



Semi-Annual Progress Report for University Transportation Centers

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1) ACCOMPLISHMENTS

1.A - What are the major goals and objectives of the program?

The Tier-1 UTC, Center for Durable and Resilient Transportation Infrastructure (DuRe-Transp), focuses on the statutory research priority area “Improving the durability and extending the life of transportation infrastructure”. The consortium driving the Center’s mission is comprised of a transdisciplinary team of prominent researchers from six universities in the U.S.: The University of Texas at Arlington (UTA-Lead), Howard University (HU), Missouri University of Science and Technology (S&T), Oregon State University (OSU), Purdue University (PU), and the University of Puerto Rico - Mayagüez (UPRM). By leveraging such collaboration, DuRe-Transp addresses critical scientific and technological advancements in the strategic topics of Durability, Construction and Finance.

Research Goals

DuRe-Transp Center’s overall goal is premised on Innovation, Durability, Life-cycle performance, and Performance-based standards for revitalization of the nation’s infrastructure. DuRe-Transp addresses critical challenges in 7 Research Themes (RT):

- **Durability**
 1. RT-I: Inspection, Maintenance and Preservation (IMP)
 2. RT II: Durability and Longevity (DL)
 3. RT III: Health Monitoring (HM)
- **Construction**
 4. RT IV: Next Generation Construction Materials (NGM)
 5. RT V: Advanced Materials and Technologies for Construction and Retrofitting (CR)
 6. RT VI: Construction Methods and Management (CMM)
- **Finance**
 7. RT VII: Innovative Revenue and Finance (RF)

DuRe-Transp’s Research Themes identify and prioritize scientific and technological advancements that support U.S. DOT’s goals for inspecting, repairing, and rebuilding the transportation infrastructure, and improving roadway safety for all users. Under the 7 Research Themes, the Center will lead cross-disciplinary research projects to develop and deploy the next generation of durable concrete-based materials, with emphasis on mitigation of degradation mechanisms liable for diminishing the service life of transportation infrastructure. The performance of these materials will be rigorously tested in both laboratory and field conditions, evaluating the materials’ exposure to various environments, e.g., marine and frost. This research will support the development of standard guidelines for the formulation and deployment of the next generation of durable materials. The Center will also dedicate resources for comprehensive research on advanced structural retrofitting and repair solutions for existing infrastructure. The Center will develop and implement in-place and remote-sensing technologies for structural health monitoring (SHM). The SHM tools will provide the ability to detect damage in the infrastructure elements. Such tools will be supplemented with advanced data-driven models to perform life-cycle analysis, asset management, and performance characterization. The models will employ deep learning methods for data inference, prediction, and optimization. The Center will also deploy novel technologies and data-fusion frameworks to advance revenue and finance in transportation sector, with an emphasis on the design and implementation of data-driven blockchain-based smart contracts and commercial vehicle user fee models. Such finance systems will provide actionable managerial data that will ultimately increase return on investment while also reducing project risks.

Education and Workforce Development

The educational, training and professional development activities of the project are closely integrated with the research objectives with the aim to contribute to the successful training of students at all levels of education, graduate, undergraduate and pre-college/K-12. The DuRe-Transp Center will also contribute to enhancing the potential of postdoctoral fellows and early career researchers to flourish as scholars and become the nation's front-line engineers, allowing them to acquire new scientific knowledge, technological know-how and professional skills in engineering practices that can extend the durability and service life of our TI. This goal will be facilitated by specific education and workforce development activities:

- New Certificate program with cross-disciplinary courses in the strategic focus area “Improving the durability and extending the life of transportation infrastructure”. The courses will be delivered blended/hybrid (face-to-face and on-line), and in live webcasts and self-paced on-line. To complete the certificate, students will select 4 courses from the following list: Inspection and Preservation of Concrete Structures; Durability and Long-term Performance of Infrastructure; Structural Health Monitoring (SHM) of Existing Superstructures and Substructures; Next Generation Construction Materials and Structures; Advanced Materials for Construction and Retrofit; Additive Manufacturing in Transportation Infrastructure; Assets Management and Risk Assessment of Concrete Infrastructure; Digital Financing for Transportation Infrastructure.
- Special education modules, aligned with the Center's research activities, to reinforce existing academic programs and support the development of new skill sets in upper-level undergraduate and graduate courses.
- New learning opportunities, i.e., development of cutting-edge materials, technologies and tools, that can be used for senior undergraduate design and capstone projects.
- Educational seminars/webinars with invited plenary lectures from scientists and engineers from the academia and industry.
- DuRe-Transp Outstanding Student of the Year. DuRe-Transp will select an outstanding student of the year, annually, starting the AY 24-25 based on accomplishments in one or more Research Themes of DuRe-Transp, academic performance, professionalism, and leadership.
- Research Scholarships to Community College Students. DuRe-Transp will provide scholarships to students from community colleges through existing partnerships, such as the Tarrant County College to The University of Texas at Arlington (TCC-to-UTA) admission program, and TCC-UTA-Dallas College partnerships supported by the North Central Texas Council of Governments (NCTCOG). The scholarship awardees will participate in undergraduate research activities and attend courses at the consortium's universities, e.g., UTA's Department of Civil Engineering.
- Pre-college/K-12 summer camps to deliver age-appropriate presentations and research showcases to pre-college/K-12 students.
- Webinars and Educational Modules to K-12 teachers about innovative construction technologies, novel infrastructure materials and smart structure through existing education programs in the consortium's universities, i.e., STEM Education program of the Kummer Center at S&T.

