



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 University Transportation 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). 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, e.g., ASR. The performance of these materials will be rigorously tested in both laboratory and field conditions, evaluating the materials subjected to diverse environmental conditions. 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, and 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:

- 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., develop and implement emerging 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 undergraduate students. DuRe-Transp will provide scholarships to undergraduate students 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.

- Workshops and online training sessions in collaboration with Local Technical Assistance Programs (LTAP) to integrate new research findings and robust technologies developed by the Center's projects into practice. Topics of the training sessions will cover, but not limited to, 3D printed concrete with adaptive rheology; inspection, maintenance and preservation of concrete pavements and bridges, structural health monitoring; and repair and rehabilitation of concrete infrastructure; emergent concrete materials, such as Ultra High Performance Concrete (UHPC) and nanoengineered concrete.
- Annual meeting 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?

Update on the DuRe-Transp projects for the performance period 10/01/2024 – 03/31/2025

- **Durability**

1. *RT-I: Inspection, Maintenance and Preservation (IMP)*

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>

A new fiber-optic Raman probe for real-time sulfate ingress detection was developed. The proposed Raman probe addresses limitations in current corrosion monitoring techniques by providing real-time, high-resolution chemical analysis of sulfate-induced degradation. Its portability and rapid monitoring nature enable rapid assessments of concrete durability, contributing to proactive maintenance strategies and extending the lifespan of infrastructure.

2. *RT II: Durability and Longevity (DL)*

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>

Metakaolin (MK) blends reinforced with well dispersed carbon nanotubes (CNTs) were successfully developed for mitigating the effects of ASR. Experimental results showed that the addition of CNTs effectively modifies the calcium-to-silica (Ca/Si) ratio of Calcium-Silicate-Hydrates (C-S-H) at the interfacial transition zone (ITZ), enhancing the alkali binding capacity of the cementitious matrix to a larger extent compared to using MK alone. The synergistic action of MK and CNTs is shown to reduce the rate of expansion with exposure time and keep the 14-day MK-CNT blend expansion value well below the 0.1% threshold.

3. *RT III: Health Monitoring (HM)*

AI/video-driven SHM and Lifespan Estimation of In-service Bridges

RIP Database: <https://rip.trb.org/view/2344522>

The research team focused on improving the computational code used to estimate displacement profiles from video images by incorporating camera calibration techniques to reduce measurement errors and increase accuracy of the developed computer vision software for displacement analysis in structural health monitoring (SHM) applications.

- **Construction**

1. *RT IV: Next Generation Construction Materials (NGM)*

Next Generation Concrete Pavement Materials for Transportation Infrastructure

Lead Institution: The University of Texas at Arlington

RIP Database: <https://rip.trb.org/view/2344523>

The objective of the project during the reported performance period was to develop and characterize the mechanical properties of Portland Limestone Cement (PLC) blends and off-spec supplementary cementitious materials. Experimental results demonstrated the significant effect of graphene-based nanomaterials in enhancing the compressive strength, pre- and post-crack tensile load bearing ability, and prolonging the ultimate strain capacity of the PLC/off-spec blends.

Optimizing Cementitious Systems for Alternative Cement Using Thermodynamic Modeling

Lead Institution: Oregon State University

RIP Database: <https://rip.trb.org/view/2344524>

Towards, the project's objective for quantifying the effect of binder composition on corrosion rates, the team focused on predicting the pore volume, compressive strength, pore connectivity and formation factor in cementitious specimens with different types of SCMs and PLC.

2. RT V: Advanced Materials and Technologies for Construction and Retrofitting (CR)

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>

A new model, based on permutation-based mean squared error (MSE) reduction method, was employed to evaluate the mechanical properties of UHPC shotcrete mixtures. The results will be used for machine learning-driven mixture optimization.

Performance of Fiber-Reinforced Concrete for Bridge Construction and Rehabilitation

Lead Institution: Missouri University of Science and Technology

RIP Database: <https://rip.trb.org/view/2344525>

The effect of several fiber-reinforced concrete (FRC) mixtures with high volumes of SCMs on the corrosion process of reinforcing bars in RC elements was experimentally evaluated. The residual strength and ductility of FRCs were also assessed.

