website:
https://tridurle.wsu.edu/staff/

(4) **Financial and Annual Recipient Share Reports:** The Federal Financial Report (SF-425) requirements will be met by separate reports.

(5) **Research Project Descriptions:** Available on the program website (once the projects are selected via a peer review process and officially awarded):
https://tridurle.wsu.edu/research/

Appendix

TriDurLE Year one (2019-2020) projects that have successfully passed the peer review process and will soon be funded.

University(s)	Principle Investigator(s)	Category	Title of Funded Project
Alabama A&M University	Mohamad Ashour	Applied Research	Evaluation of Downdrag Loads on Bridge Pile Foundations in Inundated Collapsible Soils
Case Western Reserve University	Christian Carloni	Applied Research	Fatigue Life Analysis of Reinforced Concrete Beams Strengthened with Composites
Case Western Reserve University	Xiong (Bill) Yu	Applied Research	Development of Environmental Responsive Asphalt Technology for Asphalt Pavement Life Extension
Case Western Reserve University	Xiong (Bill) Yu	Applied Research	Develop an Innovative Self-Healing Concrete Technology for Bridge Deck Life Extension
Florida Atlantic University	Francisco Presuel-Moreno	Applied Research	Corrosion Propagation Monitoring Using Galvanostatic Pulse on Reinforced Concrete Legacy Samples
Florida Atlantic University	Pierre-Phillipe Beaujean	Applied Research	Modeling and Measurement of Rebar Corrosion on Crack Formation Using High Frequency Ultrasonics in Three Dimensions and with No Contact with the Sample
Missouri University of Science & Technology	Jenny Liu	Applied Research	Use of Recycled Plastics in Asphalt Pavements
Missouri University of Science & Technology	Jenny Liu	Applied Research	Exploring the Feasibility of Innovative Integration of Place Change Materials for Thermo-Adaptive Asphalt Pavements
Missouri University of Science & Technology, Texas A&M; University of Utah	Jenny Liu, PI, MST; Fujie Zhou, PI, TAMU; Pedro Romero, PI, UU	Applied Research	Development of Holistic Methodologies for Improving Asphalt Mix Durability
South Dakota State University	Mostafa Tazarv	Applied Research	Post-Earthquake Serviceability of RC Bridge Bents Using Visual Inspection

University(s)	Principle Investigator(s)	Category	Title of Funded Project
Texas A&M University and Missouri University of Sci. & Tech.	Dan Zollinger, PI, TAMU; Jenny Liu, PI, MST	Applied Research	Durability of Transverse Sawcut Joints in Mid-Western Jointed Concrete Pavements
University of Mississippi	Waheed Uddin	Applied Research	Highway Pavement Condition Deterioration Modeling Considering Maintenance History
University of Colorado, Denver	Wesley Marshall; Arunprakash Karunanithi	Applied Research	Evaluating Sidewalk Infrastructure & Prioritizing Investment
University of Utah and University of Colorado, Denver	Chris Pantelides, PI, UU; Jimmy Kim, PI, UCD	Applied Research	Performance of ABC Columns and Cost-Effective Retrofit Strategies Subjected to Synergistic Distress Resulting from Corrosion and Seismic Loading
Washington State University	Xianming Shi	Applied Research	Design of Long-Lasting Discrete Sacrificial Anode for Corrosion Mitigation of Reinforcement in Chloride Contaminated Concrete
Washington State University and Case Western Reserve University	Ji Yun Lee, PI, WSU; Yue Li and Bill Yu, PIs, CWRU	Applied Research	Multi-Level Resilience-Based Transportation Asset Management (TAM) Framework using Bayesian Network
Washington State University	Christopher Motter and Adam Phillips	Applied Research	Fiber Reinforced Polymer (FRP) Seismic Retrofit of Reinforced Concrete Bridge Columns Vulnerable to Long-Duration Subduction Zone Earthquakes
Washington State University	Xianming Shi	Applied Research	Impacts of Magnesium Chloride Deicer on the Durability of Nanosilica-Modified HVA Concrete
Washington State University	Xianming Shi	Applied Research	Development of a Multi-Scale Self-Healing High-Volume Fly Ash UHPC
Washington State University	Muhunthan Balasingam	Applied Research	An Innovative Approach to Enhance Self-Healing in Cementitiously Stabilized Soils and Mitigate Shrinkage Cracking