Technology Transfer Activities

A primary objective of the DuRe-Transp Center is the transition of research into practice by developing hands-on technologies for engineers and transportation practitioners. Specific plans for technology transfer and collaboration activities to accelerate the development and deployment of research findings will be designed.

- Technical webinars to highlight new technological advances from the Center's research projects. The webinars will provide Professional Development Hours to professional, engineers and practitioners.
- Training sessions to students from Technical Trade Schools, i.e., Edge Tech Academy in Arlington, TX and the Rolla Technical Institute in Rolla, MO, in new areas such as bridge inspection, Structural Health Monitoring (SHM) and 3D printing of concrete.
- Online training webinars in collaboration with Local Technical Assistance Programs (LTAP). DuRe-Transp will collaborate with LTAPs in Texas (TxLTAP), Missouri (MoLTAP) and Puerto Rico (PRLTAP) to integrate new research findings and robust technologies developed by the Center's projects into practice. Topics of the quality training webinars will cover, but not limited to, the use of non-metallic reinforcement, inspection, maintenance and preservation of concrete pavements and bridges, structural health monitoring, and repair and rehabilitation of concrete infrastructure using novel materials, such as Ultra High Performance Concrete (UHPC).
- Annual half-day seminar to highlight research outcomes/products, starting the AY 24-25. Target audiences are consortium members, transportation professionals from state and local governments, and transportation agencies/enterprises.
- DuRe-Transp faculty will disseminate knowledge and develop guidelines and standards through numerous technical committees in Transportation Research Board (TRB), American Concrete Institute (ACI), American Society of Civil Engineers (ASCE), and International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM).
- The Center's faculty members will also organize sessions at the technical conventions, e.g., TRB Annual Meeting and ACI Fall and Spring Conventions to disseminate the research findings from the Center's projects.
- The Center's research teams will publish the research findings in joint publications in peer-reviewed journals actively involving postdoctoral fellows and Ph.D. students.
- The Center's website will be created and utilized to publicize on-going research, educational activities, technology transfer events, and project reports.
- Research outcomes of the DuRe-Transp Center will be uploaded into the U.S. DOT Research Hub in a timely manner.

1.B - What was accomplished under these goals?

The research projects are categorized within the Center's 7 research themes as follows:

Durability

- *RT-I: Inspection, Maintenance and Preservation*
 1. Best Practices for Application of Sealers/Coatings for Extending Service Life of Bridges
Lead Institution: The University of Texas at Arlington
RIP Database: <https://rip.trb.org/view/2344520>
- *RT II: Durability and Longevity*
 2. Extending the Lifespan of Concrete Superstructures via Alkali-Silica Reaction Mitigation
Lead Institution: The University of Texas at Arlington
RIP Database: <https://rip.trb.org/view/2343323>
- *RT III: Health Monitoring*
 3. Comprehensive Diagnostic System for Corrosion Assessment of Concrete Infrastructure
Lead Institution: Missouri University of Science and Technology
RIP Database: <https://rip.trb.org/view/2344530>
 4. AI/video-driven SHM and Lifespan Estimation of In-service Bridges
Lead Institution: Howard University
RIP Database: <https://rip.trb.org/view/2344522>

Construction

- *RT IV: Next Generation Construction Materials*
 5. Next Generation Concrete Pavement Materials for Transportation Infrastructure
Lead Institution: The University of Texas at Arlington
RIP Database: <https://rip.trb.org/view/2344523>
 6. Optimizing Cementitious Systems for Alternative Cement Using Thermodynamic Modeling
Lead Institution: Oregon State University
RIP Database: <https://rip.trb.org/view/2344524>
- 1) *RT V: Advanced Materials and Technologies for Construction and Retrofitting*
 7. Design and Performance of Shotcrete Using Ultra-High Performance Concrete
Lead Institution: Missouri University of Science and Technology
RIP Database: <https://rip.trb.org/view/2344521>
 8. Performance of Eco-Fiber-Reinforced Concrete for Bridge Construction and Rehabilitation
Lead Institution: Missouri University of Science and Technology
RIP Database: <https://rip.trb.org/view/2344525>
- *RT VI: Construction Methods and Management*
 9. Quantitative Risk Assessment of Concrete Infrastructure Assets
Lead Institution: The University of Texas at Arlington
RIP Database: <https://rip.trb.org/view/2344526>

Finance

- *RT VII: Innovative Revenue and Finance*
 10. Role of Blockchain Enabled Smart Contracts in Facilitating Transportation Sector Projects
Lead Institution: Missouri University of Science and Technology
RIP Database: <https://rip.trb.org/view/2344527>
 11. Commercial Vehicle Life Cycle Use Fees Based on Pavement Impact
Lead Institution: The University of Texas at Arlington
RIP Database: <https://rip.trb.org/view/2344528>
 12. Machine Learning Maintenance Cost Forecasts for Better Infrastructure LCCA
Lead Institution: Missouri University of Science and Technology
RIP Database: <https://rip.trb.org/view/2344529>