UHPC for Durable and Post-Earthquake Functional Recovery Bridge Piers

Lead Institution: The University of Texas at Arlington

RIP Database: <https://rip.trb.org/view/2344527>

The team conducted mechanical property tests to evaluate the crack resistance, strength, and ductility of UHPC mixtures that will be used for the functional recovery of bridge piers. The results will be used to design case studies for existing and newly constructed bridge piers in high-seismic regions and highly corrosive environment.

3. RT VI: Construction Methods and Management (CMM)

Quantitative Risk Assessment of Concrete Infrastructure Assets

Lead Institution: The University of Texas at Arlington

RIP Database: <https://rip.trb.org/view/2344526>

Quantitative risk assessments of a road network, including multiple concrete assets (e.g., bridge and pavement), considering a single-hazard (earthquake) scenario, were conducted. The research team characterized concrete assets' performance uncertainties and estimated the pre- and post-disaster transportation network functionality using traffic simulation software to identify critical links to maximize post-disaster system functionality.

- **Finance**

1. *RT VII: Innovative Revenue and Finance (RF)*

Blockchain-based Smart Contracts for Allocating Resources and Automating Contract Payments

Lead Institution: Missouri University of Science and Technology

RIP Database: <https://rip.trb.org/view/2344528>

The research team conducted interviews on transportation and blockchain professional to collect data on the value of smart contracts to transportation projects and validate the findings from the research conducted during the previous performance period.

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/2344529>

A commercial vehicle user fee model based on pavement life cycle costs was developed for a case study deployment. This model integrates data from the Long-Term Pavement Performance (LTPP) database and a sensor network with infrastructure cost data and pavement resilience models to establish the user fee structure.

Machine Learning Maintenance Cost Forecasts for Better Infrastructure LCCA

Lead Institution: Missouri University of Science and Technology

RIP Database: <https://rip.trb.org/view/2344530>

The work performed during this performance period extended on redefining highway maintenance cost estimation by contrasting traditional LCCA methods with modern neural network (NN)–based forecasting approaches.

Education and Workforce Development (EWD) Objectives Accomplished

- 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 research activities and findings from DuRe-Transp project “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 projects “Next Generation Concrete Pavement Materials for Transportation Infrastructure” and “Extending the Lifespan of Concrete Superstructures via Alkali-Silica Reaction Mitigation”.
 - 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 highly resilient and durable concrete.
- Two graduate students from UTA's DuRe-Transp team received fellowships from the Dwight D. Eisenhower Transportation Fellowship program, sponsored by the Federal Highway Administration (FHWA), to participate in the 2025 TRB Annual Meeting.
 - Two graduate students from UTA's DuRe-Transp team received the Innovation Scholarship Award by The Greater Arlington Chamber of Commerce Foundation, due in part to their participation in DuRe-Transp projects.

Technology Transfer Objectives Accomplished

- The DuRe-Transp Annual Meeting was held in The University of Texas at Arlington in Arlington, Texas on Friday October 18, 2024, to emphasize the Center's notable research and technology transfer activities and outcomes during Year 1. The annual meeting featured a keynote panel session "The Future of Transportation Infrastructure: New Directions and Critical Challenges" with member from DuRe-Transp's External Advisory Committee (EAC): TxDOT Director of Materials and Tests Division and Chair of EAC, and representatives from EAC members CRH North America and Heidelberg Cement North America. The meeting highlighted 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.
- A DuRe-Transp online workshop titled "Integrating Structural Engineering and AI for Infrastructure Monitoring" was organized by *Marin* on October 28, 2024. The workshop was provided to engineers and students at HU and focused on new practices for integrating AI tools with engineering principles to assess structural vulnerabilities in the infrastructure. Key topics included integration of AI-assisted sensors and video information with structural dynamics principles, and failure case studies. The participants also learned about upcoming field-based data collection activities involving pedestrian bridges.
- A monthly Webinar Series focusing on the Center's Research Area "Improving the Durability and Extending the Life of Transportation Infrastructure" were organized by DuRe-Transp' Associate Director for Technology Transfer *Weiss*.
- A DuRe-Transp seminar title "Innovative Applications in Construction Materials for Highway Construction" was organized by UPRM's faculty *Acosta* and *Caceres*, in collaboration with PR-LTAP. The seminar was offered to local professionals and practitioners.
- 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 traditional and non-traditional pozzolans.

