

28th Annual NJDOT Research Showcase

October 28, 2026

The Conference Center at Mercer
1200 Old Trenton Road
West Windsor, NJ 08550

WELCOME

The 28th New Jersey Department of Transportation Research Showcase is an opportunity for New Jersey's transportation community to experience the broad scope of ongoing academic research initiatives and share technology transfer activities being conducted by institutions of higher education (IHE) partners and their associates. It also serves to highlight the benefits of transportation research, including NJDOT's own program. As part of the event, the annual implementation award and recognition of outstanding university students will be presented. The agenda will include a general session, topic breakout sessions, and a poster display. Continental breakfast and lunch will be provided.

This program is organized by the NJDOT Bureau of Research and Innovation in partnership with the Rutgers Center for Advanced Infrastructure and Transportation (CAIT) and the Alan M. Voorhees Transportation Center (VTC). It meets requirements for up to 2 professional development hours (PDHs) for continuing professional competency for licensed professional engineers. The 28th Annual Research Showcase is sponsored by the Federal Highway Administration and the New Jersey Department of Transportation.

AGENDA

9:30 a.m. **Introduction and Housekeeping**
David Maruca, Program Development Administrator, Rutgers CAIT

9:40 a.m. **Welcoming Remarks**
Michael J. Manzella, Director of Statewide Planning, NJDOT

9:45 a.m. **Opening Remarks**
Priya Jain, Commissioner, NJDOT

9:55 a.m. **Keynote Address**
Craig Thor, Chief Scientist, Turner Fairbank Highway Research Center, FHWA
Matt Cuddy, Operations Research Analyst, Volpe Center, USDOT

10:45 a.m. **Break**

10:55 a.m. **Bureau of Research and Innovation Overview**
Pragna Shah, Manager, Bureau of Research and Innovation, NJDOT

11:00 a.m. **Panel Discussion: *AI and the Future of Transportation***
Moderator: Giri Venkiteela, Innovation Officer, NJDOT Bureau of Research and Innovation

Kimbrali Davis, Executive Manager, NJDOT Bureau of Aeronautics
Luna Katbah, Head of Innovation, IT and Digital, NJ TRANSIT
Neha Panchal, Management Improvement Specialist, NJDOT Bureau of Information Technology
Jeevanjot Singh, Executive Manager, NJDOT Bureau of Safety Improvement Program
Seth Wainer, Director of Planning and Innovation, Port Authority of New York and New Jersey

11:45 a.m. **Presentation of 2026 Awards**
2026 AASHTO High Value Research Awards
2026 Best Poster Award
2026 NJDOT Build a Better Mousetrap Awards
2026 NJDOT Research Champion Excellence Award
2026 Outstanding University Student in Transportation Research Award

RESEARCH SHOWCASE

12:00 p.m. **Buffet Lunch/Break**

1:05 - 1:20 p.m.

Infrastructure *Room: Auditorium | Moderator: Hussain Mustafa*
Flooding Incident Based Exposure Score Classification for NJDOT Roadway Segments
Presenter: Nishigandha Rajeshwar Jukte, Rowan University

Safety *Room: 214/215 | Moderator: Jeevanjot Singh*
Applying Artificial Intelligence (AI) to Safety Analysis
Presenters: Danielle Baer and Lauren Kretzing, Urban Engineers

Digital Transformation *Room: 213 | Moderator: Ethan Osias*
What are the Digital infrastructure Components for State DOTs?
Presenters: Giri Venkiteela and La Zhao, NJDOT

1:30 - 1:45 p.m.

Infrastructure *Room: Auditorium | Moderator: Hussain Mustafa*
A Paradigm Shift in Steel Assembly: Tool-Free Field Splices Enabled by Metal Additive Manufacturing
Presenter: Islam Mantawy, Rowan University

Safety-*Room: 214/215 | Moderator: Jeevanjot Singh*
From Roadside LiDAR to Actionable Traffic Data: AI-Enabled Monitoring for Traffic Operations, Safety and Freight
Presenter: Yiqiao Li, City College of New York

Digital Transformation *Room: 213 | Moderator: Ethan Osias*
TrafficCube AI-based Data Fusion, Visualization, and Analysis Platform
Presenter: David Hale, Leidos

1:55 - 2:10 p.m.

Infrastructure *Room: Auditorium | Moderator: Hussain Mustafa*
A Hybrid Vision-Language Model and Deep Learning Framework for Infrastructure Inspection
Presenter: Hao Wang, Rutgers University

Safety *Room: 214/215 | Moderator: Jeevanjot Singh*
Research and Pilot Study on Robotic Security for NJDOT Yards Surveillance
Presenter: Alexander Warden, Rutgers University

Digital Transformation *Room: 213 | Moderator: Ethan Osias*
Evaluating CAV Impacts on Signalized Intersection Work Zone Capacity: A New Jersey Case Study
Presenter: Fahmida Rahman, Rowan University

2:20 - 2:35 p.m.

Infrastructure *Room: Auditorium | Moderator: Hussain Mustafa*
Enhancing Safety and Efficiency Embracing Challenges with Drones for Bridge Inspections
Presenter: Utsab Pokharel, NJDOT

Safety *Room: 214/215 | Moderator: Jeevanjot Singh*
AI for Smarter Safety Investment: Enhancing New Jersey's Safety Performance Functions and Network Screening
Presenters: Chaitanya Pathak and Steven Luglio, HNTB

Digital Transformation *Room: 213 | Moderator: Ethan Osias*
Transforming Existing NJDOT Traffic Cameras into Autonomous Congestion Detection Systems by Utilizing Video Vision-Language Models
Presenter: Bhargavi Reddy Kotha, NJIT

2:45 - 3:00 p.m.

Infrastructure-*Room: Auditorium | Moderator: Hussain Mustafa*
How GPI is Leveraging and Adapting to AI
Presenters: Dave Kuhn and Dave Wagner, GPI

Safety-*Room: 214/215 | Moderator: Jeevanjot Singh*
Infrastructural and Safety Barriers to E-Bike Use: Insights from a Nationwide Survey
Presenters: Hannah Younes and Yingning Xie, Rutgers University

Digital Transformation *Room: 213 | Moderator: Ethan Osias*
Automated Text Extraction from Bridge Inspection Images to Support Infrastructure Management Systems
Presenters: Maurizio Morgese and Gianluca Bruno, Rutgers University



POSTER SESSION

Room: 116/117

Infrastructure

Comparing Cost and Time Performance of Design-Build Projects Across Construction Sectors, Contract and Procurement Methods in the US Northeast States
Presenter: Bishal Poudel, Rutgers University

Development of Non-proprietary Ultra-High-Performance Concrete (UHPC) for Bridge Overlays
Presenter: Michael Ruszala, Rutgers University

Evaluating CAV Impacts on Signalized Intersection Work Zone Capacity: A New Jersey Case Study
Presenter: Fahmida Rahman, Rowan University

Extend Service Life of Concrete Bridge Decks with Internal Curing
Presenter: Sabatino Castellani, Rutgers University

Flexural Behavior of Prestressed Concrete Slabs with Varying Strand Configurations and Span-to-Depth Ratios
Presenter: Samuel Giumarello, Rutgers University

Full-Scale Accelerated Pavement Testing of a Plastic-Modified Asphalt Mixture
Presenter: Sk Md Imdadul Islam, Rowan University

Improving Signalized Intersection Operations through Signal Timing Optimization: A New Jersey Case Study
Presenter: Fahmida Rahman, Rowan University

Influence of Temperature and Seasonal Correction Methods on Falling Weight Deflectometer (FWD) Based Overlay Thickness for Asphalt Pavements in New Jersey
Presenter: Anil Kumar Baditha, Rowan University

Performance Assessment of Composite Plastic Modified and Conventional Polymer Modified Asphalt Mixtures Using the Wet Mixing Method
Presenter: Lakshmana Ravi Raj Gali, Rowan University

Root Causes of Construction Claims: A National Perspective
Presenter: Cyril Mendelek, NJIT

Toward Non-Contact Pavement Friction Measurement Using Physics-Informed Deep Learning
Presenter: Xiaoyu Zhang, Rutgers University

POSTER SESSION

Room: 116/117

Safety

Advancing Work Zone Safety with Explainable AI: Evaluating the Effect of Work Zone Presence on Crash Severity
Presenter: Salma Afia Ratri, Rowan University

An Explainable AI Framework for Identifying High-Risk Pre-Crash Driver Behaviors, Crash Mechanisms, and Incident Pathways in Heavy Commercial Vehicle Crashes in New Jersey
Presenter: Md Sadman Islam, Rowan University

Enhancing State DOT Work Zone Safety by Integrating Internal Traffic Control Plan
Presenter: Ahmed Imtiaz Zamee, Rowan University

From Crash Data to Action: An Agentic AI Framework for Segment-Level Crash Frequency Prediction
Presenter: Md Tufajjal Hossain, NJIT

Digital Transformation

A Visual Driving Car-Following Model Based on Dynamic Visual Features
Presenter: Bowen Geng, Rutgers University

AI-Driven Climate Resilience Scoring for Bridges: A Digital-Transformation Framework for the Future of Transportation
Presenter: Indira Prasad, Stevens Institute of Technology

Autonomous Systems Validation Platform: A Scaled Urban Testbed for Networked Decision-Making
Presenter: Md Wazkuruni, NJIT

Enhancement of LiDAR-based Traffic Counting Accuracy Using a Trajectory Reconstruction Technique
Presenter: Emmanuel Obeng Danquah, NJIT

From Recorded Traffic to Steering and Acceleration: A Gated Hybrid of Convolutional and Vision-Language AI
Presenter: Abolfazl Afshari, NJIT

Transforming Existing NJDOT Traffic Cameras into Autonomous Congestion Detection Systems by Utilizing Video Vision-Language Models
Presenter: Bhargavi Reddy Kotha, NJIT

ABOUT OUR PRESENTERS

Michael J. Manzella, Director of Statewide Planning, New Jersey Department of Transportation

Michael J. Manzella, AICP serves as the Director of Statewide Planning at NJDOT. The Division includes the Bureau of Statewide Strategies (BSWS) and Bureau of Research and Innovation (BRI) and provides broad, future-oriented direction for the Department's missions and programs, engages in strategic, performance-based planning and asset management, and develops innovative transportation solutions to enhance mobility, reliability, safety, and quality of life.

Mr. Manzella received a Bachelor of Engineering degree in Engineering Management with a Minor in Pre-Law and Public Policy from Stevens Institute of Technology in 2009 and a Master of City and Regional Planning degree with a concentration in Transportation Planning and Policy from the Edward J. Bloustein School at Rutgers University in 2014.

Mike has previously served as the Director of Transportation in both the City of Jersey City and the City of Asbury Park as well as the Deputy City Manager in Asbury Park. Mike has been responsible for leading municipal Vision Zero initiatives, implemented Complete Streets and low-cost pilot intervention projects to enhance the safety of all users, administered transit, microtransit, and micromobility transportation services, and managing long-range transportation planning efforts.

Priya Jain, Commissioner, New Jersey Department of Transportation

Priya Jain serves as Commissioner of the New Jersey Department of Transportation, bringing more than three decades of engineering and executive leadership experience to the state's transportation network. Her priorities as Commissioner include delivering critical transportation improvements, advancing modernization and technology, and strengthening safety and reliability across New Jersey's transportation system.

Commissioner Jain began her career as a civil and environmental engineer, working hands-on with public agencies in New Jersey and the New York metropolitan region on major transit, highway, and environmental remediation programs. That early technical grounding carried her into senior executive leadership roles with global infrastructure and program management organizations, where she oversaw growth and operations for firms delivering large-scale transportation, infrastructure, and resilience programs across North America. Throughout her career, she has led and delivered major transportation and infrastructure programs spanning environmental review, project development, capital delivery, and operations.



In her role, Commissioner Jain serves as Chair of NJ TRANSIT, the New Jersey Turnpike Authority, the South Jersey Transportation Authority, and the New Jersey Transportation Trust Fund Authority, and as Vice Chair of the New Jersey Motor Vehicle Commission. She works closely with state, regional, local, and federal partners to advance transportation priorities that improve safety, mobility, and reliability throughout New Jersey.

Commissioner Jain serves on the Board of Directors of the American Association of State Highway and Transportation Officials (AASHTO), the Northeast Association of State Transportation Officials (NASTO), and The Eastern Transportation Coalition. She also serves on the Civil Engineering Advisory Board at the City College of New York.

She holds a Bachelor of Engineering in Civil Engineering and a Master of Science in Physics from the Birla Institute of Technology and Science, Pilani, India, and a Master of Science in Environmental Engineering from the University at Buffalo.

Craig Thor, Chief Scientist, Turner Fairbank Highway Research Center, Federal Highway Administration

Dr. Craig Thor has served as the Chief Scientist at the Federal Highway Administration's Turner-Fairbank Highway Research Center (TFHRC) since August 2021. In this role he serves as a technical advisor to the Leadership Team at TFHRC and supports the Associate Administrator for Research and Development in areas of technical coordination, emerging scientific trends, and research planning. Dr. Thor coordinates research efforts across the research disciplines and other USDOT modes where there are common interests and applications.

Dr. Thor has been with FHWA for 16 years, previously serving as the Senior RD&T Legislative and Budget Analyst and as Research Civil Engineer in the Office of Safety R&D. He has a Bachelor's degree in Material Science and Engineering from Michigan State University and a Master's degree and Ph.D. in Biomedical Engineering from the Virginia Tech-Wake Forest School of Biomedical Engineering and Sciences.

ABOUT OUR PRESENTERS

Matt Cuddy, Operations Research Analyst, Volpe Center, United States Department of Transportation

Matt Cuddy focuses on Artificial Intelligence strategy at the United States Department of Transportation Volpe National Transportation Systems Center. He leads Volpe's support of USDOT's multimodal AI Program and manages the USDOT AI Community of Practice. He has bachelor's and master's degrees in mechanical engineering and a Ph.D. from Rutgers in urban planning and policy development.

Pragna Shah, Manager, Bureau of Research and Innovation, New Jersey Department of Transportation

Pragna Shah leads the Bureau of Research and Innovation at the New Jersey Department of Transportation (NJDOT), where she oversees the state's multi-modal research portfolio, technology transfer initiatives, and university research partnerships. With over two decades of public-sector transportation leadership, she directs high-impact programs including the NJ Local Technical Assistance Program (LTAP) and the Annual NJDOT Research Showcase—an initiative recognized nationally with the AASHTO Communications Best Event Award.

Pragna serves as New Jersey's State Transportation Research Board (TRB) representative and contributes actively to national initiatives on the AASHTO Research Advisory Committee (RAC) and Knowledge Management Committee. A dedicated champion for translating emerging transportation technologies and digital innovations into practice, she holds a B.S. in Electrical Engineering from the New Jersey Institute of Technology (NJIT).

Giri Venkiteela, Innovation Officer, Bureau of Research and Innovation, New Jersey Department of Transportation

As a Research Scientist at NJDOT's Bureau of Research and Innovation (BRI), Dr. Giri Venkiteela manages a diverse portfolio of research and innovation projects and programs, serving as a subject matter expert for key initiatives including the NJDOT Innovation Program, NJSTIC Program, Artificial Intelligence (AI) research, and transportation pooled fund program. His leadership extends to the national level as Chair of AASHTO-RAC Region #1 and Chair of the AASHTO-RAC AI Task Force.

He is currently leading the "State DOT Council for Strategic AI Adoption," a national pooled fund project. He actively contributes to NCHRP research projects and participates in various TRB and AASHTO committees, while regularly presenting NJDOT research at prominent venues including AASHTO, IRF, TRB and peer exchanges. He has reviewed research proposals and journal articles for NJDOT, USDOT, NCHRP, ASCE, and TRB. He holds a doctoral degree in Civil Engineering from the University of Louisville and has research scholar experience at Northwestern University. Outside of work, he enjoys playing tennis, watching movies, and reading.