Education and Workforce Development (EWD) Objectives Accomplished

- A new three credit hour undergraduate course entitled “3D Printing for Infrastructure Applications” (CE 49700) was offered for the first time at Purdue University during Spring 2024 Semester. The lecture and lab sessions of the course include presentations of the research activities and findings from DuRe-Transp projects. Several guest speakers from the 3D printing industry were invited for guest lectures in this course, including engineers from COBOD International, ICON, RCAM and 1Print companies.
- A new three credit hour senior undergraduate and graduate course entitled “Advanced Engineering Materials Mechanical Testing and Characterization” (CE 5300 – 005) was offered for the first time at UTA during Fall 2024 Semester. The lecture and lab sessions of the course include presentations of the research activities and findings from DuRe-Transp projects “Next Generation Concrete Pavement Materials for Transportation Infrastructure”.
- The curricula of courses in DuRe-Transp’s partnering institutions were updated:
 - 1) UTA’s courses “CE 5302: Advanced Concrete Materials” and “CE 4302: Advanced Topics in Civil Engineering” were updated with special course enhancement modules including lectures and lab sessions based on the research activities and findings from DuRe-Transp’s project “Next Generation Concrete Pavement Materials for Transportation Infrastructure”.
 - 2) OSU’s course “CCE 321- Ecampus – Civil and Construction Engineering Materials” was updated with course enhancement modules including research findings from DuRe-Transp’s project “Optimizing Cementitious Systems for Alternative Cement using Thermodynamic Modeling”.
 - 3) HU’s course “Introduction to Structural Protection Systems” was updated with a special course enhancement modules including lectures based on the research findings from DuRe-Transp’s project “AI/video-driven SHM and Lifespan Estimation of In-service Bridges”.
 - 4) S&T’s courses “Smart Contracts for Efficient Transportation Management” and “Data Analytics and Artificial Intelligence” were updated with lectures featuring the research activities of the project “Blockchain-based Smart Contracts for Allocating Resources and Automating Contract Payments”.
 - 5) The lecture notes of PU’s undergraduate course “Civil Engineering Materials” were updated with findings from DuRe-Transp’s research activities about the use of new supplementary cementitious materials for the transportation infrastructure.

- 6) UPRM's graduate course "Advanced Concrete Technology" was updated with findings from DuRe-Transp's research activities about durable cement-based materials and concrete.
- DuRe-Transp team at PU will organize research symposium sessions at the Engineering Mechanics Institute Conference and Probabilistic Mechanics & Reliability Conference (EMI/PMC 2024), May 28-31, 2024, including (1) Architected Materials; (2) Advances in computer vision, deep learning and artificial intelligence for structural health monitoring and inspections; (3) Infrastructure assessment automation with robotics, deep learning and digital twins.
 - DuRe-Transp faculty Acosta organized at UPRM the UPRM 2024 Summer Transportation Institute on June 6 – July 3, 2024. The event, sponsored by DuRe-Transp, attracted 16 junior and senior high school students. The summer camp included lecture presentations and lab sessions emphasizing on the use of concrete for the Transportation Infrastructure. DuRe-Transp undergraduate and graduate students at UPRM served as mentors for the K-12 students. Final presentations were delivered by the K-12 students on July 3, 2024.
 - Special guest seminars organized at UTA:
 - 1) "Portland Limestone Cement Concrete"
The Leadership of Heidelberg Materials, North America
David Perkins, Vice President, Government Affairs & Communications
Lori Tiefenthaler, Sr. Director of Marketing
Larry Rowland, Market Manager
 - 2) "Cement-Based and High-Performance Materials"
Ruben Paul Borg, Professor, Construction and Property Management, L-Università ta' Malta (UM)
 - 3) "3D Printing of Strain-Hardening Cementitious Composite (SHCC)"
Ye Qian, Assistant Professor, Structural Engineering, The University of Hong Kong, entitled "
 - One undergraduate student from DuRe-Transp team received UTA's Civil Engineering Excellence Scholarship, due in part to his participation in DuRe-Transp project "Extending the Lifespan of Concrete Superstructures via Alkali-Silica Reaction Mitigation".
 - One undergraduate student from DuRe-Transp team at PU was the recipient of the Office of Undergraduate Research (OUR) scholarship at PU. The student was also selected by the Summer Undergraduate Research Fellowship (SURF) Program at PU to participate in the research projects of DuRe-Transp.
 - One undergraduate student from DuRe-Transp team at UPRM was sponsored by LTAP Center EPC² to participate in research activities about the development concrete mixtures using lightweight aggregates for internal curing of concrete mixtures within the framework of research projects of DuRe-Transp.
 - One undergraduate student from DuRe-Transp team at UTA received the Certificate of Achievement from UTA's College of Engineering for the participation as research assistant in DuRe-Transp's projects.
 - Two UTA DuRe-Transp's students applied for the Dwight David Eisenhower Transportation Fellowship Program (DDETFP). The Program awards fellowships to students pursuing degrees in transportation-related disciplines. DDETFP advances the transportation workforce by helping to attract the nation's brightest minds to the field of transportation, encouraging future

transportation professionals to seek advanced degrees, and helping to retain top talent in the U.S. transportation industry.