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

- DuRe-Transp faculty, postdocs, students and staff were financially supported by the Center to attend workshops, symposia and conferences: ACI Fall 2024 Convention in Philadelphia, PA on November 3-6, 2024; 104th TRB Annual Convention in Washington, DC on January 5-9, 2025; ACI Spring 2025 Convention in Toronto, CA on March 30 – April 2, 2025
- DuRe-Transp team at HU provided training sessions to 12 undergraduate students on computer vision related to SHM topics within the framework of the project “AI/Video-Driven Structural Health Monitoring (SHM) and Lifespan Estimation of In-Service Bridges”. The students gained knowledge on computer science and artificial intelligence technologies, including video processing and automation for civil engineering. They also participated in fieldwork and data analysis relevant to actual infrastructure systems.
- DuRe-Transp supports faculty and students are actively involved in 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”.
- DuRe-Transp students and postdocs at S&T have participated in several training sessions to gain hands-on experience on operating new equipment on corrosion simulation and analysis and structural testing, and AI-assisted software for direct error-driven learning using Grad-CAM visualizations.

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 104th TRB Annual Meeting, ACI Fall 2024 and Spring 2025 Conventions, Planning Meeting of NHERI/E-Defense Collaborative Research on Earthquake Engineering, and SPIE Optics and Photonics Conference by the International Society for Optics and Photonics.
2. A semi-annual e-newsletter highlighting DuRe-Transp’s research, workforce development and technology transfer activities was distributed to the Center’s subscribers

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

1. The 2025 DuRe-Transp Workshop on Engineering the Next-Gen Concrete: Resiliency, Durability and Fit-For-Purpose Functionalities will be held in The University of Texas at Arlington on July 28-29, 2025. The event will feature keynote lectures from the Center's faculty and industrial partners, and poster sessions and live demonstrations within the framework of the Center's research projects.
2. A new one-week K-12 summer camp "Getting Creative with Cement and Concrete" will be organized by UTA's DuRe-Transp team and the Center for Advanced Construction Materials. Sponsored by DuRe-Transp, this immersive summer camp blends science, engineering, and hands-on learning, making it a perfect opportunity for students curious about construction, materials, and civil engineering. The summer camp is offered to students in Grade 9 and above.
3. The DuRe-Transp Annual Meeting will be held in October 2025. It will highlight the Center's notable research, workforce development and outreach, and technology transfer activities and outcomes during Year 2, featuring keynote presentations and roundtables with speakers from DuRe-Transp's EAC members, presentations by the PIs of the Center's projects, and a poster session showcasing research projects.
4. DuRe-Transp will announce the nomination for the UTC outstanding Student of the Year Award during DuRe-Transp Annual Meeting in October 2025. 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 105th TRB Annual Meeting.
5. The monthly Webinar Series focusing on the Center's Research Area "Improving the Durability and Extending the Life of Transportation Infrastructure" will be organized by DuRe-Transp' Associate Director for Technology Transfer *Weiss* for the next reporting period.

2) PARTICIPANTS & COLLABORATING ORGANIZATIONS

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

- All DuRe-Transp partners are actively involved by providing support to the Center.
 - 1) The University of Texas at Arlington, Arlington, TX – LEAD, provides financial and in-kind support, facilities and equipment, and research collaborations
 - 2) Howard University, Washington, DC, provides in-kind support, facilities and equipment, and research collaborations
 - 3) University of Puerto Rico at Mayagüez, Mayagüez, PR, provides in-kind support, facilities and equipment, and research collaborations
 - 4) Missouri University of Science and Technology, Rolla, MO, provides financial and in-kind support, facilities and equipment, and research collaborations
 - 5) Oregon State University, Corvallis, OR, provides in-kind support, facilities and and equipment, and research collaborations
 - 6) Purdue University, West Lafayette, IN, provides in-kind support, facilities and equipment, and research collaborations

- Several state government agencies and industrial partners 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) Ash Grove Cement Company, A CRH COMPANY, in-kind support
 - 11) Ecocem Materials Ltd, in-kind support
 - 12) Shelby Materials, in-kind support
 - 13) Empresas Ortiz Brunet (Aggregate Producer), Guaynabo, PR, in-kind support
 - 14) Ferrovia Construction, LLC, San Juan, 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) *Claire (Qiwei) Nowasell*, Sr. Manager of Sustainable Innovation, Heidelberg Materials North America
- The Director and Associate Directors have contacted the following potential collaborators to join the External Advisory Committee (EAC):
 - 1) *Rebekah Hernandez*, Public Involvement and Government Relations, North Central Texas Council of Governments (NCTCOG)
 - 2) *Scott Jones*, Mechanical Engineer, Materials and Structural Systems Division, National Institute of Standards and Technology (NIST)
 - 3) *Peter Taylor*, Director, National Concrete Pavement Technology Center