Kimbrali Davis, Executive Manager, Bureau of Aeronautics, New Jeraey Department of Transportation

Kimbrali Davis is a seasoned transportation engineer and public-sector leader with more than 30 years of engineering experience, including over 22 years at the New Jersey Department of Transportation (NJDOT). She currently serves as Manager of the Bureau of Aeronautics, where she oversees the Unmanned Aircraft System (UAS) Program, Advanced Air Mobility (AAM) initiatives, and Outdoor Advertising & Junkyard Services.

Throughout her NJDOT career, Ms. Davis has progressed through the engineering ranks—beginning in materials and chemical testing laboratories and advancing through research and program management roles. She has led major multimodal programs, including the Bureau of Aeronautics/UAS Technology unit, which administers more than $56 million in federal and state airport improvement grants; the Modal Grants Program, overseeing roughly $30 million annually across aviation, freight, and rail; and the Liberty Corridor Program, a federally designated Project of National and Regional Significance. Her prior leadership also includes the Office of Fixed Guideway/State Safety Oversight Agency and the Oversize/Overweight Truck Permitting Unit.

With more than 15 years supervising major programs and organizational units, Ms. Davis has demonstrated expertise in ensuring compliance with regulations across multiple federal agencies—including the FHWA, FAA, and FTA—as well as New Jersey state laws. She is skilled in organizational leadership, multi-program management, budget and project delivery, and strategic planning.

Ms. Davis holds a Bachelor of Science in Ceramic Engineering (Materials Science and Engineering) from Rutgers University. Her professional engagements include the AASHTO Leadership Institute, the Advanced Air Mobility Multistate Collaborative Working Group, the AASHTO Council on Aviation, and multiple National Cooperative Highway Research Program (NCHRP) committees and panels. Her credentials include certifications in Public Transportation Safety, the New Jersey Certified Public Manager Program, and Six Sigma (Green Belt), among others.

She is also a dedicated advocate for STEM and transportation education, regularly engaging students and professionals through career days, youth symposiums, and programs promoting minorities and women in aviation and transportation engineering.

Luna Katbah, Head of Innovation, IT and Digital, NJ TRANSIT

As Head of Innovation, IT and Digital at NJ TRANSIT, Luna Katbah shapes how one of the nation's largest transportation agencies prepares for what's next. She sets the strategic direction for emerging technologies and digital modernization, with a focus on strengthening operational readiness, elevating the customer experience, and advancing long-range infrastructure and mobility goals. Luna brings a forward-looking perspective on AI's role in transit, from powering high-impact regional events to supporting the systems riders depend on every day. Her work reflects a broader commitment to building transportation that is not only smarter, but more resilient and responsive to the communities it serves.

Neha Panchal, Management Improvement Specialist, Bureau of Information Technology, New Jersey Department of Transportation

Neha Panchal is a Management Improvement Specialist with the New Jersey Department of Transportation, with 15 years of experience within the Information Technology and Application Development Bureau. She currently leads the NJDOT IT Office of Emerging Technology (OET) within the IT Director's Office, where she drives agency-wide initiatives to evaluate, adopt, and operationalize artificial intelligence capabilities. OET focuses on developing practical AI use cases that streamline workflows, enhance performance measurement, and enable more data-driven decision-making across NJDOT. In addition to AI innovation, Neha oversees the workflow process unit, which transforms data-driven processes into digital operational improvement solutions. Her work centers on building scalable, responsible, and technically sound modernization strategies that strengthen organizational efficiency and support the evolving needs of the public sector.

Jeevanjot Singh, Executive Manager, Bureau of Safety Improvement Program, New Jersey Department of Transportation

Jeevan is a Project Management Professional (PMP) with over 31 years of experience, including 18 years in multiple divisions at NJDOT, most recently as the Manager of Bureau of Safety Improvement Programs, leading Complete Streets Implementation and Safety Programs Management sections, managing and administering the Highway Safety Improvement Program and providing safety subject matter expertise on a wide variety of analyses, programs, projects, and initiatives.

She holds a Bachelor's in Civil Engineering, multiple Masters, in Environmental Engineering, Highway Engineering, and Transportation Engineering, with a Masters Certificate in Project Management. She is also a graduate of the Freight Operations Academy and Regional Operations Forum.

She has represented NJDOT as an NCHRP Panel member for safety research, at the Connected Vehicle Pooled Fund Study, multiple AASHTO subcommittees and working groups for Safety and Connected & Autonomous Vehicles and on technical paper review committees for TRB.

Jeevan is a firm believer in the Safe System Approach to eliminate fatalities for all road users. She takes every opportunity to highlight and promote the safety achievements and innovations in New Jersey, with active participation of and collaboration with our local and regional partners.

She proudly leads a small, but mighty team. Her team administered a record Highway Safety Improvement Program in FFY 2024, with over $125 million authorized on projects, close to 60% on projects to improve safety for vulnerable road users. Outside of work, she also volunteers her time on advisory boards of multiple non-profit organizations.

Seth Wainer, Director of Planning and Innovation, Port Authority of New York and New Jersey

Seth Wainer serves as the Port Authority's Director of Planning and Innovation, where he is responsible for managing a department that pilots and plans for the long term use of innovative technologies like autonomous vehicles, artificial intelligence, and electric flight. Mr. Wainer previously served as the Chief Information Officer for the City of Newark where he focused on digital transformation for city services and building a municipally owned high-speed internet network. Before that, Mr. Wainer has also worked in corporate retail and as an Obama Administration appointee. He is passionate about government innovation today and historical innovations in infrastructure like the Otis elevator break and the Erie Canal. He lives in NJ with his wonderful wife and 3 kids, who he hopes will not need driver's licenses thanks to autonomous vehicle public transportation.

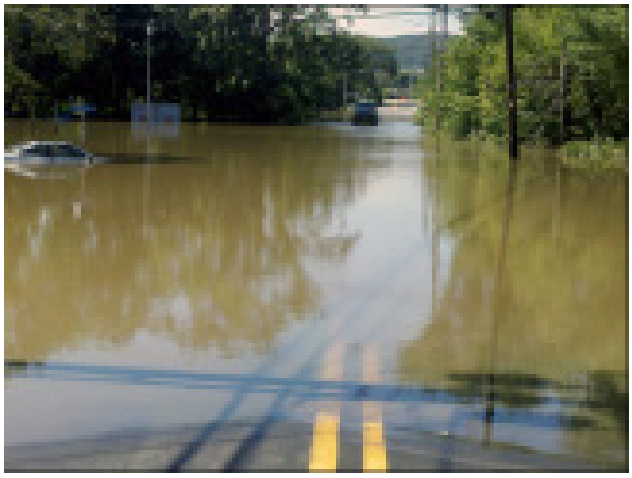
Devyn Cordero, Research Project Manager, NJDOT

Devyn Cordero joined the New Jersey Department of Transportation in 2022 as a Planner Trainee in the Office of Freight Planning. In her role in Freight Planning, Devyn contributed to major transportation plans, including the Statewide Freight Plan and New Jersey State Rail Plan. In 2024, Devyn moved to the Bureau of Research and Innovation. In this role, she manages research projects, including the Multi-Hazard Design of Highway Bridges Recommendations project, which is being recognized today for receiving an AASHTO High Value Research Award. Devyn received her bachelor's degree in planning and public policy from the Edward J. Bloustein School at Rutgers University.

Flooding Incident Based Exposure Score Classification for NJDOT Roadway Segments

Presenter: **Nishigandha Rajeshwar Jukte**

Organization: **Rowan University**



Abstract:

Reliable identification of flood-exposed roadway segments is essential for evaluating the effects of inundation on pavement performance and supporting climate-resilient asset management. This study develops an incident-based flood exposure classification framework for New Jersey Department of Transportation (NJDOT) roadway segments using dated and geolocated flood incident records as direct evidence of flood occurrence. Each incident record contains roadway route, direction, milepost range, and date of occurrence.

A total of 12,951 flood incident records were reviewed. Duplicate records identified through internal documentation indicating repeated reports of the same event, and incomplete records lacking valid route or milepost information were removed. Following data cleaning, 12,807 incidents were retained and spatially matched to roadway segments using route, direction, and milepost information. Each incident was assigned to the roadway segment containing the reported location. For each segment-year, cumulative incident frequency and incident recency were calculated. Frequency represents the total number of documented flood incidents occurring up to a given year, whereas recency represents the number of years since the most recent recorded incident.

An exposure classification scheme was subsequently developed using four categories: Minimal Exposure, Transient Wetting, Episodic Flooding, and Chronic Ponding. Classification was based on incident frequency, incident recency, and documented physical drainage conditions. Application of the framework classified 88.74% of roadway segments as Minimal Exposure, 9.42% as Transient Wetting, 1.74% as Episodic Flooding, and 0.10% as Chronic Ponding. The resulting distribution provides a network-level representation of flood exposure grounded in documented flood occurrence.

The proposed classification provides a defensible and reproducible basis for incorporating flood history into NJDOT's pavement and asset management practices. Identification of roadway segments experiencing repeated or recent flooding can support targeted monitoring, drainage improvements, rehabilitation prioritization, and allocation of maintenance resources. The framework therefore provides a practical approach for integrating observed flood exposure into network-level pavement management and infrastructure resilience planning.

Bio:

Dr. Nishigandha Rajeshwar Jukte is a Postdoctoral Research Associate at the Center for Research and Education in Advanced Transportation Engineering Systems (CREATES) at Rowan University, New Jersey. Her research focuses on pavement and asset management, pavement performance evaluation, transportation infrastructure resilience, and data-driven approaches for infrastructure decision-making. She pursued her Ph.D. in Civil Engineering from the Indian Institute of Technology Delhi, India, where her research focused on characterizing asphalt mixtures using machine learning techniques. Her current work involves collaborative research with the New Jersey Department of Transportation (NJDOT) on pavement deterioration under roadway inundation, pavement condition assessment, and the development of performance models for pavement preservation and rehabilitation treatments. Her broader research interests include sustainable pavement materials, mechanistic-empirical pavement design, statistical modeling, and the application of artificial intelligence to transportation infrastructure management.

A Paradigm Shift in Steel Assembly: Tool-Free Field Splices Enabled by Metal Additive Manufacturing

Presenter: **Islam Mantawy**

Organization: **Rowan University**



Abstract:

This research introduces a novel steel field splice that utilizes Metal Additive Manufacturing (AM) to create high-strength, interlocking metasurface mechanisms. These AM elements are proposed as a transformative alternative to traditional bolted or welded field connections in structural steel assembly. A steel field splice is defined as a connection made between two steel structural elements on the construction site, or in the field, typically used when members are too long or heavy for single-piece transport or erection. The proposed splice is specifically designed for rapid construction and minimal on-site labour. The use of interlocking elements, which feature complex geometries and tight tolerances enabled by AM, facilitates precise, self-aligning engagement between the steel components. This approach eliminates the need for specialized tools, fasteners, or certified welders, resulting in significant reductions in assembly time and equipment requirements.

The splice system features a central interlocking element, which is designed to transfer axial forces between adjoining segments (probably hot rolled steel). This central metasurface interlocking element is a 3D printed element made from a high-strength material,17-4 PH. The geometry includes projected wings that distribute the axial load through bearing contact, which generates a combination of flexural and shear stresses within the wings. The wings are intentionally curved to provide out-of-plane restraint of the native plate, which helps ensure stability and improves the global deformation behavior of the steel section. To validate the concept, a numerical study was performed using non-linear analysis with ABAQUS finite element software, comparing the results of the proposed interlocking metasurface splice to a conventional field splice.

The presentation will also include the experimental test and results for a small-scale splice integrated with interlocking metasurfaces. The proposed AM-based interlocking splice system represents a paradigm shift for the field assembly of steel structures, enhancing operational flexibility, reducing logistical constraints, and contributing to the advancement of modular, rapidly deployable infrastructure systems.

Bio:

Islam Mantawy, Ph.D., P.E –Dr. Mantawy is a tenure-track Assistant Professor in the Department of Civil and Environmental Engineering at Henry M. Rowan College of Engineering, Rowan University, since Fall 2022, and a registered Professional Engineer in Nevada. His research focuses on Concrete Additive Construction and Metal Additive Manufacturing. In concrete additive construction his expertise is in areas such as topology optimization, reinforcement techniques, hazard protective systems, functionally graded structures, and adaptive and reconfigurable structures. In metal additive manufacturing, his work includes topology optimization, repair and strengthening through cold spray, and hazard protective systems. Dr. Mantawy is an associate member of the American Society of Civil Engineers (ASCE) and Structural Engineering Institute (SEI), and a member of the American Concrete Institute (ACI), where he contributes to multiple technical sessions.

A Hybrid Vision-Language Model and Deep Learning Framework for Infrastructure Inspection

Presenter: **Hao Wang**

Organization: **Rutgers University**



Abstract:

Efficient and accurate assessment of infrastructure conditions is essential for ensuring structural safety and optimizing maintenance decisions. However, evaluating infrastructure defects requires understanding complex spatial and topological relationships between defects and structure components. Conventional deep learning models are good for visual detection but do not have spatial reasoning, while Vision-Language Models (VLMs) offer high-level semantic capabilities but lack the pixel-level precision required for quantitative engineering assessment.

This presentation introduces a novel hybrid framework that couples VLM with convolutional neural network (CNN) for infrastructure inspection applications. To illustrate the framework, an image database of steel bridge corrosion defects was evaluated to test various capabilities from element segmentation to multi-class corrosion state estimation. Two novel metrics were introduced to decouple language parsing accuracy from visual segmentation performance. The results show that the proposed method significantly outperformed the pure VLM baseline for defect detection and segmentation. The few-shot configuration achieves greater performance across different corrosion condition states. The framework is demonstrated in an interactive platform that enables inspectors to obtain quantitative localized defect metrics via conversational queries. The outputs include annotated images highlighting bridge structure elements, estimate corrosion areas, and concise textual summaries suitable for automated inspection reports. The proposed hybrid method improves interpretability and provides a unified pathway toward vision–language–report generation for bridge inspection.

*This research is based on Artificial Intelligence Research and Pilot Implementation sponsored by NJDOT.

Bio:

Dr. Hao Wang is a Professor and Graduate Program Director at Department of Civil and Environmental Engineering of Rutgers University. His research areas are focused on sustainable, resilient, and smart transportation infrastructure. He is the recipient of Walter L. Huber Civil Engineering Research Prize from ASCE in 2022 and Outstanding Engineering Faculty Award at Rutgers in 2023. He obtained his PhD from University of Illinois at Urbana-Champaign in 2011.

Enhancing Safety and Efficiency Embracing Challenges with Drones for Bridge Inspections

Presenter: **Utsab Pokharel**

Organization: **NJDOT**



Abstract:

Bridge inspection plays a pivotal role in ensuring the safety, longevity, and operational efficiency of critical transportation infrastructure in the United States. With the use of unmanned aerial vehicles, commonly known as drones, a new era in bridge inspection has emerged.

This abstract explores transformative potential showcasing real field experiences and challenges using drones for bridge inspection. Bridge inspections involved time-consuming manual assessments, often requiring the closure of lanes and causing significant disruptions to traffic flow. Additionally, inspectors face risky conditions, climbing intricate structures or utilizing specialized equipment, making it an arduous task. However, the integration of drones has brought forth a paradigm shift in this domain. The utilization of drones for bridge inspections brings several benefits. It enhances safety by reducing the exposure of human inspectors and the public to vulnerable environments. Furthermore, depending upon the bridge type, it significantly reduces the time required to inspect bridges, minimizing traffic disruptions. Moreover, it improves the accuracy and reliability of inspections - being able to reach challenging areas easily, leading to informed decision-making regarding maintenance and budget allocation. It also offers considerable cost savings compared to traditional inspection methods, as drones require fewer resources, equipment reusability, and enable swift data collection and analysis. We can get a top view of the bridge and its surroundings, which can provide valuable information on roadway design, traffic patterns and even waterway channel movements. Drones will not just collect photos and videos. The data collected by drones can be processed using computer vision algorithms, artificial intelligence, and machine learning techniques, enabling automated defect detection and analysis. The combination of aerial imagery and advanced analytics streamlines the inspection process, reduces human error, and provides valuable insights for maintenance and rehabilitation strategies. Drones can facilitate the creation of comprehensive 3Dmodels, point clouds, and orthomosaic maps, which aid engineers, policymakers, and stakeholders in visualizing the bridge conditions and prioritizing necessary repairs or upgrades.