1. *Konsta-Gdoutos* presented a key-note presentation at the Inaugural US DOT Summit for the Future of Transportation (FoT) in Washington, DC on August 13-15, 2024. The presentation highlighted significant results and broader impacts from DuRe-Transp’ research projects.
2. *Konsta-Gdoutos, Shah* and *Olek* presented key-note presentations at The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), in Catania, Italy, July 8-11, 2024.
3. *Marin* presented a lightning talk at the Natural Hazards Research Summit 2024, held on May 14 and May 15 at the University of Maryland campus in College Park, MD.
- DuRe-Transp program coordinator *Danoglidis* served as a speaker in the panel discussion “UTCs and WFD – What Works, What Does Not Work, What Needs to Change, Best Practices, And Focus on Rural and Tribal Communities” at the Transportation Industry & Workforce Development Symposium organized by the Regional UTC Southern Plains Transportation Center in University of Oklahoma on April 30, 2024.

Technology Transfer Objectives Accomplished

- Development of a monthly Webinar Series focusing on the Center’s Research Area “Improving the Durability and Extending the Life of Transportation Infrastructure”. The webinars were organized by DuRe-Transp’ Associate Director for Technology Transfer Weiss:

Webinar #5

Tuesday, May 21, 2024 – 2:00 pm – 3:00 pm CST

- 1) Exploring the Effect of Polyethylene Terephthalate (PET) Replacements in Portland Cement Mixtures
Rachel Cook, NRC Postdoctoral Researcher, NIST
- 2) Quality Control for Concrete Paving: A Tool for Agency and Industry
Tara Cavalline, Professor, Civil Engineering Technology & Construction Management, UNC Charlotte

Webinar #6

Tuesday, July 23, 2024 – 2:00 pm – 3:00 pm CST

- 1) Development of cementitious mixtures for 3D printing of elements with controlled architecture
Jan Olek, Lyles School of Civil and Construction Engineering, Purdue University
 - 2) 3D Concrete Printing
Narayanan Neithalath, Fulton Professor of Structural Materials, Ira Fulton Schools of Engineering, Arizona State University
- DuRe-Transp Workshop “Rheology and 3D Printing of Concrete”
The Center’s first Workshop on Rheology and 3D Printing of Concrete took place in Missouri University of Science and Technology (Missouri S&T) in Rolla, Missouri, on August 5-7, 2024. The event, co-sponsored by NSF’s AccelNet program, attracted 55 participants and emphasized on rheology-based investigations of cement-based materials aiming at improving the performance of high-performance 3D-printed concrete.
DuRe-Transp’s Associate Director *Khayat* and Theme Leader *Olek* chaired the workshop and presented key-note lectures on the use of rheology to quantitatively analyze the flow behavior

of construction materials, offering insights beyond traditional workability methods. Arizona's State University and NSF's AccelNet PI *Neithalath* discussed the role of rheology in the early-age hydration of 3D-printed concrete, while *Youngblood* from PU provided foundational knowledge on rheology and modeling techniques.

The workshop was a first-of-its-kind opportunity for faculty, students and engineers from several disciplines to learn about novel testing methods for evaluating 3D-printed concrete performance and advancements in bioinspired material design for 3D printing. The workshop also featured a poster session showcasing related research projects; laboratory demonstrations of 3D printing testing methods; and a tour of Missouri S&T's Clayco Advanced Construction and Materials Laboratory. Participants had the opportunity to engage in breakout sessions, discussing the opportunities and challenges in advancing rheology and 3D printing technologies, and brainstorming for future development. Industrial perspectives were shared by *Gabriel Falzone*, COO of Sperra, and *Philip Lund-Nielsen*, co-founder and Head of Americas at COBOD.

The event drew participants from a range of higher education institutions and agencies, including The University of Texas at Arlington, Arizona State University, Clemson University, Drexel University, Iowa State University of Science and Technology, Louisiana State University, Northwestern University, Oklahoma State University, Purdue University, Texas A&M University, University of Puerto Rico at Mayagüez, University of Florida, The University of Mississippi, University of Notre Dame, National Institute of Standards and Technology, U.S. Army Corps of Engineers, ICON Technology and Poland's West Pomeranian University of Technology.

- DuRe-Transp faculty *Acosta* organized in San Juan, PR the Technology Transfer Seminar "Innovative Applications in Construction Materials for Highway Construction" on July 19, 2024. The Seminar was offered in collaboration with PR-LTAP and attracted 39 engineers from governmental and industrial sectors. Emphasis was given on the benefits of internal curing of concrete mixtures, advancements in recycled concrete aggregates, and fiber-reinforced polymers for structural applications.
- Director *Konsta-Gdoutos* was the Organizer and Chair of the Scientific Committee of The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8). NICOM8 attracted more than 50 participants from a range of higher education institutions and agencies including the U.S. Army Corps of Engineers and Holcim Innovation Center.
- Field demonstrations developed by the DuRe-Transp team at Purdue University, within the framework of the Center's research activities. The demonstrations included placement of slabs with non-traditional and traditional pozzolans.

1.C - What opportunities for training and professional development has the program provided?

4. DuRe-Transp faculty, postdocs, students and staff were financially supported by the Center to attend workshops, symposia and conferences:
 1. DuRe-Transp members, including 5 Faculty, 2 postdocs and 10 students, at UTA, S&T, PU, OSU and UPRM participated in the Center's Workshop "Rheology and 3D Printing of Concrete" in Missouri S&T on August 5-7, 2024.
 2. DuRe-Transp personnel participated in the Transportation Industry & Workforce Development Symposium organized by the Regional UTC Southern Plains Transportation Center in University of Oklahoma on April 30, 2024.