3) OUTPUTS

3.A - Publications, conference papers, and presentations

Publications:

- 1) Danoglidis, P.A., Singh, R.K., and Konsta-Gdoutos, M.S. 2025. Enhancing Concrete's Resistance to ASR by Integrating Metakaolin-Carbon Nanotube Blends. *Cement and Concrete Composites* (Submitted for Publication)
- 2) Konsta-Gdoutos, M.S., Danoglidis, P.A., Maglogianni, M.E., Thomas, C.M., and Hersam, M.C. 2025. Effect of hBN on the Thermal Dissipation of Nanoreinforced Cementitious Systems. *Construction and Building Materials* (Submitted for Publication)
- 3) Marin-Artieda, C., Niure, M. and Adhikari, B., 2025. Applications for video and signal processing in monitoring transportation infrastructure health. In *Proceedings of the 2025 ASCE Transportation Conference*. (Submitted for Publication)
- 4) Wei, J. and Khayat, K.H. 2025. Effect of shrinkage-mitigating materials, fiber type, and repair thickness on flexural behavior of beams repaired with fiber-reinforced self-consolidating concrete. *Cement and Concrete Composites*, 156, p.105868.
- 5) Wei, J., Farzadnia, N. and Khayat, K.H. 2025. Flexural post-cracking performance of macro synthetic fiber reinforced super workable concrete influenced by shrinkage-reducing admixture. *Cement and Concrete Composites*, 155, p.105847.
- 6) Gu, Y., Mohseni, E., Farzadnia, N. and Khayat, K.H. 2024. An overview of the effect of SAP and LWS as internal curing agents on microstructure and durability of cement-based materials. *Journal of Building Engineering*, p.109972.
- 7) Enke, D. 2025. Machine Learning Maintenance Cost Forecast for Better Infrastructure LCCA. *The Engineering Economist Journal* (Submitted for Publication)
- 8) 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).

Presentations in Conferences and Symposia:

- 1) Konsta-Gdoutos, M.S., Singh, R.K., Danoglidis, P.A. Enhancing Concrete's Resistance to ASR by Integrating Metakaolin-Carbon Nanotube Blends. 104th TRB Annual Meeting, January 5-9, 2025, Washington, DC.
- 2) Konsta-Gdoutos, Danoglidis, P.A., M.S., Singh, R.K. Engineering Concrete: Effects of 1D and 2D Carbon-Based. ACI Fall 2024 Convention, November 3-6, 2024, Philadelphia, PA.
- 3) Danoglidis, P.A., Konsta-Gdoutos, M.S. Development of Engineered Concrete Using Carbon- and Cellulose- based Byproducts and Nanomaterials. ACI Fall 2024 Convention, November 3-6, 2024, Philadelphia, PA.
- 4) Singh, R.K., Danoglidis, P.A., Konsta-Gdoutos, M.S. Enhancing the Pre- and Post-crack Tensile Load Carrying and Ultimate Strain Capacity of Metakaolin-Portland Limestone Cement Blends. ACI Spring 2025 Convention, March 30 – April 2, 2025, Toronto, CA.

- 5) Margas, M., Danoglidis, P.A., Konsta-Gdoutos. Impact of GNPs on the Buildability of Fiber Reinforced Concrete for Additive Manufacturing. ACI Spring 2025 Convention, March 30 – April 2, 2025, Toronto, CA.
- 6) Danoglidis, P.A., Konsta-Gdoutos, M.S. Highly Resilient Concrete Using Calcined Clay-Based Binders and Nanomaterials. ACI Spring 2025 Convention, March 30 – April 2, 2025, Toronto, CA.
- 7) Weiss, J. Internally Cured Concrete Bridge Decks: Why Details and Data Matter. ACI Fall 2024 Convention, November 3-6, 2024, Philadelphia, PA.
- 8) Weiss, J. Introduction of Next-Gen Concrete. 104th TRB Annual Meeting, January 5-9, 2025, Washington, DC.
- 9) Isgor, B. SCM reactivity, optimization, and mixture design. 104th TRB Annual Meeting, January 5-9, 2025, Washington, DC.
- 10) Lucero, C., Weiss, J., Isgor, B. The Carbonation Potential for Concrete Using Thermodynamic Modeling. 104th TRB Annual Meeting, January 5-9, 2025, Washington, DC.
- 11) Olek, J. Evaluation of Reactivity and Performance of Non-traditional SCMs. 104th TRB Annual Meeting, January 5-9, 2025, Washington, DC.
- 12) Akande, M.P., Danoglidis, P.A., Konsta-Gdoutos, M.S. Electrifying Pavements Through Thermoelectric Concrete Battery Technology. 104th TRB Annual Meeting, January 5-9, 2025, Washington, DC. (Poster Presentation)