Despite the numerous advantages, the integration of drones for bridge inspections poses certain challenges. Regulatory frameworks are being developed and refined to ensure the safe and responsible operation of drones in national airspace. Privacy concerns and public perception also require careful consideration to address potential issues and build public trust in this evolving technology. As per federal mandate, for non-redundant steel tension members (NSTM), hands-on inspection is a must. But for rest of the areas of the structure's drones can reach out easily and gather essential data prioritizing on critical areas where inspectors need to reach hands-on. Furthermore, there can be issues such as equipment funding sources, inclement weather, loss of GPS signals under the deck, battery capacity limits, sensitivity and delicacy of the equipment, postprocessing requirement for its huge amount of data, learning curve on proper training, registration and certification. However, with careful planning and implementation, these challenges can be successfully overcome.

Bio:

Utsab Pokharel is a Principal Engineer in Structural Evaluation at the New Jersey Department of Transportation (NJDOT), specializing in bridge and infrastructure assessment. I hold a bachelor's in civil engineering from Nepal Engineering College and master's degree in civil engineering with major in structure and project management from NJIT. I bring more than a decade of experience in design, evaluation, and inspection of structures including bridges, buildings, and irrigation canals. As a Certified Bridge Inspector and FAA Part 107–certified pilot, I lead NJDOT's Structural Evaluation drone program, advancing the use of unmanned aerial systems for safer and more efficient infrastructure inspections. I have presented my work at numerous professional forums, including ASNEngr's Annual Conferences and the International Highway Engineering Exchange (IHEEP). I also contribute to national initiatives in UAS-based inspection, serving as a course introducer and panelist for the AASHTO TC3 course "Application of Unmanned Aerial Systems (UAS) for In-Service Bridge Inspection" and as a panelist to the NCHRP 13-10 document "Guidelines for Maintenance of Uncrewed Aircraft Systems Used in Transportation Infrastructure."

How GPI is Leveraging and Adapting to AI

Presenters: **Dave Kuhn and Dave Wagner**

Organization: **Greenman Pederson, Inc**

Abstract:

GPI is a consulting engineering firm with a staff of over 1,800 employees in 17 Branch Offices and 40 additional regional offices. GPI is an award-winning, multi-discipline engineering firm that has been providing professional planning and design, building systems design, and construction management/ inspection services to all levels of government and industry throughout the United States for 60 years. Like most organizations, GPI has begun to implement AI in all aspects of our business, however, we are only scratching the surface. GPI has been working proactively within our business to identify new opportunities to improve efficiency and create innovative work products. We will share examples of how we have leveraged AI to date and discuss how GPI is responding to the changing AI landscape.

Bios:

David Kuhn, PE, serves as Vice President and Director of Operations at GPI's Philadelphia office. Dave currently serves as project manager for two NJDOT quick turnaround research contracts as well as the New Jersey Strategic Highway Safety Plan. Dave has worked with many New Jersey counties and municipalities to develop safety action plans and safety-related infrastructure projects.

Dave Wagner, GISP, MBA, serves as Director of Geospatial Services for GPI's New Jersey operations. Dave currently serves as assistant project manager for two NJDOT quick turnaround research contracts as well as project manager for a geotechnical asset management project. Dave has worked with many New Jersey counties and public agencies to create data collection, asset management, and GIS projects.

Applying Artificial Intelligence (AI) to Safety Analysis

Presenters: **Danielle Baer and Lauren Kretzing**

Organization: **Urban Engineers**



Abstract:

As transportation professionals continue to explore practical applications of artificial intelligence (AI) to enhance our work, emerging technologies are creating new opportunities to expand how roadway safety is evaluated. This presentation demonstrates the application of AI-based video analytics to evaluate operational and safety conditions. Specifically, two multilane roundabout safety studies conducted in Pennsylvania will be presented, providing real-world examples of how AI technology can be incorporated into transportation safety analysis. The presentation will explore the use of AI to analyze vehicle speeds, near-miss events, heavy braking, lane discipline, and truck movements, providing a more detailed understanding of driver behavior and vehicle interactions within the study areas. By transforming drone footage into detailed vehicle-level data, AI-based analysis can provide transportation professionals with information that may be difficult or impractical to collect through traditional field observation or hot spot analysis, allowing professionals to better understand the existing conditions and design improvements accordingly.

Bios:

Lauren Kretzing, EIT has rotated through the Civil Departments for the past 2 years at Urban Engineers, working on projects ranging from managing the City Hall Lighting Project to helping on preliminary and final design of Bridge, highway and traffic PennDOT projects. Recently, Lauren has helped use AI software to perform analyses on roundabouts.

Danielle Baer, PP, AICP has a wide range of experience as a Senior Planner in both the public and private sectors, serving municipal, county, MPO, and agency clients. In addition to zoning/land use planning and transportation planning, Danielle has extensive public involvement program management experience, most recently managing the public involvement effort for SJTPO's Countywide Local Road Safety Plans.

From Roadside LiDAR to Actionable Traffic Data: AI-Enabled Monitoring for Traffic Operations, Safety, and Freight

Presenter: **Yiqiao Li**

Organization: **City College of New York**



Abstract:

Transportation agencies increasingly require accurate, continuous, and scalable information on traffic operations, safety, and freight movement. In collaboration with the New York State Department of Transportation (NYSDOT), this research investigates an AI-enabled roadside sensing framework that transforms high-resolution LiDAR and complementary sensor observations into actionable transportation information. While conventional traffic sensors provide valuable measurements such as traffic volume and speed, they often provide limited information about individual vehicle trajectories, detailed vehicle types, and safety-critical interactions.

The framework integrates roadside LiDAR sensing with AI-based point-cloud processing to automatically detect and track road users and derive traffic measures including vehicle counts, trajectories, speeds, lane-level movements, and traffic interactions. For freight applications, the framework further characterizes commercial vehicles beyond conventional vehicle counts. AI-based vehicle classification is used to distinguish truck body types and configurations, providing more detailed information on freight activity and truck composition that can support freight corridor monitoring, infrastructure planning, and operational analysis.

Working with NYSDOT, the research team has deployed a roadside LiDAR sensing system along I-95 in the Bronx to evaluate the technology under real-world freeway conditions. The deployment demonstrates how emerging AI-enabled sensing can complement existing agency traffic monitoring infrastructure while providing detailed trajectory- and vehicle-level information that is difficult to obtain from conventional point sensors. The resulting data can support continuous traffic monitoring, freight vehicle characterization, and automated identification and review of potentially safety-critical interactions involving passenger vehicles and trucks.

This work demonstrates how collaboration between transportation agencies and academic researchers can accelerate the evaluation and adoption of emerging AI technologies. By integrating traffic monitoring, safety analysis, and freight vehicle characterization within a common sensing framework, the approach provides a pathway toward scalable, privacy-preserving, and automated transportation monitoring for data-driven agency decision-making.

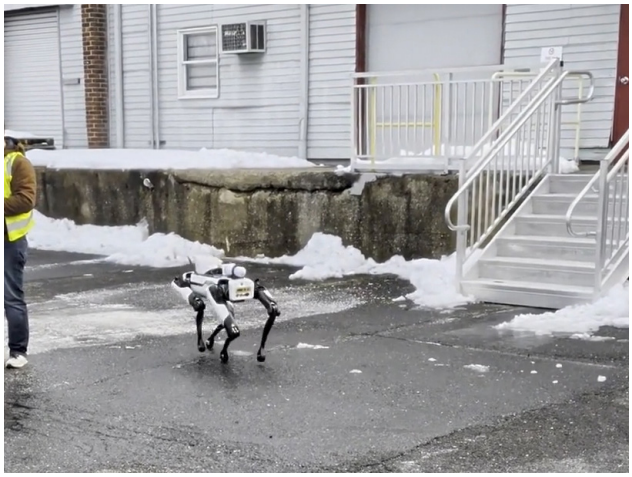
Bio:

Dr. Yiqiao Li is an Assistant Professor of Civil Engineering at The City College of New York (CCNY) and a faculty member in the Computer Science Program at the CUNY Graduate Center. She directs the AI & Mobility Research Lab at CCNY. Her research focuses on cyber-physical transportation systems, AI-enabled intelligent infrastructure, and cooperative driving, with applications in traffic safety, operations, and freight mobility. Her work integrates roadside LiDAR, computer vision, machine learning, and infrastructure-based perception to develop intelligent transportation systems that better understand, predict, and respond to dynamic traffic conditions. Dr. Li's recent research has been supported by the U.S. Department of Transportation (USDOT), the National Science Foundation (NSF), the New York City Department of Environmental Protection (NYC DEP), and other public sponsors.

Research and Pilot Study on Robotic Security for NJDOT Yards Surveillance

Presenter: **Alexander Warden**

Organization: **Rutgers University**



Abstract:

The New Jersey Department of Transportation (NJDOT) aims to address growing concerns about equipment theft, vandalism, and site security issues at its facilities. This study proposes researching, evaluating, testing, and piloting a suitable mobile robotic security system to improve site safety and security, increase surveillance efficiency, reduce financial losses, and enhance collaboration with law enforcement through improved incident reporting and evidence collection. Upon reviewing the implementation of the Asylon DroneDog Security Robot during the testing period, the study's findings, to be presented in a final report, will assist NJDOT in making long-term, informed decisions and implementing solutions that meet the agency's specific operational needs.

Bio:

Alexander Warden is an assistant project manager at the Rutgers Center for Advanced Infrastructure and Transportation (CAIT), specializing in GIS-based transit analysis. He received his B.A. in Geography from Rutgers University, with a concentration in Geospatial Analysis. To further his knowledge of the transportation field, he is pursuing an online M.S. in Transportation Management at San Jose State University. Previous work has included resiliency and flood mitigation planning as an intern at CAIT, using life cycle cost analysis and comparative cost-benefit analysis, informed by GIS data layers, for the Delaware River Port Authority (DRPA) and the New York State Department of Transportation (NYSDOT).



AI for Smarter Safety Investment: Enhancing New Jersey's Safety Performance Functions and Network Screening

Presenters: **Chaitanya Pathak and Steven Luglio**

Organization: **HNTB**

Abstract:

New Jersey has an established data-driven framework for roadway safety analysis, including state-specific Safety Performance Functions (SPFs) and calibration factors supporting Highway Safety Manual (HSM) applications. However, conventional SPFs represent average relationships between traffic exposure, roadway characteristics, and expected crash frequency and may not fully capture nonlinear interactions or localized variation. As artificial intelligence (AI) becomes increasingly integrated into transportation practice, this research examines whether machine learning can improve the precision of New Jersey's existing safety screening framework while preserving its established statistical foundation.

The study develops a hybrid framework integrating conventional SPFs, machine learning, regional adjustment, and Empirical Bayes (EB) analysis. A negative binomial SPF developed by facility type provides an explainable, HSM-compatible baseline. A gradient-boosted model then estimates a multiplicative correction to the SPF prediction, allowing nonlinear relationships and interactions among roadway, traffic, and geometric characteristics to be captured without replacing the underlying SPF. A statistically shrunk regional adjustment accounts for geographic variation, while EB estimation incorporates site-specific crash history and addresses regression-to-the-mean effects.

To evaluate whether predictive improvements extend beyond the data used for model development, geographic areas and recent observations are withheld during validation rather than relying solely on random data splits. Initial proof-of-concept testing on synthetic roadway networks with known interaction, regional, and site-level effects substantially reduced out-of-sample prediction error relative to the SPF alone while maintaining calibration across traffic-volume ranges. The framework is being applied to New Jersey crash records integrated with roadway inventory, geometric, and traffic-volume data across the roadway network. The analysis will quantify the incremental predictive contribution of each modeling component by facility type and evaluate the geographic and temporal transferability of the AI-based correction.

The resulting framework is intended to provide an AI-enhanced network safety screening methodology, identify and prioritize candidate locations for further safety investigation, and establish a reproducible analytical process that can be updated as new crashes, roadway, and traffic data become available. By combining AI with established SPF and EB methods, the research provides a practical pathway for improving precision safety screening while maintaining compatibility with HSM-based safety analysis and supporting more informed allocation of limited roadway safety resources.

Bios:

Dr. Chaitanya Pathak earned his Ph.D. in Civil Engineering with a focus on Transportation Engineering from the New Jersey Institute of Technology (NJIT) and currently serves as a Senior Project Engineer and Team Lead in HNTB's Traffic and ITS Department. He has experience in transportation planning, traffic operations, roadway safety, traffic simulation, and data-driven transportation analysis, supporting a wide range of transportation projects throughout New Jersey. His research interests include roadway safety, crash prediction, and the application of artificial intelligence, machine learning, and advanced analytics to transportation engineering. Dr. Pathak is a certified Professional Transportation Planner (PTP), is actively involved with the Institute of Transportation Engineers (ITE) and has served as a peer reviewer for the Transportation Research Board (TRB) and other transportation research publications.

Steven holds a B.S. in Civil Engineering from the University of Connecticut and is a licensed Professional Engineer (P.E.) with seven years of experience in transportation planning, traffic modeling, and roadway safety throughout the tri-state area. His work focuses on applying data-driven analysis and engineering principles to identify transportation safety needs and develop practical improvements. His recent experience includes Safe Streets and Roads for All (SS4A) grant applications, corridor-level safety analyses, development of safety countermeasures, and roadway safety design for municipal and regional transportation projects.

Infrastructural and Safety Barriers to E-Bike Use: Insights from a Nationwide Survey

Presenters: **Hannah Younes and Yingning Xie**

Organization: **Rutgers University**



Abstract:

Background: Low-speed electric bicycles (e-bikes) are increasingly recognized as a mode of transportation that can support climate, mobility, equity, and public health goals. However, growing ridership has also brought public concern regarding cyclist safety, battery fires, high-speed electric devices falsely marketed as e-bikes, and conflicts between vulnerable road users and motor-vehicles.

Methods: We deployed an online survey to understand perceptions of e-bikes, barriers to ownership, willingness to purchase an e-bike, and support for policy interventions. We received 998 valid responses: 555 from respondents that were e-bike owners and 443 from respondents who did not own an e-bike (45% residing in New Jersey).

Findings: Survey results emphasized infrastructure-related safety concerns. Among non-e-bike owners, approximately half reported that using an e-bike in their neighborhood would be dangerous. When asked about barriers to purchasing an e-bike, 50% reported that the cost was too high, 27% noted unsafe road conditions, 24% worried about secure parking, and 20% had concerns about battery safety. Nevertheless, 80% believed e-bikes could replace some car trips, 76% agreed that e-bikes provide environmental benefits over driving, 64% were in favor of supportive e-bike policies, and 43% were interested in purchasing an e-bike in the future, indicating substantial demand if safety concerns were addressed. Over 60% of e-bike users reported “not enough bike lanes” as a barrier to using their e-bike more often, followed by “worry about secure parking” (over 40%). In supplementary semi-structured interviews, e-bike users also widely cited road safety and lack of bike lanes as factors affecting their perceived accessibility and well-being.

Implications: Infrastructural, safety, and perceptual barriers emerge as dominant concerns for both e-bike users and non-users. Safety concerns extend beyond the bicycle itself. Survey respondents repeatedly identified roadway conditions as a barrier to purchase and use. Consequently, incentives (and restrictive measures) will not maximize cycling safety without complementary investments in protected bike lanes, traffic calming, lower vehicle speeds, and secure bicycle parking. Because e-bike users are part of a broader group of vulnerable road users or otherwise unprotected in traffic and face higher risk of injury than car users, it is crucial to consider New Jersey Target Zero goals and actions to ensure that e-bike users are safe.