3. DuRe-Transp faculty, postdocs and students at UTA and HU participated in the 2024 ASCE International Conference on Transportation & Development in Atlanta, GA on June 15-18, 2024.
 4. DuRe-Transp faculty and students at UTA and PU participated in the Inaugural US DOT Summit for the Future of Transportation (FoT) in Washington, DC on August 13-15, 2024.
 5. DuRe-Transp personnel participated in the 2024 CUTC Summer Meeting hosted by the University Transportation Center for Railway Safety (UTCRS) at the University of Texas Rio Grande Valley (UTRGV), June 10-12, 2024.
- DuRe-Transp supports faculty and students who are actively involved in the Technical Committees and Tasks Groups of the American Concrete Institute (ACI) and International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM). DuRe-Transp's Director *Konsta-Gdoutos* is the Chair of ACI TC 241 "Nanotechnology of Concrete" and TG-2 "Nanoscale Fiber Reinforced Concrete". DuRe-Transp Program Coordinator, *Danoglidis*, and the Center's Ph.D. Students are involved in the development of a new Technical Note "Why Carbon Nanofibers in Concrete?" within the activities of ACI TG-2 "Nanoscale Fiber Reinforced Concrete".

1.D - How have the results been disseminated?

1. Research findings of DuRe-Transp's research projects were disseminated through scientific papers, and oral and poster presentations in national and international conferences, including but not limited to, the 2024 ASCE International Conference on Transportation & Development, The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), 12th ACI/RILEM International Conference on Cementitious Materials and Alternative Binders.
2. Poster presentations from DuRe-Transp's projects were presented in the Inaugural US DOT 2024 FoT Summit: "Extending the Lifespan of Concrete Superstructure via Alkali-Silica Reaction Mitigation" by *Danoglidis*, UTA; and "Performance of Nontraditional Natural Pozzolans (NNPs) in Concrete Field Mixtures" by *Zhaksybay*, PU, within the framework of DuRe-Transp's projects "Extending the Lifespan of Concrete Superstructure via Alkali-Silica Reaction Mitigation" and "Design and Performance of Shotcrete Using Ultra-High-Performance Concrete".
3. Associate Director *Marin* presented a lectern presentation in the 2024 ASCE International Conference on Transportation & Development in Atlanta, GA on June 15-18, 2024. DuRe-Transp students at HU participated in the Conference within the framework of DuRe-Transp's project "AI/video-driven SHM and Lifespan Estimation of In-service Bridges".
4. DuRe-Transp faculty *Shahandashti* and postdoctoral fellow *Roy* at UTA presented a lectern presentation in the 2024 ASCE International Conference on Transportation & Development in Atlanta, GA on June 15-18, 2024, within the framework of DuRe-Transp's project "Quantitative Risk Assessment of Concrete Infrastructure Assets"

1.E - What Do You Plan to Do During The Next Reporting Period To Accomplish The Goals And Objectives?

1. The DuRe-Transp Annual Meeting will be held in The University of Texas at Arlington in Arlington, Texas on Friday October 18, 2024, to emphasize the Center's notable research, workforce development and outreach, and technology transfer activities and outcomes during Year 1. The annual meeting will feature a meeting with the External Advisory Committee; a keynote panel session "The Future of Transportation Infrastructure: New Directions and Critical Challenges" with speakers from DOTs and private firms in construction and transportation sector; presentations by the PIs of the Center's projects; a poster session showcasing related research projects; and a lab tour in the research facilities of UTA's Center for Advanced Construction Materials.
2. A request for proposals for new projects starting 2025 will be issued. DuRe-Transp Director *Konsta-Gdoutos*, Directors of Scientific Committee *Shah* and *Karbhari* and one representative from DuRe-Transp's External Advisory Committee (EAC) will evaluate the research proposals based on specific intellectual merit and broader impact criteria. The selected project will be sent to the Grant Manager for review.
3. The webinars #7-10 of the monthly Webinar Series will be held in the next reporting period of Fall 2024 – Spring 2025.
4. A new Ambassador Program entitled "Chasing Structural Anomalies: Using AI and Videos to Detect Infrastructure Vulnerabilities" will be developed by the Associate Director *Marin*, in collaboration with the HU-ASCE student organization, within the educational and workforce development activities of DuRe-Transp. The objective of the program is to provide fundamental and advanced knowledge for integrating new AI components in structural engineering topics for identification of vulnerabilities in constructions with a focus on transportation infrastructure, i.e., bridges and pavements. This program will offer lectures, lab/hands-on sessions and field trips to undergraduate students from HU's departments of civil engineering and computer science.
5. S&T will contact Rolla Technical Institute to initiate discussions for organizing training sessions to the Technical Trade School students. These sessions will provide insights into the durability, longevity, and resilience of cement concrete infrastructure through STEM research.
6. DuRe-Transp will announce the nomination for the UTC outstanding Student of the Year Award during DuRe-Transp Annual Meeting on Friday October 18, 2024. The nominee will be selected based on accomplishments in one or more Research Themes of DuRe-Transp, academic performance, professionalism, and leadership. The DuRe-Transp Outstanding Student of the Year will be officially recognized at a special ceremony during the TRB Annual Meeting on Saturday, January 4, 2025.

2) PARTICIPANTS & COLLABORATING ORGANIZATIONS

2.A - What organizations have been involved as partners?