3.B - Policy papers

Nothing to report.

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

- A website was created for the DuRe-Transp Center <https://duretransp.uta.edu/>. The website is used for listing the Center's activities. In this reporting period, the following information/tabs have been added and updated: The Center, Research Team, Projects, Reports, Directory, News, Webinars, Workshops, Reports.
- 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) S&T News: S&T researchers on cutting edge of 3D concrete printing developments
<https://news.mst.edu/2025/02/st-researchers-on-cutting-edge-of-3d-concrete-printing-developments/>
 - 3) 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/2025-Spring>

3.D - New methodologies, technologies or techniques

- An interactive visualization tool in practitioner-friendly workspaces, e.g., dashboards and heat maps, was designed by the DuRe-Transp team at UTA to present the probabilistic impacts, i.e., likelihood and consequences of the threats to road networks, within the framework of the project “Quantitative Risk Assessment of Concrete Infrastructure Assets”.
- The DuRe-Transp research team at 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.
- A new integrated Raman spectroscopy-based corrosion monitoring system was designed by S&T within the framework of the project “Diagnostic System for Corrosion Assessment of Concrete Infrastructure”.
- A draft of a machine learning-based model for the optimization of UHPC shotcrete mixtures was developed by S&T using Random Forest and cost-function integration. The team will continue updating the model using input data/benchmarks from experimental results obtained from the project “Design and Performance of Shotcrete Using Ultra-High Performance Concrete”.

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

1. Konsta-Gdoutos, M.S., Danoglidis, P.A., Jaberizadeh, M. Naturally Treated Cellulose-Based Fibers for Durable and Thermal Strain Resilient Cementitious Composites. Invention 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.

- 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.
- 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.
- 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

- **Extending the Lifespan of Concrete Superstructures via Alkali-Silica Reaction Mitigation**

The research outcomes of this project include the development of recommendations and quantitative metrics for new mix designs of MK-CNT blends intended for use in concrete superstructures and substructures.

- **Comprehensive Diagnostic System for Corrosion Assessment of Concrete Infrastructure**

A multi-faceted approach, integrating chemical composition analysis and strain monitoring, for monitoring, forecasting, and elucidating structural remediation. This technology can operate in real-time, enabling direct responses to emerging issues, potentially extending the lifespan of concrete infrastructures.

- **AI/video-driven SHM and Lifespan Estimation of In-service Bridges**

Integration of AI-driven techniques into SHM has the potential to advance the management methods for the transportation infrastructure. The anticipated research outcomes can significantly reshape the transportation system's approach to bridge monitoring, leading to safer, more reliable, and more durable infrastructure while ensuring cost efficiencies.

- **Next Generation Concrete Pavement Materials for Transportation Infrastructure**

The development of new protocols for the design and property characterization of next-gen concrete with Portland limestone cements (PLC), off spec SCMs and nanomaterials paves the way to adopting low-cost pathways for manufacturing resilient and durable concrete at large scales with direct application to transportation infrastructure systems.

- **Optimizing Cementitious Systems for Alternative Cement Using Thermodynamic Modeling**

The guidelines/specifications of the physical and chemical properties of off-spec SCMs, designed within the framework of this project, will provide valuable insights to the state DOTs and local industries to implement new types of cementitious materials that can be used to reduce the US imports of cement and clinker while improving the performance of concrete.

- **Design and Performance of Shotcrete Using Ultra-High Performance Concrete**

By utilizing machine learning approaches to optimize mixture proportions, construction decision-makers can select UHPC shotcrete designs that align performance objectives with cost-effectiveness. The project also provides technical knowledge to advance the construction processes of 3D printed concrete for precast bridges.