Funding: This research was funded in part by the New Jersey State Policy Lab.

Bio:
Hannah Younes, PhD, is a Senior Research Specialist at VTC and brings more than a decade of experience conducting transportation safety research with transit agencies, departments of transportation, and public safety organizations. She is an expert in safety analysis and advanced statistical methods. She has researched transit rider safety, active modes, travel behavior, safety perceptions, and crash data analysis.

What are the Digital infrastructure Components for State DOTs?

Presenters: **Giri Venkiteela and La Zhao**

Organization: **NJDOT**

BUREAU OF RESEARCH AND INNOVATION

Abstract:

This presentation explains the eight core digital infrastructure components that are transforming state Department of Transportation (DOT) operations and provides insights from a comprehensive survey of 23 state transportation agencies conducted by the NJDOT Bureau of Research and Innovation (BRI) in collaboration with AASHTO Research Advisory Committee (RAC).

Bios:

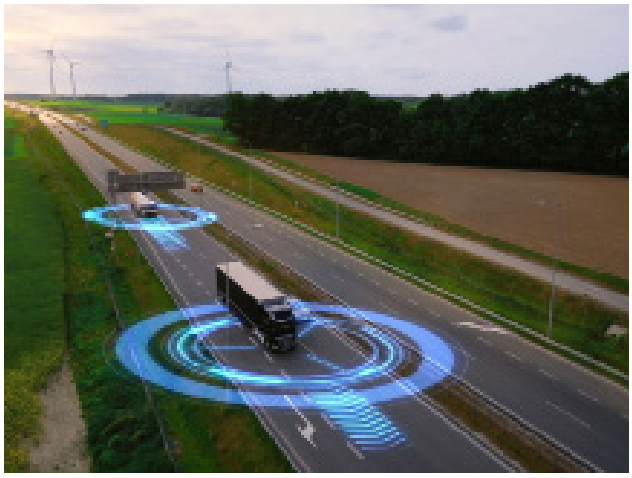
As a Research Scientist at NJDOT's Bureau of Research and Innovation (BRI), Dr. Giri Venkiteela manages a diverse portfolio of research and innovation projects and programs, serving as a subject matter expert for key initiatives including the NJDOT Innovation Program, NJSTIC Program, Artificial Intelligence (AI) research, and transportation pooled fund program. His leadership extends to the national level as Chair of AASHTO-RAC Region #1 and Chair of the AASHTO-RAC AI Task Force. He is currently leading the "State DOT Council for Strategic AI Adoption," a national pooled fund project. He actively contributes to NCHRP research projects and participates in various TRB and AASHTO committees, while regularly presenting NJDOT research at prominent venues including AASHTO, IRF, TRB and peer exchanges. He has reviewed research proposals and journal articles for NJDOT, USDOT, NCHRP, ASCE, and TRB. He holds a doctoral degree in Civil Engineering from the University of Louisville and has research scholar experience at Northwestern University. Outside of work, he enjoys playing tennis, watching movies, and reading.

La Zhao is a Professional Engineer with extensive experience in transportation engineering, pavement and drainage management, construction materials, and transportation research. Currently serving in the New Jersey Department of Transportation (NJDOT), La Zhao worked on statewide transportation research, innovation, and technology transfer initiatives through the Bureau of Research and Innovation, including the Local Technical Assistance Program (LTAP) and the Annual Research Showcase. Previously, La Zhao served as a Principal Engineer in the Bureau of Materials, overseeing laboratory quality management, accreditation, materials certification, and initiatives to modernize materials data systems and facilities. La Zhao also has extensive experience in pavement design, drainage management, capital project development, and engineering research, with a strong background in technical leadership, multidisciplinary collaboration, and the implementation of innovative transportation solutions. La Zhao holds graduate-level research experience from Iowa State University, where research focused on pavement foundation design, drainage, and geotechnical engineering.

TrafficCube AI-based Data Fusion, Visualization, and Analysis Platform

Presenter: **David Hale**

Organization: **Leidos**



Abstract:

A central truth of modern computer science is that artificial intelligence (AI) delivers its highest value when processing large volumes of well-structured data. Despite this truth, many traffic analysts and researchers are trying to leverage AI chatbots (e.g., Claude, ChatGPT) to expedite their analyses. Although capable of impressive feats, chatbots may be prone to oversights and hallucinations when forced to operate on ad-hoc datasets. To fill this gap, a new data analytics platform called TrafficCube seeks to bring AI-powered traffic analysis to the general public. TrafficCube is available free of charge and uses a simple file format that anyone can work with. This presentation will describe and demonstrate TrafficCube's approach to fusing, visualizing, and simultaneously analyzing multiple datasets from multiple sources. This presentation will also discuss upcoming opportunities to perform AI-assisted similarity searches, contributing factor analyses, simulation calibrations and validations, data quality and anomaly identifications, Highway Capacity Manual methods, short-term predictions, pattern recognitions, congestion diagnoses, and Traffic Analysis Toolbox Volume 3 cluster analyses, among other opportunities. Time permitting, the presentation may also comment on ongoing FHWA AI efforts such as the AI-in-transportation case study series, capability maturity model, traffic analysis report reviewer, AI community of practice, and ITS-AMS community of practice.

Bio:

Dr. David Hale is a senior transportation engineer with Leidos in McLean VA. His technical background is in traffic analysis tools and data analytics. His service includes contributions to the TRB committee on Traffic Flow Theory, Models, and Simulation, plus the ITE committee on Simulation and Capacity Analysis.

Evaluating CAV Impacts on Signalized Intersection Work Zone Capacity: A New Jersey Case Study

Presenter: **Fahmida Rahman**

Organization: **Rowan University**



Abstract:

Work zones are a major source of non-recurrent congestion and can significantly reduce the capacity of signalized intersections through lane closures, speed reductions, and disruptions to traffic flow. Connected and Autonomous Vehicles (CAVs) have the potential to mitigate these impacts through reduced headways, cooperative lane changing, and improved merging behavior. However, their effects on the capacity of signalized intersections under work-zone conditions remain understudied.

This study evaluates how CAV market penetration rates (MPRs) affect signalized intersection capacity through changes in saturation flow rate (SFR). A real-world corridor in Sewell, New Jersey, consisting of two signalized intersections along Cross Keys By-Pass, was selected as the study area. Field data collected during the AM peak period were used to develop and calibrate a PTV VISSIM microsimulation model following Highway Capacity Manual (HCM) guidance. A near-side lane-closure work zone was then introduced, and CAV driving behaviors were modeled using reduced intraplatoon headways, cooperative lane changing, and advanced merging.

Results show substantial capacity benefits as CAV penetration increases from 0% to 100%. The through movement, which was most affected by the lane closure, exhibited a nearly linear capacity increase, with saturation flow rate improving by up to 51%. The protected left-turn movement experienced a more moderate improvement of up to 16%, indicating that CAV benefits vary by movement and level of traffic interaction. The findings demonstrate that CAVs can potentially mitigate capacity losses associated with work-zone lane closures by improving vehicle discharge rates.

The study provides transportation agencies, planners, and traffic engineers with a practical framework for evaluating how increasing CAV adoption may affect signalized intersection operations during work zones. The findings can support future work-zone planning, traffic management strategies, and preparation for mixed CAV and human-driven traffic environments.

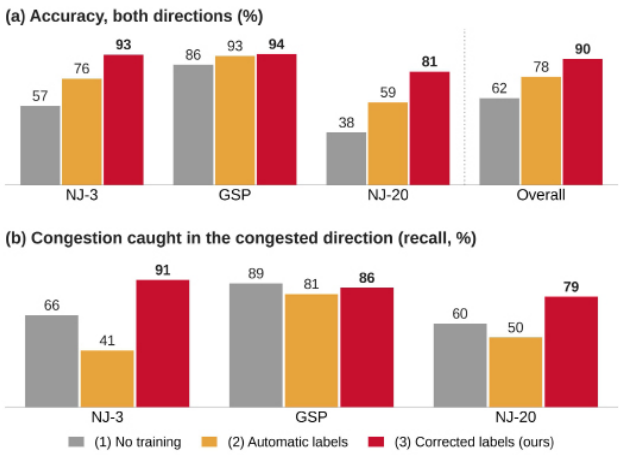
Bio:

Fahmida Rahman is an Assistant Teaching Professor in the Department of Civil and Environmental Engineering at Rowan University. She earned her Ph.D. in Civil Engineering with a concentration in Transportation Engineering from the University of Kentucky. Her research interests include traffic operations, highway safety, intelligent transportation systems, connected and automated vehicles, and data-driven transportation analysis. Her work applies statistical analysis, machine learning, traffic simulation, and emerging transportation technologies to address practical challenges related to roadway operations and safety. She is also actively involved in transportation education and student-centered projects that integrate real-world transportation data and industry-relevant analytical tools.

Transforming Existing NJDOT Traffic Cameras into Autonomous Congestion Detection Systems by Utilizing Video Vision-Language Models

Presenter: **Bhargavi Reddy Kotha**

Organization: **NJIT**



Abstract:

State transportation agencies operate thousands of roadside CCTV cameras. Congestion detection from these feeds is still mostly manual. The goal of this work is to use training labels derived from probe-based travel times, instead of manual annotation, to fine-tune a video vision-language model (VLM) and turn existing traffic cameras into automated congestion sensors.

Thirty-second clips covering two directional freeway flows were recorded from three New Jersey Department of Transportation cameras at peak hours over 41 days (51,344 clips) and labeled Low or High per direction by thresholding minute-level travel times from a commercial probe-data API on short segments through the camera view. Qwen2.5-VL-7B-Instruct was evaluated under three setups: (1) zero-shot (no fine-tuning), (2) a combined model fine-tuned with low-rank adaptation on 42,235 automatically screened labeled clips, and (3) per-site models fine-tuned on manually corrected subsets (5,036-8,197 clips). Models were evaluated on four fully hand labeled held-out days per site (14,450 direction labels).

Joint (both-direction) accuracy rose from 62.2% with zero-shot to 77.6% with the combined model and 90.3% with the per-site models. The automatic labels themselves agreed with human judgment 90.5% of the time, yet the combined model trained on them became strongly conservative and missed almost half of true congestion (High-class recall 53.7%). The per-site models restored the balance (precision 95.6%, recall 83.4%, and F1 89.1) and were more accurate than the automatic labels (F1 81.4).

This is among the first works to fine-tune a video VLM for roadside-camera congestion detection with probe-derived weak supervision; it also quantifies the label quality versus quantity trade-off: small corrected per-site datasets outperform a fivefold larger noisy dataset.

Agencies can use existing CCTV as congestion sensors without new hardware or camera calibration, at the cost of one adapter per camera trained on a single GPU.

Bio:

Bhargavi Reddy Kotha is an Associate Application Developer in the Department of Civil and Environmental Engineering at the New Jersey Institute of Technology (NJIT). She began at NJIT as a graduate researcher while earning her master's degree in Computer Science and now develops tools that turn academic research into real-world applications. Her work focuses on using artificial intelligence and computer vision to monitor traffic and improve roadway safety. She also brings a strong background in software engineering and open-source development, including contributions to the Red Hat community through Google Summer of Code. She is especially interested in creating technology that makes a real difference on New Jersey's roads.

Automated Text Extraction from Bridge Inspection Images to Support Infrastructure Management Systems

Presenters: **Maurizio Morgese and Gianluca Bruno**

Organization: **Rutgers University**



Abstract:

Bridge inspection reports contain valuable geometric and location information embedded within annotated images, but this information typically remains locked in unstructured, non-machine-readable form. Manual extraction is slow and inconsistent. It is increasingly incompatible with the pace required for transportation agencies to digitize legacy inspection records under the transition to the Specifications for the National Bridge Inventory (SNBI).

This work presents an automated pipeline for extracting and structuring text embedded in bridge inspection images, in direct support of infrastructure asset management workflows. The framework integrates image preprocessing, dual-pass optical character recognition for horizontal and vertical text, spatial clustering of fragmented detections, and rule-based classification of location and measurement annotations. Extracted information is normalized into a structured tabular format ready for integration into asset management systems.

The framework was applied to 120 real bridge inspection images provided by the New Jersey Department of Transportation, and validated quantitatively on a 24-image sample. Horizontal measurement text was extracted with 98% precision and 80% recall, while vertical measurement text reached 87% precision and 59% recall. A prototype web application was also developed, allowing bridge inspectors and asset managers to use the pipeline without interacting with the underlying code. By converting unstructured image content into machine-readable data, this work directly supports NJDOT's ongoing transition to SNBI-based digital records.

Bio:

Dr. Gianluca Bruno is a Postdoctoral Researcher at the Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers University, where he joined in August 2026. He received his PhD cum laude from the Politecnico di Bari and spent a period as a visiting scholar at ETH Zurich. His research focuses on structural health monitoring, model updating, and digital twins of bridges and other infrastructure, with particular attention to physics-informed and artificial intelligence-based methods. At CAIT, he contributes to projects on the digitalisation of bridge inspection data and bridge management systems.

RUTGERS NEW BRUNSWICK

Comparing Cost and Time Performance of Design-Build Projects across Construction Sectors, Contract and Procurement Methods in the US Northeast States

Bishal Poudel[1] and Vassiliki A. Demetracopoulou, Ph.D.[1]

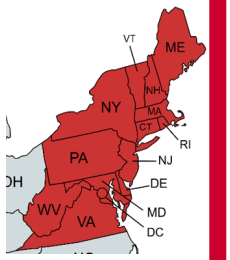
[1]Department of Civil and Environmental Engineering, Rutgers University

1. INTRODUCTION

- **Design-Build (DB)** is an **alternative project delivery** method where the design and construction phases are integrated under a single point of responsibility to improve efficiency
- DB is increasingly used in the U.S. due to its potential to improve project integration, innovation, and delivery efficiency.
- However, DB project performance can vary across different **project-specific conditions, such as contract type, procurement method, or sector.**
- **These impacts have not been examined in existing literature.**

Contract Provision → Procurement Method → Construction Sector

- The **U.S. Northeast** presents unique conditions, including aging infrastructure, dense urban environments, and complex project requirements.
- This study evaluates the **cost and time performance** of DB projects across **construction sectors, contract methods, and procurement methods in NE states.**



2. METHODOLOGY

- **Data:** 103 DB projects from the
- **Coverage:** 11 construction sectors in the U.S. Northeast states
- **Metrics:** Cost Overrun Rate (COR) and Time Overrun Rate (TOR)
- **Data screening**: Missing data and Outliers
- **Normality:** Shapiro–Wilk test
- **Significance:** $p < 0.05$

COR (%) = [(Actual completion cost – Contracted Cost)/ Contracted Cost] *100
TOR (%) = [(Actual time taken – Contracted time)/ Contracted time] * 100

Null Hypotheses	No significant difference between
H1	COR among sectors
H2	TOR among sectors
H3	COR among contract methods
H4	TOR among contract methods
H5	COR among procurement methods
H6	TOR among procurement methods

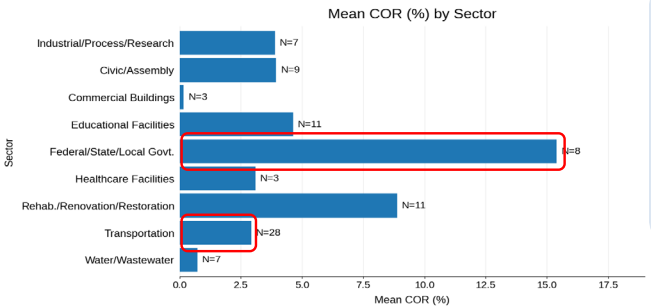
Exclusion of Extreme outliers:

- Lower bound=Q1-3*IQR
- Upper bound=Q3+3*IQR
  - Q1= First quartile,
  - Q3= Third quartile
  - IQR= Inter Quartile Range

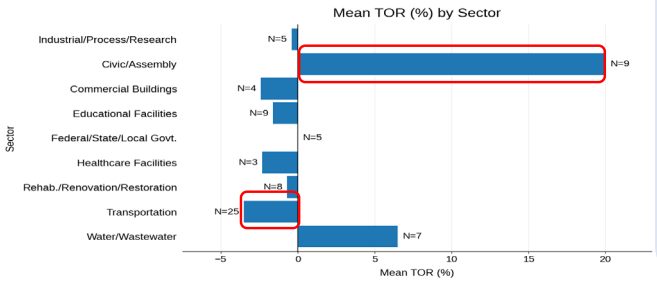
Data exhibited non-normal distributions, so non-parametric statistical tests were utilized

- Among Sectors: **Kruskal-Wallis**
- Among contract and procurement methods: **Mann-Whitney U**

3. RESULTS: COR & TOR AMONG SECTORS



The Federal, State,.. Sector exhibited the highest cost overruns (15.4%). The transportation sector had the highest DB sample in the NE and presented a modest 2.92% average COR.