- All the participating institutions of DuRe-Transp are actively involved by providing support to the Center.
 - 1) The University of Texas at Arlington, Arlington, TX – LEAD, financial and in-kind support, supply facilities and equipment, and research collaborations
 - 2) Howard University, Washington, DC, in-kind support, supply facilities and equipment, and research collaborations
 - 3) University of Puerto Rico at Mayagüez, Mayagüez, Puerto Rico, in-kind support, supply facilities and equipment, and research collaborations
 - 4) Missouri University of Science and Technology, Rolla, MO, financial and in-kind support, supply facilities and equipment, and research collaborations
 - 5) Oregon State University, Corvallis, OR, in-kind support, supply facilities and equipment, and research collaborations
 - 6) Purdue University, West Lafayette, IN, in-kind support, supply facilities and equipment, and research collaborations
- Several state governments and industrial partners are in the process of partnering with DuRe-Transp to provide financial and in-kind support and facilities to the Center:
 - 1) Texas Department of Transportation, Austin, TX, in-kind support
 - 2) Missouri Department of Transportation, Jefferson City, MO, in-kind support
 - 3) District of Columbia Department of Transportation, in-kind support
 - 4) Oregon Department of Transportation, Salem, OR, in-kind support
 - 5) Indiana Department of Transportation, Indianapolis, IN, in-kind support
 - 6) Federal Highway Administration (FHWA), financial and/or in-kind support
 - 7) Puerto Rico Local & Tribal Technical Assistance Program, financial and/or in-kind support
 - 8) Puerto Rico Highway Authority, in-kind support
 - 9) Heidelberg Materials, North America, in-kind support
 - 10) CRH Company plc, in-kind support
 - 11) Ash Grove Cement Company, A CRH COMPANY, in-kind support
 - 12) Ecocem Materials Ltd, in-kind support
 - 13) Shelby Materials, in-kind support
 - 14) Empresas Ortiz Brunet (Aggregate Producer), Guaynabo, PR, in-kind support
 - 15) Ferrovial Construcción, LLC, San Juan, PR, in-kind support
 - 16) Macro Mix Concrete, Hormigueros, PR, in-kind support

2.B - Have other collaborators or contacts been involved?

- DuRe-Transp's External Advisory Committee (EAC), indicatively:
 - 1) *Enad Mahmood*, Chair of DuRe-Transp's EAC, Deputy Director, Materials and Tests Division, TxDOT
 - 2) *Jennifer Harper*, Research Director, MoDOT
 - 3) *Bruno Carraro*, Vice President - Innovation Centre for Construction Strategy, Innovation & Ventures
 - 4) *Lori Tiefenthaler*, Sr. Director, Marketing, Heidelberg Materials North America
- The Director and Associate Directors have contacted the following potential collaborators to join the External Advisory Committee (EAC):
 - 1) *Victor Fishman*, Executive Director, Texas Research Alliance
 - 2) *Rebekah Hernandez*, Public Involvement and Government Relations, North Central Texas Council of Governments (NCTCOG)
 - 3) *Scott Jones*, Mechanical Engineer, Materials and Structural Systems Division, National Institute of Standards and Technology (NIST)
 - 4) *Peter Taylor*, Director, National Concrete Pavement Technology Center

3) OUTPUTS

3.1 - Publications, conference papers, and presentations

Publications:

- 1) Konsta-Gdoutos, M.S., Singh, R.K., and Danoglidis, P.A., 2024. Enhancing Concrete's Resistance to ASR by Integrating Metakaolin-Carbon Nanotube Blends. *Transportation Research Record* (Accepted for Publication)
- 2) Roy, A. and Shahandashti, M., 2024. Proactive Seismic Rehabilitation Decision Making for a Road Network Considering Multiple Assets' Performance Uncertainties. In *International Conference on Transportation and Development 2024*. pp. 230-241.
- 3) Marin-Artieda, C., Akpareva, O. and Arhin, S., 2024. Leveraging Computer Vision for Transportation Infrastructure Health Monitoring. In *International Conference on Transportation and Development 2024*. pp. 710-721 .
- 4) Jaberizadeh, M.M., Danoglidis, P.A., Shah, S.P. and Konsta-Gdoutos, M.S., 2023. Eco-efficient cementitious composites using waste cellulose fibers: Effects on autogenous shrinkage, strength and energy absorption capacity. *Construction and Building Materials*, **408**, p.133504.
- 5) Aghaee, K. and Khayat, K.H., 2024. Use of hybrid fibers and shrinkage mitigating materials in SCC for repair applications. *Construction and Building Materials*, **413**, p.134903.
- 6) Wei, J., Farzadnia, N. and Khayat, K.H., 2024. Synergistic effect of macro synthetic fiber and shrinkage-reducing admixture on engineering properties of fiber-reinforced super-workable concrete. *Construction and Building Materials*, **414**, p.134566.