- **Performance of Fiber-Reinforced Concrete for Bridge Construction and Rehabilitation**

This project provides a comprehensive understanding about the effect of different types of fibers and alternative SCMs on the performance of FRC specifically used for Bridge Construction and Rehabilitation applications under different field conditions.

- **Quantitative Risk Assessment of Concrete Infrastructure Assets**

The statistical and physics-based simulation models are used in various asset management programs, life-cycle analyses, and resource allocation, and planning applications related to the safety and operational efficiency of roads in the presence of ever-increasing natural hazards.

- UHPC for Durable and Post-Earthquake Functional Recovery Bridge Piers**
 The findings from this project will provide comprehensive information for enhancing the resilience and extending the lifetime of bridge structures, in addition to reducing the construction, repair, and maintenance costs.
- Blockchain-based Smart Contracts for Allocating Resources and Automating Contract Payments**
 The guidelines developed in this project will enhance transparency and security of transportation systems, while minimizing the risk of fraud and disputes. Furthermore, addressing the challenges, needs, requirements, and capabilities inherent in implementing smart contracts will not only ensure compliance with regulations but also foster innovation and competitiveness.
- Commercial Vehicle Life Cycle Use Fees Based on Pavement Impact**
 The project provides DOTs with a tool to collect commercial vehicle user fees based on the infrastructure cost they impose on the system. The commercial vehicle user fee tool represents an advancement in collecting sufficient revenues to properly maintain the existing transportation system.
- Machine Learning Maintenance Cost Forecasts for Better Infrastructure LCCA**
 The models developed in this project will enable better risk management of any forecast, given that a measure of LCCA volatility can also help identify the risk of incorrect decisions, as well as how such volatility might affect the value of managerial flexibility, such as the ability to expand, contract, or delay a maintenance project.

5) IMPACTS

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

- The field demonstrations developed within the framework of DuRe-Transp's projects, including but not limited to the concrete slabs constructed by the research team at PU using traditional and non-traditional pozzolans, can be 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 new sensors and monitoring/diagnostic systems designed in DuRe-Transp's projects "Comprehensive Diagnostic System for Corrosion Assessment of Concrete Infrastructure" and "AI/video-driven SHM and Lifespan Estimation of In-service Bridges" can be used to advance the SHM technologies related allowing for a more efficient prediction of service life of the infrastructure.
- The adoption of smart contracts developed within the framework of the DuRe-Transp's projects will reduce costs by minimizing delays and disputes, enhance safety through more reliable project execution, and improve the overall durability of transportation infrastructure by ensuring consistent quality and maintenance. This comprehensive approach will lead to a more resilient and efficient transportation system construction process.

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?

- DuRe-Transp's research teams at UTA and OSU work closely with technical societies and standardization bodies for the development of new specifications and technical notes for DOTs' professionals and practitioners within the framework of the projects "Extending the Lifespan of Concrete Superstructures via Alkali-Silica Reaction Mitigation", Next Generation Concrete Pavement Materials for Transportation Infrastructure" and "Optimizing Cementitious Systems for Alternative Cement Using Thermodynamic Modeling".
- The AI-driven inspection models developed by DuRe-Transp's projects can be used as tools in government and industry settings, promoting automation and data-driven decision making.
- Demonstrating the practical benefits and effectiveness of smart contracts and LCCA models through well-designed pilot projects and detailed case studies can provide a strong evidence base for policymakers. This evidence may support the development of regulatory frameworks that facilitate the integration of smart contracts into public infrastructure projects. Such a shift could promote standardized practices, enhance project management efficiency, and strengthen accountability mechanisms.

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

The interdisciplinary research activities and methodologies employed in the successful execution of the Center's projects demonstrate strong potential for exploring and assessing the performance of advanced concrete materials. The research framework of several DuRe-Transp projects introduces innovative methods for multi-scale property evaluation of engineered concrete, starting at scales as low as sub-1 nm. This scientific direction is expected to make significant contributions to the advancement of current technologies for engineering the microstructure and properties of complex cementitious and concrete materials. The concept of the design of durable and resilient cementitious materials and concrete fosters cross-disciplinary research spanning all STEM fields, including Civil and Environmental Engineering, Materials Science and Engineering, Chemistry, Computational Mechanics and Modelling, Prototyping (Technology), and Data/Mathematical Sciences.

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