The Civic/Assembly exhibited the highest time overruns (20%). The transportation sector had the highest DB sample in the NE and presented the highest time savings, with a -3.5% average TOR.

- Despite these descriptive differences, statistical tests revealed no significant variation in COR & TOR across sectors ($p > 0.05$)

4. RESULTS: COR & TOR AMONG CONTRACT & PROCUREMENT METHODS

	Contract methods	Mean	Median
COR (%)	Lump Sum (N=54)	4.40	3.32
	Non-Lump Sum (N=24)	1.91	0.72
TOR (%)	Lump Sum (N=45)	-2.46	0.00
	Non-Lump Sum (N=19)	-0.20	0.00

	Procurement types	Mean	Median
COR (%)	Best Value (N=55)	3.88	3.29
	Non-Best Value (N=23)	3.04	1.12
TOR (%)	Best Value (N=40)	-1.00	0.00
	Non-Best Value (N=23)	-3.45	-0.15

- Despite these descriptive differences, statistical tests revealed no significant variation in COR & TOR across sectors ($p > 0.05$)

5. SUMMARY & CONCLUSION

- **No significant differences** in cost or time performance across sectors, contract methods, or procurement methods.
- **Project-specific factors**—owner experience, risk allocation, management, and governance—may be more influential than method selection.
- Sample size of projects within certain individual categories was small, limiting broad generalization
- Analysis focused only on **cost and time**, excluding quality, safety, and environmental outcomes.

6. ACCESS THE FULL PAPER

https://ascelibrary.org/doi/abs/10.1061/9780784486986.031

RUTGERS–NEW BRUNSWICK
Center for Advanced Infrastructure and Transportation
School of Engineering

Development of Non-Proprietary Ultra-High-Performance Concrete (UHPC) for Bridge Overlays

Presented by **Michael Ruszala**, RIME Group, Rutgers University

Authors: Hani Nassif · Reid Holland · Michael Ruszala · Chaekuk Na

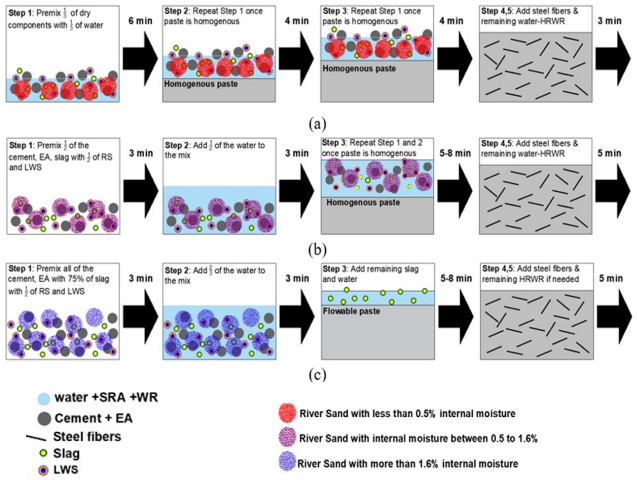
01 BACKGROUND & OBJECTIVES

Ultra-high-performance concrete (UHPC) offers exceptional strength and durability for bridge overlays, but wider use is often limited by large-volume workability and high autogenous shrinkage that can lead to early-age cracking and delamination. To address these shortcomings, a non-proprietary UHPC overlay mix developed using pre-saturated lightweight sand (LWS), expansive agents (EA), and shrinkage-reducing admixtures (SRA), validated under restrained conditions (AASHTO T334). Practical mixing protocols tailored to aggregate moisture conditions and field demonstration results will also be discussed.

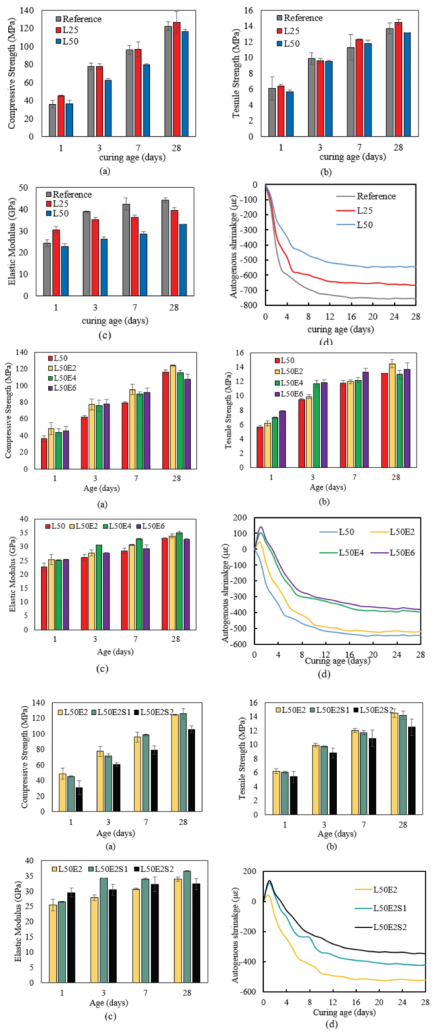
02 Mix Design and Procedure

Mixtures	Cement	Slag	EA	RS	LWS	HRWR	SRA	Water	SF
Reference	459.0	633.9	0	965.4	0	9.8	0	244.8	156
L25	459.0	633.9	0	721.4	163.9	7.8	0	245.9	156
L50	459.0	633.9	0	482.7	327.9	6.0	0	247.0	156
L50E2	447.5	623.2	22.9	482.7	327.9	6.0	0	247.6	156
L50E4	435.9	612.5	45.9	482.7	327.9	6.0	0	247.8	156
L50E6	423.3	601.8	68.8	482.7	327.9	6.0	0	247.8	156
L50E2S1	447.5	623.2	22.9	482.7	327.9	6.0	11	236.6	156
L50E2S2	447.5	623.2	22.9	486.7	327.9	6.0	22	225.4	156

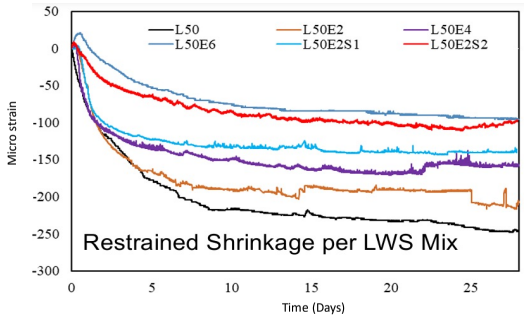
Note: EA represents expansive agent; LWS represents pre-saturated lightweight sand; HRWR represents high-range water reducer; RS represents natural river sand/fine aggregates and SF represents steel fibers



04 Effects of Variables

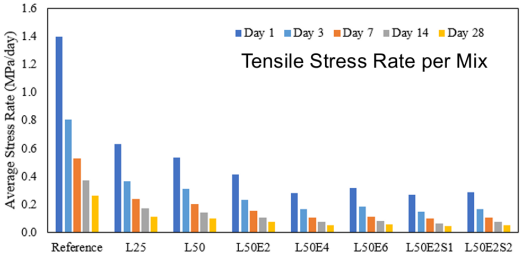


05 Results





Restrained Shrinkage Ring Test



06 Conclusions

1) Crack free UHPC under restrained conditions can be produced using LWS (50% by sand volume), EA (2%), and SRA (2%).

2) When combined, chemical shrinkage can be reduced by as much as 60% without compromising strength.

3) Mixing protocols are proposed based on mixture rheology and sand moisture. Mono-batching produces best results.

Acknowledgements: The authors gratefully acknowledge the New Jersey Department of Transportation (NJDOT) for its support and guidance throughout this work. The authors also acknowledge Xiaohua "Hannah" Cheng, Dipen Mehta, Habel Sabu, Hemant Padalia, and other SMEs in the Bureau of Structural Engineering Services. Additional thanks to all undergraduate student in RIME Group for the help on this project

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Evaluating Connected and Autonomous Vehicle (CAV) Impacts on Signalized Intersection Work Zone Capacity: A New Jersey Case Study

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Advisor: Fahmida Rahman (rahmanf@rowan.edu), Ph.D.

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Introduction

- Work zones contribute to 24% of nonrecurrent congestion, causing 482 million vehicle hours of delay annually (FHWA, 2006). Increasing travel demand and aging infrastructure can make work zone management challenging, as lane closures and lower speed limits reduce roadway capacity and lead to delays.
- The adoption of connected and automated vehicles (CAVs) offers a solution to enhance efficiency and reduce congestion through real-time traffic information, shorter gaps, smooth speed adjustments, and platooning.
- The Highway Capacity Manual (HCM) includes CAV impacts on roadway capacity for various facility types but falls short in providing guidance on signalized intersection work zones. Limited studies have explored the impact in work zones, necessitating evaluation to develop effective management strategies.
- With increasing CAV deployment, work zones will operate under mixed traffic conditions consisting of both HDVs and CAVs, making it important to understand their combined effects.

Study Goals

The objective of this study is to quantify the impact of CAV penetration rates and their driving behavior on the capacity of a signalized intersection approach with a right closure for:

- A shared through-and-right-turn movement
- A protected left-turn movement

Study Area and Data

A representative four-leg signalized intersection geometry was selected, with a major street and a minor street in Washington Township, NJ.

- Each approach consists of an exclusive left-turn lane, an exclusive through lane, and a shared through-and-right-turn lane.
- All lanes are 11 ft wide, and the posted speed limit on both the major and minor streets is 45 mph.
- Traffic count data were collected in the field on March 9, 2026, between 7:00 and 8:00 AM to capture peak-hour conditions. The observed traffic stream consisted of 96.5% passenger cars and 3.5% trucks.
- Left-turn storage length is 300 ft for each approach.
- A 100-s cycle length was selected, and the optimized timing plan was used for the analysis.

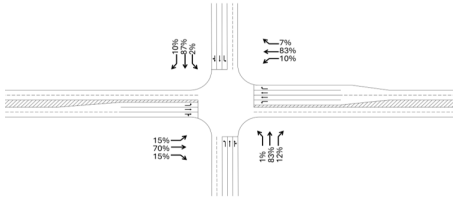


Figure 1: Study Intersection

Methodology

Modeling Approach

- Developed models in VISSIM microsimulation software for normal and work zone conditions.
- Calibrated using HCM saturation flow rates and verified the good fit of the model with Geoffrey E. Havers (GEH) (GEH < 5 is an acceptable fit).

Table 1: Comparison of HCM and simulated saturation flow rates for protected movements under normal condition

Movement	HCM SFR (pc/h/ln)	Simulated SFR (pc/h/ln)	GEH
Shared Right-and-Through	1800	1722	1.86
Through	1900	1916	0.37
Left Turn (Protected Phase)	1600	1585	0.38

Work Zone Setup

- Configured a right-lane closure at the signalized intersection approach.
- Calibrated for HDVs.

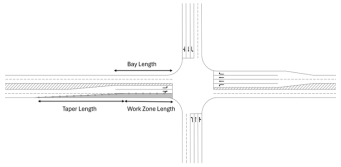


Figure 2: Schematic Diagram of Work Zone Configuration

Table 2: Work Zone Design Parameters

Attribute	Value
Work Zone Length, ft	250
Work Zone Speed Limit, mph	35
Taper Length, ft	495
Distance Between Warning Signs, ft	350

Table 3: Comparison of HCM and simulated saturation flow rates for work zone condition

Movement	HCM SFR (pc/h/ln)	Simulated SFR (pc/h/ln)	GEH	HCM Saturation Headway (s)	Simulated Saturation Headway (s)
Shared Right-and-Through	1575	1587	0.32	2.29	2.27
Left Turn (Protected Phase)	1400	1362	1.01	2.57	2.64

CAV Operation and Assumptions

- Level of Automation: 5
- Smoother and coordinated merging through V2V and V2I communication and cooperative lane-changing.
- Advanced merging.
- Minimize stop-and-go patterns & reduce speed variability
- Evaluated operations under mixed traffic conditions with CAV MPRs ranging from 0% to 100%.
- Applied Wiedemann 99 car-following parameters adopted for CAVs (CoEXist project) for three behavior categories: Cautious, Normal, and All-knowing.
- All-knowing CAVs feature more aggressive parameters, with a headway time of 0.6 s, compared to 0.7 sec for Normal CAVs and 1.1 s for Cautious CAVs.

Capacity Estimation

- Saturation flow rates (SRFs) and mean saturation headways were extracted from the simulation across varying CAV levels to estimate capacity.

$$s = \frac{3600}{h}$$

$$capacity = s \times \frac{g}{C}$$

Where,
s = Saturation Flow Rate
h = Saturation Headway
g = Effective Green Time
C = Cycle Length

Results and Applications

Shared Through-and-Right-Turn Lane

- SFR increases nonlinearly with CAV penetration.
- Mean saturation headway decreases as CAV MPR increases from 0% to 100%.
- At 100% CAV penetration, SFR increases by approximately 84% for All-Knowing, 81% for Normal, and 70% for Cautious CAVs.

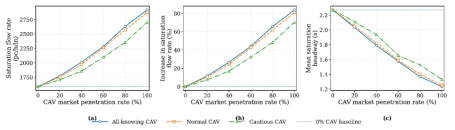


Figure 3: Impact of CAV penetration rate and driving behavior on saturation flow rate and saturation headway for the shared through-and-right-turn lane (work zone condition): (a) SFR, (b) percent SFR increase, and (c) mean saturation headway

Protected Left-Turn Lane

- SFR increases consistently with higher CAV MPRs.
- Experienced greater relative improvements due to a lower baseline SFR, allowing greater reductions in discharge headway.
- At 100% CAV penetration, capacity increases by approximately 88% for All-Knowing, 83% for Normal, and 78% for Cautious CAVs.
- Even the Cautious scenario provided substantial capacity improvements.

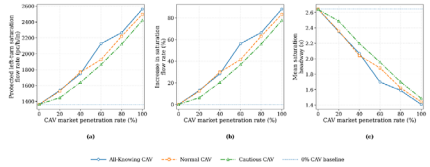


Figure 4: Impact of CAV penetration rate and driving behavior on saturation flow rate and headway for the protected left-turn lane (work zone condition): (a) SFR, (b) percent SFR increase, and (c) mean saturation headway

Practical Applications

- Developed HCM-compatible Capacity Adjustment Factors (CAFs) to support work zone planning and design.
- Look-up tables provide specific CAFs for Shared Through-and-Right-Turn and Protected Left-Turn movements based on targeted CAV penetration levels and driving behavior.