- 7) Teng, L., Addai-Nimoh, A. and Khayat, K.H., 2024. Contribution of Shrinkage Reducing Admixture and Lightweight Sand on Moist Curing Requirement for Fiber-Reinforced Ultra-High-Performance Concrete. *Materials Journal*.
- 8) Li, H., Addai-Nimoh, A., Kreiger, E. and Khayat, K.H., 2024. Methodology to design eco-friendly fiber-reinforced concrete for 3D printing. *Cement and Concrete Composites*, **147**, p.105415.
- 9) Han, S.H., Khayat, K.H., Park, S. and Yoon, J., 2024. Machine learning-based approach for optimizing mixture proportion of recycled plastic aggregate concrete considering compressive strength, dry density, and production cost. *Journal of Building Engineering*, **83**, p.108393.
- 10) Teng, L., Jin, M., Du, J. and Khayat, K.H., 2024. Synergetic effect of viscosity modifying admixtures and polycarboxylate ether superplasticizer on key characteristics of thixotropic UHPC for bonded bridge deck overlay rehabilitation. *Case Studies in Construction Materials*, **20**, p.e02739.
- 11) Huang, Y-T., Jahanshahi, M.R., Shen, F. Autonomous comprehensive road condition assessment using crowdsourcing data and RGB-D sensors: enhancing pavement condition evaluation. *IEEE Transactions on Intelligent Transportation Systems*, in review, submission date: November 2023.

Presentations in Conferences and Symposia:

- 1) Konsta-Gdoutos, M.S. Engineered Concrete. The Inaugural US DOT Summit for the Future of Transportation (FoT), August 13-15, 2024, Washington, DC.
- 2) Danoglidis, P.A. Extending the Lifespan of Concrete Superstructures via Alkali-Silica Reaction Mitigation, The Inaugural US DOT Summit for the Future of Transportation (FoT), August 13-15, 2024, Washington, DC. (Poster Presentation)
- 3) Zhaksybay, B. Performance of Nontraditional SCMs (NNPs) in Concrete Field Mixtures. Poster Presentation. The Inaugural US DOT Summit for the Future of Transportation (FoT), August 13-15, 2024, Washington, DC. (Poster Presentation)
- 4) Danoglidis, P.A., Highly Resilient Fiber Reinforced Concrete Using Fibrillar Cellulose-Based Byproducts. XI International Symposium on Fiber Reinforced Concrete, September 15-18, 2024, Dresden, Germany.
- 5) Konsta-Gdoutos, M.S. Next Generation Concrete. The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), July 8-11, 2024, Catania, Italy.
- 6) Olek, J., Impact of Nanoparticles on the Durability of Concrete. The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), July 8-11, 2024, Catania, Italy.
- 7) Shah, S.P. Concrete and Nanotechnology. The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), July 8-11, 2024, Catania, Italy.
- 8) Margas, M. The Role of Graphene Nanoplatelets on Enhancing the Mechanical Properties of Engineered Concrete. The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), July 8-11, 2024, Catania, Italy.

- 9) Maglogianni, M. Tunable Thermal Properties of Engineered Concrete. The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), July 8-11, 2024, Catania, Italy.
- 10) Castillo, A. Impact of Nanosilica Admixtures on Strength and Durability of Concrete Produced Under Field and Lab Conditions. The 8th International Symposium on Nanotechnology in Construction Materials (NICOM8), July 8-11, 2024, Catania, Italy.
- 11) Li, H. Feasibility of Using Natural Pozzolan Limestone-Based Cement Composite for 3D Printing. 12th ACI/RILEM International Conference on Cementitious Materials and Alternative Binders. June 23-26, 2024, Toulouse, France.
- 12) Marin, C. Leveraging Computer Vision for Transportation Infrastructure Health Monitoring. International Conference on Transportation and Development 2024. June 15-18, 2024, Atlanta, GA.
- 13) Roy, A. Proactive Seismic Rehabilitation Decision Making for a Road Network Considering Multiple Assets' Performance Uncertainties. International Conference on Transportation and Development 2024. June 15-18, 2024, Atlanta, GA.
- 14) Marin, C. Enhancing Infrastructure Condition Assessment through Computer Vision. Natural Hazards Research Summit 2024, May 14-15, 2024, University of Maryland, College Park, MD.
- 15) Hawkins, W. Enhancing Infrastructure Integrity Assessment through Interdisciplinary Research in Structural Health Monitoring Innovative Applications in Construction Materials for Highway Construction. Research Week at Howard University. April 25, 2024, Washington DC. (Poster Presentation)
- 16) Zhussupbekova, A. Potential Incompatibilities between Admixtures and Nontraditional and Natural Pozzolans (NNPs) in Cementitious Systems. Spring Undergraduate Research Conference, April 9, 2024, Purdue University. (Poster presentation)

3.B - Policy papers

Nothing to report.

3.C - Website(s) or other Internet site(s)

1. A website was created for the DuRe-Transp Center <https://duretransp.uta.edu/>. The website will be used for listing all activities related to the grant. In this reporting period, the following information/tabs have been added and updated: The Center, Research Team, Projects, Reports, Directory, News, Webinars, Workshops, Reports.

3.D - New methodologies, technologies or techniques

2. The research team from HU worked jointly with the District Department of Transportation (DDOT) for the development of new technologies/tools for monitoring and evaluating the structural condition of in-service bridges in Washington, DC including the Frederick Douglass Memorial Bridge and Anacostia Riverwalk Trail Bridge.

3.E - Inventions, patents, and/or licenses

1. Tour; James M., Nagarajaiah; Satish, Cheng; Yi, Konsta-Gdoutos; Maria S. Silicon Carbide Nanowire Reinforced Cement and Concrete and Methods of Making and Using Same. Invention Disclosure Submitted September 2024. Disclosure Status: Approved

3.F - Other products, such as data or databases, physical collections, audio or video products application software, analytical models, educational aids, courses or curricula, instruments, equipment, or research material.