Table 4: Capacity Adjustment Factors

CAV MPR	Shared Through-and-Right-Turn			Protected Left Turn		
	All-knowing	Normal	Cautious	All-knowing	Normal	Cautious
0	1.00	1.00	1.00	1.00	1.00	1.00
20	1.12	1.10	1.07	1.13	1.12	1.06
40	1.27	1.24	1.17	1.28	1.30	1.20
60	1.44	1.43	1.32	1.56	1.41	1.37
80	1.66	1.62	1.48	1.66	1.63	1.56
100	1.84	1.81	1.70	1.88	1.83	1.78

Conclusion & Future Work

- CAVs significantly improve work zone capacity, even without full connectivity.
- Protected left-turn movements experience the greatest capacity improvements.
- The proposed CAFs should be applied within the context of this study.
- Behavioral parameters will be recalibrated as real-world CAV and HDV mixed traffic data become available.
- The work will be expanded to other intersection layouts, right-turn proportions, and lane-closure configurations.

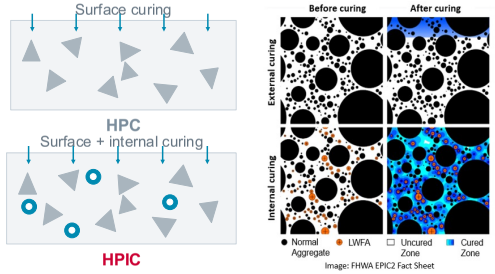
Extend Service Life of Concrete Bridge Decks with Internal Curing

Presented by **Sabatino Castello**, RIME Group, Rutgers University

Authors: Hani Nassif[1] · Michael Ruszala[1] · Chaekuk Na[1] · Reid Holland[1] · Mohammad Mahgoub[2] · Kaan Ozbay[3] · Jannie Gao[3] · Eren Kaval[3]
[1]Rutgers University / RIME Group [2]New Jersey Institute of Technology [3]New York University

01 BACKGROUND & OBJECTIVES

High-performance concrete (HPC) has a dense, low-permeability matrix that limits moisture supplied by external curing. As hydration consumes pore water, autogenous shrinkage develops. Under bridge-deck restraint, shrinkage can initiate early-age cracking, allowing chlorides to reach reinforcement and accelerate corrosion.



High-performance internally curing concrete (HPIC) replaces part of the normal-weight sand with prewetted lightweight fine aggregate (LWFA). Stored water is released during hydration, supporting curing within the concrete and reducing self-desiccation.

Study Objectives

1. Evaluate materials: identify suitable LWFA and superabsorbent polymer (SAP) products for NJDOT HPC.
2. Verify performance: compare shrinkage, strength and durability; assess dosage and curing requirements.
3. Support implementation: demonstrate production, assess costs and inform NJDOT guide specifications.

02 MATERIALS & TEST PROGRAM



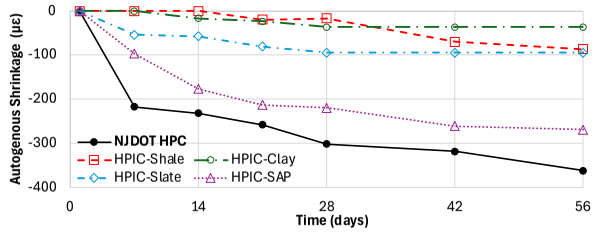
A review of 16 state DOT studies and supplier surveys informed the testing program. NJDOT HPC mixtures were modified using expanded shale, slate, clay, or SAP. Testing covered fresh properties, strength, chloride permeability, freeze-thaw durability, and free and restrained shrinkage.

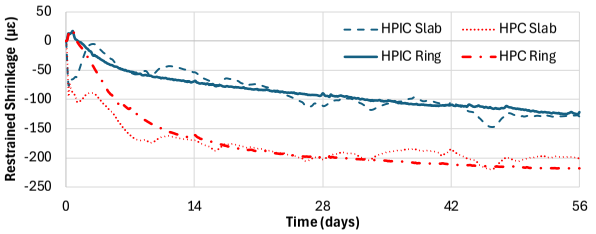
LWFA was soaked for 72 hours and drained for 24 hours. Stored-water dosages of 3.5, 7, and 10.5 lb per 100 lb of cementitious material were compared. Seven-day wet curing plus curing compound increased laboratory shrinkage compared with 14-day wet curing.

03 LABORATORY FINDINGS

Strength, chloride permeability, fresh properties, and finishability of LWFA-based HPIC were generally comparable to HPC. Expanded-shale HPIC maintained freeze-thaw resistance, while expanded-clay HPIC had lower resistance. SAP mixtures showed lower strength and stiffness.

All HPIC mixtures reduced autogenous shrinkage, with larger reductions for LWFA than SAP. Expanded-shale HPIC also reduced shrinkage-related response in restrained ring tests and simulated bridge-deck slabs, particularly at early ages when HPC is most susceptible to cracking.





04 PROJECTED LIFE-CYCLE BENEFITS

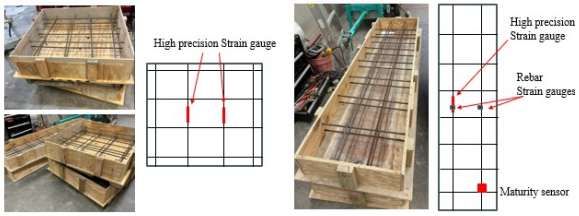
75-year analysis; assumed life: HPC 25 yr / HPIC 40–50 yr.
Total LCC applies a 0.3 weight to user costs.

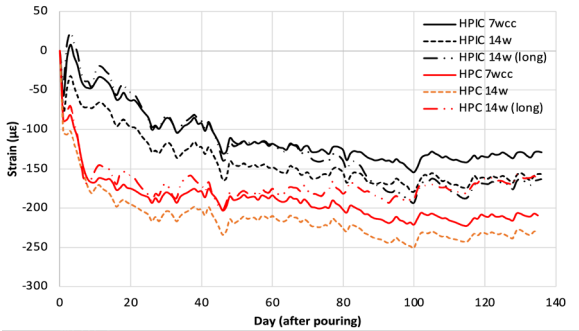


Over a 75-year analysis, HPIC was projected to lower costs through less frequent maintenance and rehabilitation. With a 10% unit-price premium, agency savings were about 31-41%. Service-life extensions are model assumptions, not field-verified outcomes.

05 FIELD DEMONSTRATION

Ready-mix HPC and expanded-shale HPIC were cast into 8-in.-thick reinforced slabs (4 ft × 4 ft and 2 ft × 8 ft). Eighteen vibrating-wire strain gauges (VWSGs) monitored field behavior for 136 days.





Slabs were cast outdoors in May 2025 and wet-cured for 14 days or for 7 days followed by curing compound. A 24-hour moving average reduced daily thermal fluctuations of 10–15 με.

HPIC shrinkage was 68% lower than HPC at 14 days and 29% lower at 136 days. These reinforced slabs simulated bridge-deck segments but were not highly restrained.

06 CONCLUSIONS AND IMPLEMENTATION

Expanded-shale HPIC is a feasible option for NJ bridge decks: it reduced shrinkage while maintaining strength and durability comparable to HPC. Internal curing complements, but does not replace, proper external wet curing.

Use 7 lb of stored water per 100 lb of cementitious material and retain 14-day wet curing. Determine LWFA moisture using the centrifuge method to support accurate batching. Instrument pilot bridge decks to verify in-service performance.

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Flexural Behavior of Prestressed Concrete Slabs with Varying Strand Configurations and Span-to-Depth Ratios

Presented by **Samuel Giumarello** and Roy Atallah, RIME Group, Rutgers University

Authors: Hani Nassif · Roy Atallah · Samuel Giumarello

01 BACKGROUND

In an unbonded post-tensioned member the tendon slips freely inside its duct, so it is never strained together with the concrete section it passes through. The tendon stress at ultimate, f_pU, is set by the elongation of the whole member between anchorages rather than by compatibility at any one cross section, which makes the stress gain Δf_pU a global, deformation-driven quantity.

With no section-level compatibility to rely on, codes predict Δf_pU using empirical expressions fitted largely to beam tests. ACI 318 separates slab from beam behavior at a single discrete cutoff of $L/d_p = 35$. How Δf_pU develops across slab slenderness, whether one discrete cutoff represents that behavior, and whether FRP systems follow the same trend remain open questions for the long-span floor systems now being built.

Objectives

1. Measure Δf_pU across a continuous slenderness range, $L/d_pU = 18.7$ to 40, spanning the ACI 318 cutoff at 35.
2. Compare steel and CFRP tendons against mild-steel and GFRP passive reinforcement at constant slenderness.
3. Evaluate capacity and tendon stress against ACI 318, AASHTO LRFD, ACI 440.4R and MDBA.
4. Build a FEM of the unbonded system calibrated to the measured response.

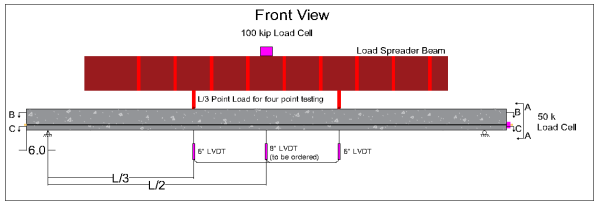
02 TEST PROGRAM

Nine one-way slabs were tested in two phases. Both share the same cross section, tendon depth, anchorage detail and four-point loading arrangement, so the two sets form one continuous series.

Phase	Primary variable	Slabs	L/d_pU	Status
I	Span-to-depth ratio	5	18.7 to 34.7	Complete
II	Tendon / passive type	4	40.0	2 of 4 tested

Specimens and Materials

Parameter	Phase I	Phase II
Cross section, b × h	15 × 6 in.	15 × 6 in.
Clear span, L	7 to 13 ft	15 ft
Tendon depth, d_pU	4.5 in.	4.5 in.
L/d_pU	18.7 to 34.7	40.0
Tendons, 2 per slab	3/8 in. strand	Steel 1/2 in. or CFRP 0.425 in.
Effective prestress, f_{se}	155 to 178 ksi	162 ksi steel, 221.6 ksi CFRP
Concrete f'c / Ec	8 to 10 ksi	8.5 ksi / 5,255 ksi
Passive reinforcement	4 #3 mild steel	4 #3 mild steel or #3 GFRP
FRP properties	—	GFRP 123.3 ksi, CFRP 369.4 ksi



03 PHASE I: SLENDERNESS

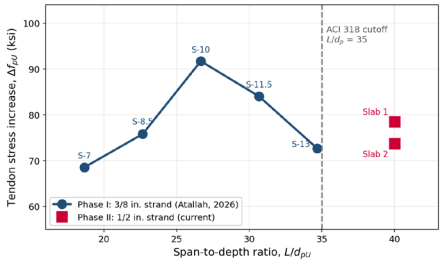
Five slabs identical except in clear span were proportioned to reach approximately the same nominal moment, so differences in response are attributable to slenderness alone. Each was post-tensioned with two unbonded 3/8 in. low-relaxation strands and loaded to failure.

Slab	L/d_pU	F_u (kip)	M_u (kip-in)	f_pU,exp (ksi)	Δf_pU (ksi)
S-7	18.67	24.22	339.2	238.1	68.6
S-8.5	22.67	19.66	334.3	245.5	75.8
S-10	26.67	17.83	356.6	251.6	91.7
S-11.5	30.67	14.91	343.1	245.3	84.0
S-13	34.67	12.76	331.9	241.5	72.7

Cracking and Failure Modes

Slab	Failure mode	Location	$\bar{w}^f$ (in)	$\bar{s}$ (in)	Cracks
S-7	Flexure + crushing	L/2	0.0141	2.46	11
S-8.5	Flexure–shear	L/3	0.0158	3.79	10
S-10	Flexure–shear	Near L/3	0.0181	3.20	12
S-11.5	Flexure + crushing	L/2	0.0188	3.75	13
S-13	Flexure + crushing	Near L/3	0.0211	3.20	15

Crack width at failure grows steadily with slenderness, from 0.0141 in. at L/d_pU = 18.7 to 0.0211 in. at 34.7, and spacing widens from 2.46 in. to roughly 3.2 to 3.8 in. The response shifts from a distributed multi-crack pattern toward a localized hinge, with top-fiber crushing growing more severe as the span lengthens.



Δf_pU against slenderness across both phases. The stress gain is not monotonic: it peaks near $L/d_pU \approx 27$, then declines toward the ACI 318 cutoff at 35.

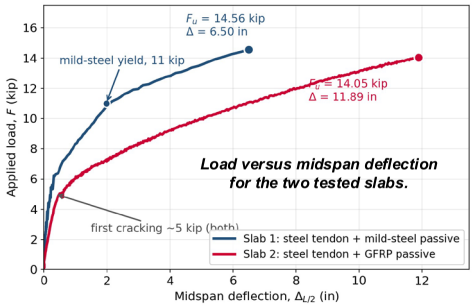
Slab	f_pU,exp (ksi)	ACI 318 (ksi)	Under-predict	AASHTO (ksi)	Under-predict
S-7	238.1	215.0	9.7%	203.6	14.5%
S-8.5	245.5	217.3	11.5%	198.8	19.0%
S-10	251.6	208.2	17.3%	185.2	26.4%
S-11.5	245.3	211.2	13.9%	183.9	25.0%
S-13	241.5	219.3	9.2%	188.6	21.9%

Both codes are conservative throughout and least accurate in the intermediate band around S-10 and S-11.5, where the measured stress gain peaks. That is the same interval in which the governing mechanism appears to change, suggesting the single discrete cutoff in ACI 318 does not capture the transition it is meant to represent.

04 PHASE II: STRAND TYPE

Four slabs at $L/d_pU = 40$, past the ACI cutoff and past the Phase I range, pair steel and CFRP tendons with mild-steel and GFRP passive reinforcement. A load cell at each anchorage reads tendon force directly, so Δf_pU is measured rather than inferred.

Slab	Tendon	Passive	φM_n (kip-in)	Pred. Δf_pU (ksi)	Status
1	Steel	Mild steel	371.8	76.0	Tested
2	Steel	GFRP	339.5	63.8	Tested
3	CFRP	Mild steel	308.1	80.2	Pending
4	CFRP	GFRP	402.5	64.5	Pending

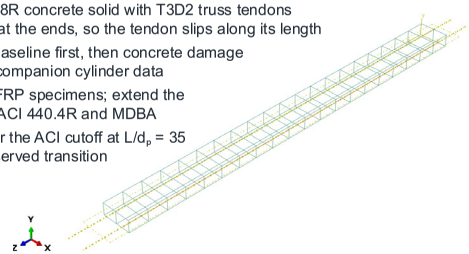


	F_u (kip)	Δ_u at L/2 (in)	M_u (kip-in)	M_u / φM_n	Δf_pU meas. (ksi)	Predicted (ksi)
Slab 1	14.56	6.50	436.7	1.17	78.7	76.0
Slab 2	14.05	11.89	421.4	1.24	73.6	63.8

Both slabs cracked near 5 kip and carried load well past prediction. Replacing mild steel with GFRP removes the yield plateau: Slab 2 stays nearly linear after cracking and reaches almost twice the deflection of Slab 1 at a comparable peak load. At failure the GFRP strain was 3,902 με, only 28% of rupture, so the compression zone governed the peak, not the reinforcement.

05 MODEL AND NEXT STEPS

- ABAQUS: C3D8R concrete solid with T3D2 truss tendons anchored only at the ends, so the tendon slips along its length
- Linear-elastic baseline first, then concrete damage plasticity from companion cylinder data
- Test the two CFRP specimens; extend the comparison to ACI 440.4R and MDBA
- Assess whether the ACI cutoff at $L/d_p = 35$ reflects the observed transition



Acknowledgements: The authors gratefully acknowledge the New Jersey Department of Transportation (NJDOT) for its support and guidance throughout this work. The authors also acknowledge Xiaohua "Hannah" Cheng, Dipen Mehta, Habel Sabu, Hemant Padalia, and other SMEs in the Bureau of Structural Engineering Services. Additional thanks to all undergraduate student in RIME Group for the help on this project

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Full-Scale Accelerated Pavement Testing of a Plastic-Modified Asphalt Mixture

Rowan University
CENTER FOR RESEARCH & EDUCATION IN ADVANCED TRANSPORTATION ENGINEERING SYSTEMS

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CRREL ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

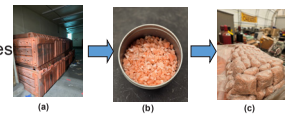
Background & Goal of the study

- Growing interest in using recycled plastics to modify asphalt mixtures addresses both performance challenges and the environmental issue.
- Although having substantial research on plastic modified asphalt binders and mixtures, full-scale accelerated pavement testing performance evaluation and effective incorporation method in plant level to produce plastic modified pavements are yet limited.