3. 2D Pixel Tracking Software. The research team of the HU developed a specialized 2D pixel tracking code in the preliminary stages of software development. This program is designed to capture displacement responses at points of interest within video data of specific infrastructures.
4. The DuRe-Transp research team at S&T developed an AI platform to predict and optimize the durability of concrete based on the information of mixture design and environment. This application is instrumental in developing the new concrete formula to achieve specific durability criteria.
5. The DuRe-Transp research team at S&T conducted structural equation modeling as a statistical analysis of the responses using an open-sourced statistics program: JASP 0.18.1.

4) OUTCOMES

6. The research activities of the Center's partners have been reported in the Center's news and national media, increasing the public awareness of novel technological developments:
 - 1) DuRe-Transp Workshop on Rheology and 3D Printing of Concrete
<https://duretransp.uta.edu/workshops/>
 - 2) OSU News: Looking down the road to better transportation infrastructure
<https://engineering.oregonstate.edu/all-stories/looking-down-road-better-transportation-infrastructure>
 - 3) S&T News: S&T researchers on cutting edge of 3D concrete printing developments
<https://news.mst.edu/2023/02/st-researchers-on-cutting-edge-of-3d-concrete-printing-developments/>
 - 4) Purdue News: Purdue panels to address US semiconductor needs, 'Next Big Things in Tech' at Fast Company Innovation Festival
<https://www.purdue.edu/newsroom/releases/2023/Q3/purdue-panels-to-address-us-semiconductor-needs-next-big-things-in-tech-at-fast-company-innovation-festival.html>
 - 5) Purdue News: Purdue's 'talking concrete' embedded into new I-465 and I-69 interchange in Indianapolis
<https://www.purdue.edu/newsroom/releases/2023/Q3/purdue-talking-concrete-embedded-into-new-i-465-and-i-69-interchange-in-indianapolis.html>
 - 6) The educational activities of PU team have been featured on the cover page of CE Impact magazine, increasing public awareness of educational and technological developments.
<https://engineering.purdue.edu/CE/Media/Impact/2024-Spring>

5) IMPACTS

5.A - What is the impact on the effectiveness of the transportation system?

- The findings of DuRe-Transp's projects, such as the projects "Next Generation Concrete Pavement Materials for the Transportation Infrastructure" and "Performance of Fiber-reinforced Concrete for Bridge Construction and Rehabilitation", are used as case studies to show the implementation potential of advanced materials and technologies developed by the Center for the construction of durable concrete pavements and bridge decks.
- The research team at HU will deliver new sensor, monitoring and diagnostic systems that support Structural Health Monitoring of transportation infrastructure, i.e., "Comprehensive Diagnostic System for Corrosion Assessment of Concrete Infrastructure" and "AI/video-driven SHM and Lifespan Estimation of In-service Bridges". These systems can allow better prediction of service life and enable better management of the infrastructure.

5.B - What is the impact of technology transfer on industry and government entities, on the adoption of new practices, or on research outcomes which have led to initiating a start-up company?

- Development of technical specifications and design protocols of new concrete mixtures and products, i.e., off-spec materials, alternative cements and supplementary cementitious materials (SCMs) (DuRe-Transp projects "Next Generation Concrete Pavement Materials for the Transportation Infrastructure" and "Optimizing Cementitious Systems for Alternative Cement Use via Thermodynamic Modeling").
- Design of new guidelines for smart contract implementations for DOTs' professionals and practitioners within the framework of DuRe-Transp project "Role of Blockchain-Enabled Smart Contracts in Facilitating Transportation Sector Projects".

5.C - What is the impact on the body of scientific knowledge?

The interdisciplinary research activities and methodologies followed for the successful execution of the Center's projects exhibit a strong potential for the study and assessment of yet unexplored properties of advanced concrete materials. The research tasks of the project "Next Generation Concrete Pavement Materials for the Transportation Infrastructure" include the first-time evaluation of the chemical, mechanical and electrical properties of concrete interfaces at the atomic- and nano- scale. This scientific direction will significantly contribute to the development of a nano-to-macro scale research pipeline for tailoring and tuning the properties of complex cementitious and concrete materials targeting new functionalities. The concept of developing new functional concrete materials by performing atomic- and nano- scale experimental realization and characterization fosters research activities from all STEM disciplines including Civil and Environmental Engineering, Materials Science and Engineering, Chemistry, Computational Mechanics and Modelling, Prototyping (Technology) and Data/Mathematical Science.

5.D - What is the impact on transportation workforce development?

DuRe-Transp continues to recruit several postdoctoral fellows, graduate and undergraduate students for the 1st and the 2nd year of the Center. The cross-disciplinary research and technology transfer activities of the DuRe-Transp projects are specifically designed to enrich the academic portfolio of the postdocs and students with scientific and technological know-how in major transportation related topics as they move towards an independent research career and reach scientific maturity. The collaboration activities between universities for the projects also contribute to advancing the

professional skills of the early career researchers including research method planning and development, research-specific critical thinking and decision making, and professional network build-up.

6) CHANGES/PROBLEMS

6.A - Changes in approach and reasons for change

Nothing to report

6.B - Actual or anticipated problems or delays and actions or plans to resolve them

Nothing to report

6.C - Changes that have a significant impact on expenditures

Nothing to report

6.D - Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

Nothing to report

6.E - Change of primary performance site location from that originally proposed

Nothing to report

7) SPECIAL REPORTING REQUIREMENTS

Nothing to report