Goal of the study: Produce, instrument, and construct full-scale pavement sections using plastic modified Asphalt Mixtures, and evaluate field rutting, fatigue and thermal cracking performance.

Materials & Mix Design

- ♦ Asphalt Binders: PG 64-22
- ♦ Gradation: Type-III 9.5 mm NMAS aggregate gradation (Unified Facilities Guide Specifications: UFGS 32 12 16.16)
- ♦ Two full-scale pavement sections (200 ft × 12 ft × 5 in.)



(a) USPS postal cart (LDPE) (b) Shredded plastics (c) Packing of plastics

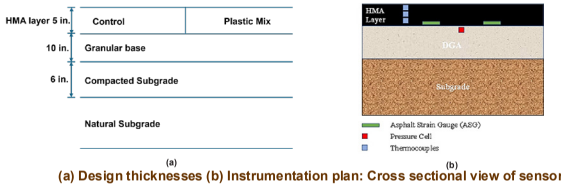
Dry Mixing Methodology



Construction of Field Section

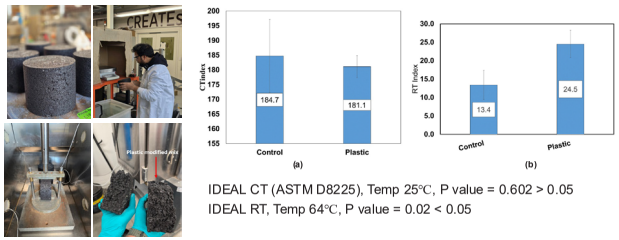


Pavement Instrumentation



(a) Design thicknesses (b) Instrumentation plan: Cross sectional view of sensors

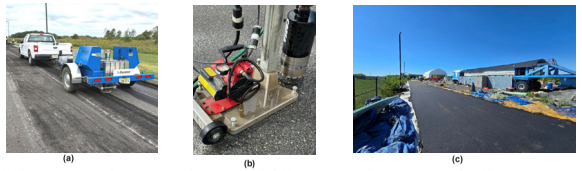
Laboratory Investigation



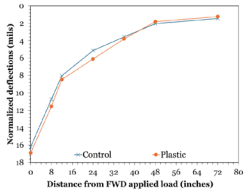
IDEAL CT (ASTM D8225), Temp 25℃, P value = 0.602 > 0.05
IDEAL RT, Temp 64℃, P value = 0.02 < 0.05

(a) IDEAL-CT (b) IDEAL-RT QA/QC tests on control and plastic modified plant mixes.

Performance Monitoring and Evaluation



(a) FWD testing (b) Collection of cores for DCM testing (c)Preparation of HVS loading



Section	D1	D2	D3	D4	D5	D6	D7
Control	16.20	10.72	8.03	5.14	3.56	2.04	1.46
Plastic	16.90	11.54	8.47	6.11	3.79	1.82	1.25

Deflection basin from FWD testing for control and plastic modified section

Conclusions

- Plastic modification improved the rutting resistance more than 150% compared to unmodified (control) section.
- Comparable performance in Intermediate temperature cracking (No statistical significant difference) and FWD structural performance based on average deflection have been observed with control and plastic modified section.

Acknowledgement

This material is based upon work supported by Broad Agency Announcement Program and the U.S. Army Engineer Research and Development Center (ERDC) under Contract No. W913E523C0007. Any opinions, findings conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of Broad Agency Announcement Program and the U.S. Army Engineer Research and Development Center (ERDC).

Improving Signalized Intersection Operations through Signal Timing Optimization: A New Jersey Case Study

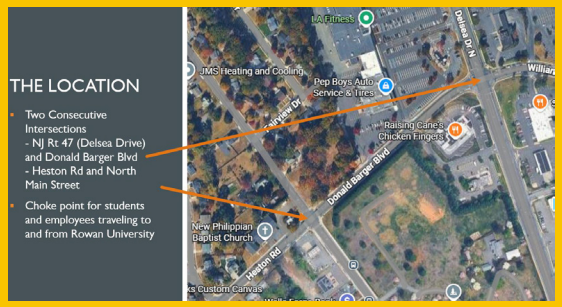
Corinne Beck, Eamon Kinney, Matthew Francis, Nash Appell
Advisor: Fahmida Rahman (rahmanf@rowan.edu), Ph.D.
Department of Civil and Environmental Engineering, Rowan University, NJ 08028

PROJECT NEED AND OBJECTIVE

Poor signal timing can create excessive delay, uneven lane use, and recurring queues. This project tested whether revised cycle lengths and phase splits could improve two consecutive intersections near Rowan University without widening the roadway.

OBJECTIVE: Reduce delay and improve intersection LOS during the AM peak period.

STUDY CORRIDOR



Two intersections in Glassboro, NJ
NJ 47 (Delsea Drive) at Donald Barger Boulevard
North Main Street at Heston Road

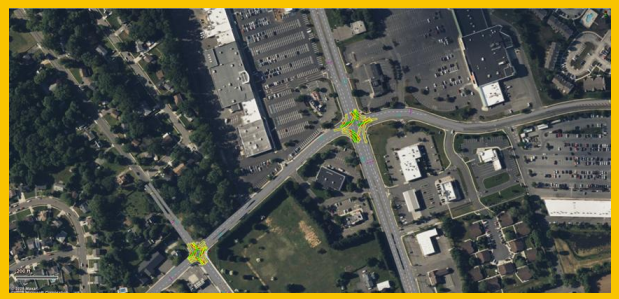
FIELD DATA

- Traffic flow data collected for the AM peak at 15-minute intervals. The dataset included all the turning movements at both intersections.
- Existing phase sequence and signal timing observed in the field
- Fleet composition: 92% passenger cars and 8% trucks

ANALYSIS FRAMEWORK

1. **Collect** — Traffic and Timing Data
2. **Model** — VISSIM Network
3. **Calibration** — GEH Check
4. **Optimize** — Vistro Genetic Algorithm

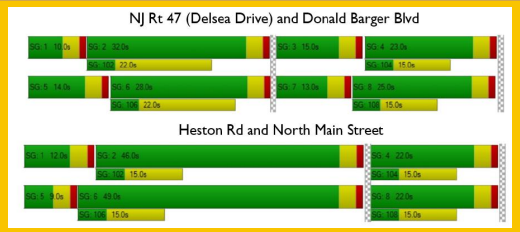
VISSIM MODEL AND CALIBRATION



CALIBRATION
100%
of movements had GEH < 5

GEH RESULTS
Avg. 1.26 • Max. 3.75
Model accepted for scenario testing

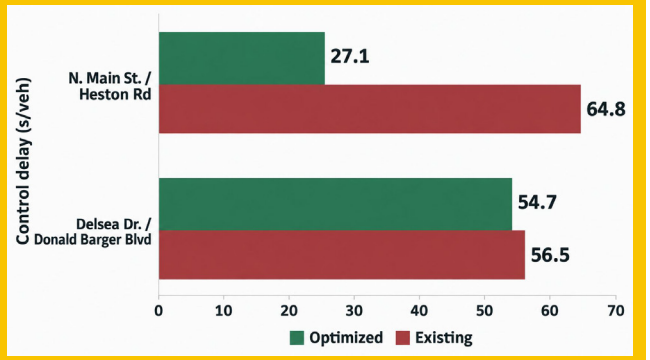
TIMING OPTIMIZATION



PTV Vistro used a genetic algorithm to minimize total network delay by adjusting cycle length and phase splits. The optimized plans shifted green time toward the most congested approaches.

OPERATIONAL RESULTS

Average Intersection Control Delay



DELSEA DRIVE
LOS E to D
3.2% lower delay

NORTH MAIN STREET
LOS E to C
58.2% lower delay

KEY FINDINGS

- The optimized signal timing plan improved overall LOS at both intersections.
- North Main Street showed the largest benefit, cutting average delay by more than half.
- Delsea Drive improved only slightly, indicating that signal timing alone cannot resolve every bottleneck.
- Several movements improved from LOS E or F to LOS C or D.

CONCLUSION AND NEXT STEPS

Signal optimization provided a low-cost operational improvement, especially at North Main Street. Future work should test PM peak demand, evaluate actuated control, and examine geometric or demand-management options for the remaining Delsea Drive bottleneck.

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Influence of Temperature and Seasonal Correction Methods on Falling Weight Deflectometer (FWD) based Overlay Thickness for Asphalt Pavements in New Jersey

Anil Kumar Baditha Ph.D.[(1)], Ayman Ali Ph.D.[(1)], Yusuf Mehta Ph.D.[(1)]
[(1)]Center for Research and Education in Advanced Transportation Engineering System (CREATES), Rowan University,

Background & Goal of the study

- Falling Weight Deflectometer (FWD) testing is widely used in the rehabilitation design of asphalt pavements; however, proper consideration of temperature and seasonal variations significantly influences final overlay thickness.
- Typically, corrections are applied either to measured deflections or to back-calculated layer moduli. Nevertheless, limited research has been conducted on the selection of correction approach affects the final design thickness.
- ***Goal of the study:*** To evaluate the influence of correction approaches (deflection and modulus) on asphalt overlay thickness design for thin pavements, with reference to the standard AASHTO 1993 design procedure.

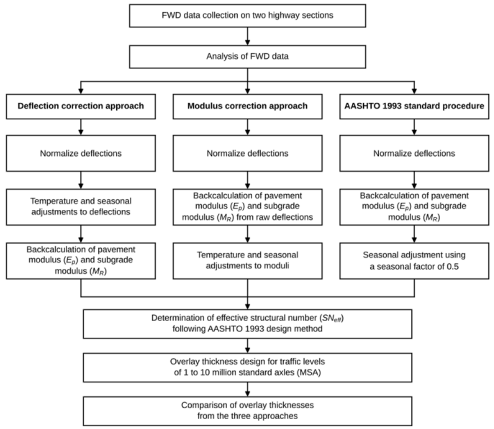
Data Collection

- FWD deflection data were collected from two highway sections in New Jersey, representing thin (<10 inches) pavement classifications as defined in the New Jersey Department of Transportation (NJDOT) FWD manual.
- Pavements are classified as thin if they have an asphalt layer less than 10 inches or a total pavement thickness above the subgrade of less than 30 inches.
- The thin pavement section, located on Interstate-295 Southbound, consisted of a 7-inch asphalt layer over 19 inches of granular base and subbase, yielding a total thickness of 26 inches.
- Another section was NJ-47 northbound section, the thicknesses of the asphalt, granular layers are 4.5 inches and 12 inches,




FWD data collection on I-295 Southbound section

Methodology



Raw Deflection Data

Route	Station	Load (lbs)	Air temp (°F)	Surface temp (°F)	Pavement temp (°F)	Deflections (mils)								
I-295	41.136	9347	75	76	74	9.81	7.42	8.42	7.49	4.97	3.2	2.1	1.48	1.09
I-295	41.136	9355	75	76	74	9.82	7.39	8.41	7.46	4.96	3.2	2.1	1.48	1.1
I-295	41.136	9421	75	76	74	9.97	7.48	8.52	7.58	5	3.22	2.11	1.44	1.11
I-295	41.183	9490	75	75	74	15.71	11.22	12.75	10.91	6.58	3.92	2.44	1.74	1.33
I-295	41.183	9490	75	75	74	15.65	11.19	12.71	10.88	6.56	3.93	2.45	1.75	1.31
I-295	41.183	9509	75	75	74	15.88	11.3	12.84	10.98	6.6	3.93	2.44	1.78	1.3
I-295	41.233	9620	75	75	74	13.07	9.11	10.23	8.62	4.93	2.79	1.65	1.15	0.81

Raw Deflection Data of I-295 Southbound section

Data Analysis and Results

Traffic level	Subgrade Resilient Modulus (psi)				Required Structural number (SN_{req})				Effective Structural number (SN_{eff})				Overlay thickness (inches)				Thickness difference (inches) compared to 0.5-factor design method			
	NJDOT manual		FWD manual		NJDOT manual		FWD manual		NJDOT manual		FWD manual		NJDOT manual		FWD manual		NJDOT manual		FWD manual	
	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus
10	7757.4	3878.7	6957.5	65941	5.01	6.23	5.19	5.28	5.30	5.30	5.04	5.07	NR	2.1	0.3	0.5	-2.1	-	-1.9	-1.6
7					4.76	5.95	4.93	5.02	5.30	5.30	5.04	5.07	NR	1.5	NR	NR	-1.5	-	-1.5	-1.5
5					4.53	5.69	4.70	4.78	5.30	5.30	5.04	5.07	NR	0.9	NR	NR	-0.9	-	-0.9	-0.9
3					4.19	5.30	4.35	4.44	5.30	5.30	5.04	5.07	NR	NR	NR	NR	-	-	-	-
1					3.51	4.52	3.66	3.74	5.30	5.30	5.04	5.07	NR	NR	NR	NR	-	-	-	-

SNeff and Overlay Thickness for the Southbound Section of I-295

Traffic level	Subgrade Resilient Modulus (psi)				Required Structural number (SN_{req})				Effective Structural number (SN_{eff})				Overlay thickness (inches)				Thickness difference (inches) compared to 0.5-factor design method			
	NJDOT manual		FWD manual		NJDOT manual		FWD manual		NJDOT manual		FWD manual		NJDOT manual		FWD manual		NJDOT manual		FWD manual	
	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus	Without factor 0.5	With factor 0.5	Deflection	Modulus
10	5252.4	2646.2	4486.7	4249.4	5.66	6.99	5.96	6.06	3.11	3.11	2.91	2.80	5.8	8.8	6.9	7.4	-3.0	-	-1.9	-1.4
7					5.40	6.68	5.69	5.78	3.11	3.11	2.91	2.80	5.2	8.1	6.3	6.8	-2.9	-	-1.8	-1.3
5					5.15	6.39	5.43	5.52	3.11	3.11	2.91	2.80	4.6	7.5	5.7	6.2	-2.8	-	-1.8	-1.3
3					4.75	5.98	5.06	5.15	3.11	3.11	2.91	2.80	3.8	6.5	4.9	5.3	-2.7	-	-1.6	-1.2
1					4.05	5.15	4.30	4.38	3.11	3.11	2.91	2.80	2.1	4.6	3.2	3.6	-2.5	-	-1.4	-1.0

SNeff and Overlay Thickness for the Northbound Section of NJ47

Conclusions

Overlay thickness: The NJDOT companion-manual approach with the 0.5 seasonal factor gave the largest overlay thickness. Without the 0.5 factor, it gave a higher SNeff and a thinner overlay than the FWD manual methods.

Deflection correction: The FWD manual method gave lower Ep and SNeff than the current NJDOT procedure. NJDOT (AASHTO 1993) corrects deflections for temperature only, while the FWD manual also applies a seasonal correction.

Modulus correction: The FWD manual method also gave lower Ep and SNeff than the NJDOT method, because its seasonal multipliers reduce Ep directly.

Acknowledgement

This study was conducted as part of the Pavement Support Program (PSP), sponsored by the New Jersey Department of Transportation (NJDOT) and awarded to Rowan University. The authors thank NJDOT for its support. The findings of this study are being used to develop NJDOT's FWD manual and guidelines.

Performance Assessment of Composite Plastic Modified and Conventional Polymer Modified Asphalt Mixtures Using the Wet Mixing Method

Lakshmana Ravi Raj Gali [1], Sk Md Imdadul Islam[1], Anil Kumar Baditha Ph.D.[1], Ayman Ali Ph.D.[1], Yusuf Mehta Ph.D.[1], Mohamed H. Elshaer Ph.D.[2], Ben C. Cox Ph.D.[2]

[1]Center for Research and Education in Advanced Transportation Engineering System (CREATES), Rowan University,

[2] US Army Engineer Research and Development Center (ERDC)

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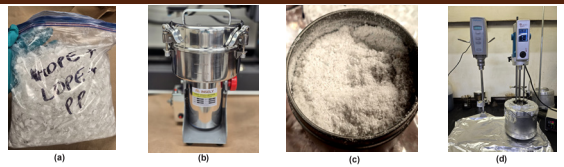
CRREL ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

Background & Goal of the study

- Incorporating recycled plastic into asphalt mixtures for the purpose of road paving presents a promising solution, offering dual benefits of reducing plastic waste and pavement distresses like rutting, fatigue and thermal cracking.
- However, the combined use of composite plastics and stabilizers like Reactive Elastomeric Terpolymer (RET) and has not been thoroughly explored in terms of performance and conventional polymer modified asphalt mixtures.

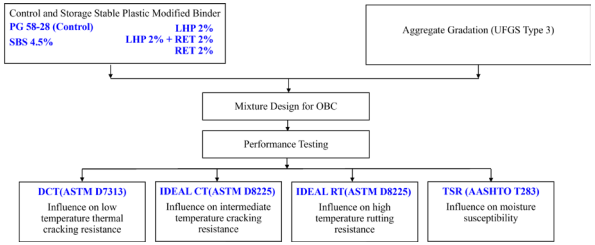
Goal of the study: To assess whether composite plastic-RET modified asphalt mixtures produced in wet mixing process can deliver the comparable mixture level performance of conventional polymer (SBS) modified mixtures.

Materials

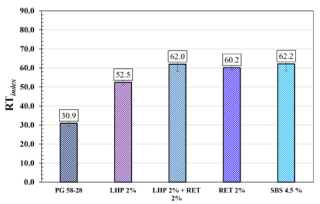


(a) Composite plastic (LHP) (b) Shredding machine (c) Ground Plastics (d) Blending Setup

Experimental Methodology



Results & Discussion: High Temperature Performance

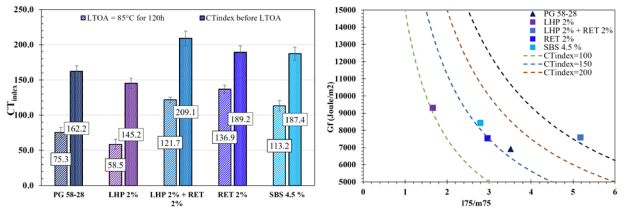


IDEAL-RT results for rutting performance

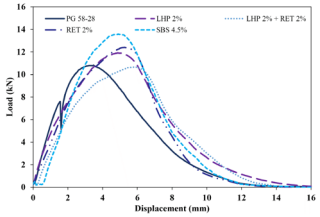


Testing setup of mixtures for IDEAL CT

Results & Discussion: Intermediate Temp. Performance

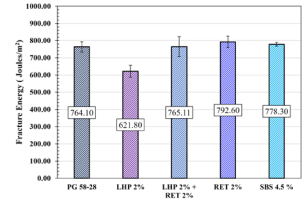


IDEAL-CT test for intermediate temperature cracking resistance at long term oven aged condition



Load vs Displacement curve from IDEAL-CT test to determine crack propagation

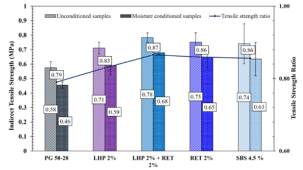
Low Temperature Cracking and Moisture Susceptibility







Fracture energy of asphalt mixtures evaluated at low temperature (-18°C)





TSR and ITS values of control and modified asphalt mixtures

Conclusions

- Composite Plastic-RET modification substantially improved high-temperature rutting resistance, comparable to SBS modified mixtures.
- Plastic alone reduced intermediate-temperature cracking tolerance, whereas the addition of RET increased it by 29% comparing to control.
- All modified mixtures improved resistance to moisture-induced damage relative to the control mixtures.

Acknowledgement

This material is based upon work supported by Broad Agency Announcement Program and the U.S. Army Engineer Research and Development Center (ERDC) under Contract No. W913E523C0007. Any opinions, findings conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of Broad Agency Announcement Program and the U.S. Army Engineer Research and Development Center (ERDC).

Toward Non-Contact Pavement Friction Measurement Using Physics-Informed Deep Learning

Xiaoyu Zhang[1], Hao Wang[2], Thomas Bennert[3]

1. Ph.D. student, Rutgers University; 2. Professor, Rutgers University; 3. Research Professor, CAIT, Rutgers University

RUTGERS Center for Advanced Infrastructure and Transportation

INFRASTRUCTURE POSTERS

Motivation

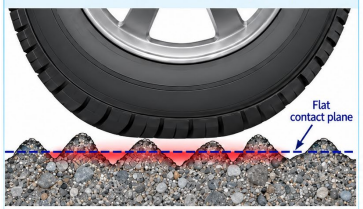
- Pavement friction is essential for vehicle braking and roadway safety.
- Conventional friction measurements rely on inspection vehicles (contact-based, low coverage, time-consuming, traffic control).
- Non-contact, vision/laser-based texture measurement can enable efficient, large-scale friction evaluation



- **Goal:** Develop a physics-informed framework that estimates pavement friction directly from surface texture, enabling future **non-contact and network-level friction assessment**.

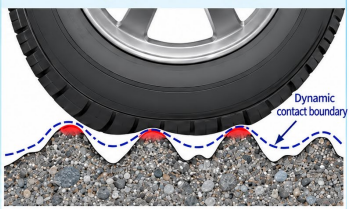
Key Challenge: What Texture Actually Contacts the Tire?

Global flat contact plane
(conventional assumption)



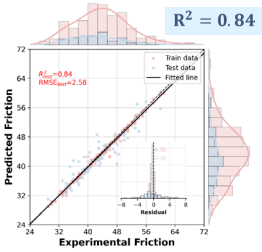
- Single global contact plane
- Ignores local texture variation

Dynamic contact boundary
(proposed concept)



- Contact varies with texture
- Local deformation creates dynamic contact

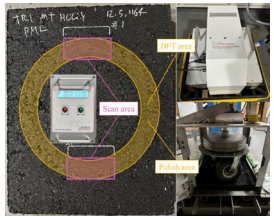
Friction Prediction Results



Comparison with baseline

Models	R^2	RMSE
Proposed	**0.84**	**2.58**
Resnet18 baseline	0.77	3.11
Resnet18+CBAM	0.75	3.34
Global-plane PE-CNN	0.77	3.08

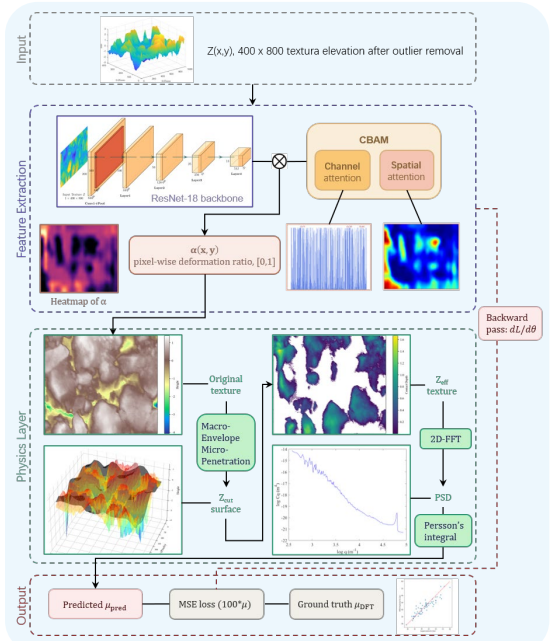
Experiment Program



Laboratory test setup

Key elements:
- Controlled polishing cycles
- Measured DFT friction
- 3D texture laser scanning
- Multiple pavement surface types

Physics-Embedded Deep Learning Framework



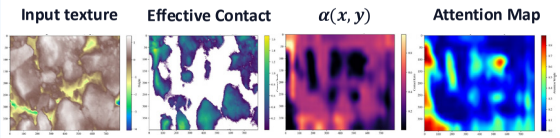
Data-driven feature learning (with attention)

Physics-based contact modeling

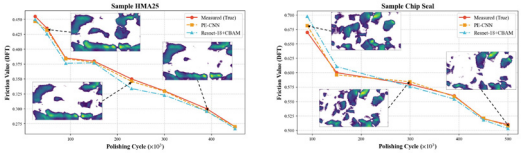
Spectral analysis and friction prediction

Physics is embedded in the network architecture - not just loss penalty.

Physics Guided Contact and Attention



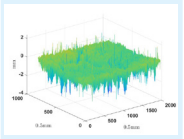
Contact Evolution with polishing



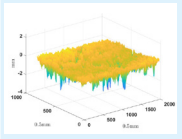
Dataset & Preprocessing

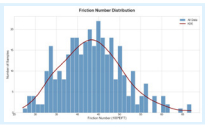
- 3D pavement surface scan with paired friction measurements.
- Process to obtain a clean, aligned surface topography.
- 326 paired data with HMA, SMA, OGFC, HPTO, and chip seal.

Raw 3D texture



Preprocessing
(filtering, alignment)

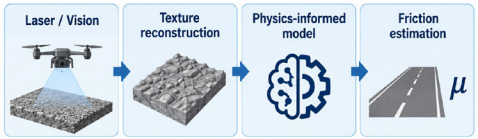




Friction distribution

Key Findings & Future Vision

- Physics-informed deep learning can accurately predict pavement friction with texture.
- Dynamic contact modeling provides a physics-meaningful contact representation.
- Attention mechanism highlights friction-relevant surface features.
- Enabling large-scale, non-contact friction estimation from remote sensing.



Advancing Work Zone Safety with Explainable AI: Evaluating the Effect of Work Zone Presence on Crash Severity

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Introduction

- 891 people died in U.S. work-zone crashes in 2022 (FHWA, 2024)
- Work zones raise crash frequency, but their effect on crash severity is mixed
- Prior ML/SHAP studies explain severity predictions inside work zones, not the effect of work-zone presence
- Unanswered: where and when do work zones make crashes worse?

Objectives

- Measure whether work zones make crashes more or less severe on average, using six different methods.
- Estimate the work-zone effect for every crash, including where it happened.
- Find what drives that effect and map where work zones help or hurt.
- Check that the results hold up, and turn them into simple rules for work-zone traffic control

Methodology

- 934,860 NJDOT crashes, 2019-2025; 14,803 in construction, maintenance or utility zones
- Outcome: any injury (KABC); fatal/serious (KA) and 5-level KABCO as checks
- 425,316 geocoded crashes; overlap sample keeps 97.4% of work-zone crashes

Methodology

1. **COMPARE** Six methods test if work zones change injury risk
2. **ESTIMATE** An effect for every crash, including its location
3. **EXPLAIN** What makes a work zone more or less harmful
4. **MAP** Where work zones help and where they hurt
5. **CHECK** Re-test on newer data and repeated model runs
6. **ACT** Turn results into simple traffic-control rules

Validation & Reliability

- Temporal holdout (zones from 2019-2021, tested on 2022-2025): hot +0.60 pp, elsewhere -1.71 pp, cold -3.82 pp; the ordering holds
- SHAP importance stable across refits (ρ = 0.94); single-crash effects less so (ρ = 0.58)
- E-value 1.39: hidden confounding could shift the small average, so conclusions rest on the pattern

Result 1 · Work Zones Protect, on Average

-1.75 pp
injury probability
(causal forest, doubly robust)

OR 0.82
fatal / serious injury
(adjusted logit)

6 of 6
estimators agree
in direction

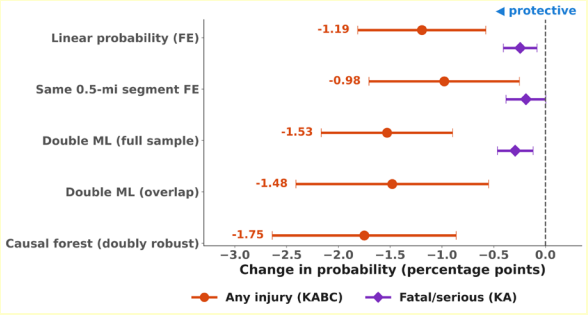


Figure 1. Work-zone effect across estimators (95% CI). Every estimate is below zero.

Result 2 · When Protection Vanishes

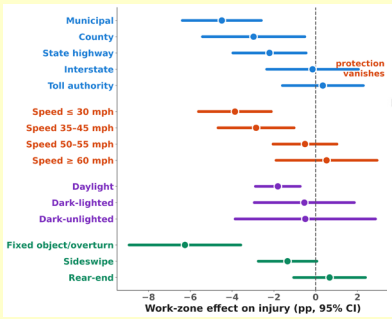


Figure 2. Average work-zone effect by subgroup (double ML)

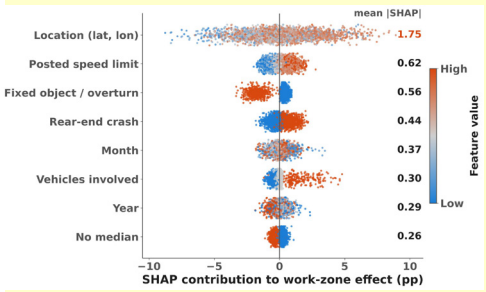
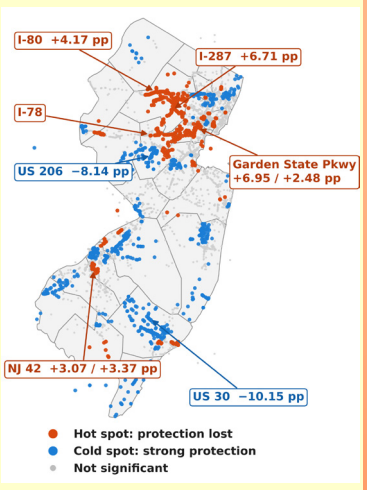


Figure 3. SHAP on the causal effect τ(x): what makes a work zone more harmful

Effect becomes more harmful on **interstate/toll roads (×1.26)** and **after dark (×1.18)**; location is the **#1 driver (29% of attribution)**

Result 3 · Where: GeoXAI Hot Spots



Corridors in significant clusters

Corridor	County	τ(x), pp
Garden State Pkwy	Union	+6.95
I-287	Morris	+6.71
I-80	Morris	+4.17
NJ 42	Gloucester	+3.37
NJ 42	Camden	+3.07
Garden State Pkwy	Essex	+2.48
US 30	Atlantic	-10.15
US 206	Somerset	-8.14
US 46	Passaic	-4.74
NJ 18	Middlesex	-4.22

Hot spots: 52 mph avg., 64% interstate/toll
Cold spots: 44 mph avg., 22% interstate/toll

IF speed limit ≥ 55 mph **AND** a rear-end crash, **THEN** injury risk rises (+1.27 pp)

From Explanation to Action

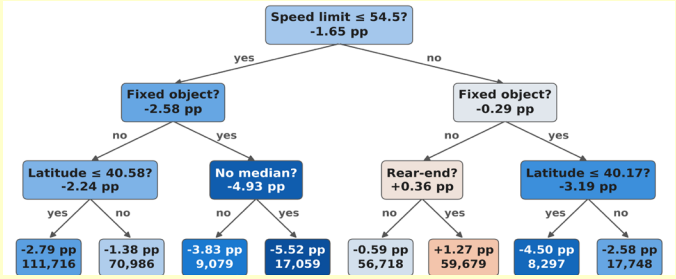


Figure 5. Effect tree. Only harmful leaf: speed ≥ 55 mph + rear-end (+1.27 pp)

- Prioritize **≥ 55 mph corridors**: GSP, I-80, I-287, I-78, NJ 42
- **Queue-end warning** & speed harmonization for rear-end risk
- **Night work:** stronger lighting & conspicuity
- Use hot/cold layers when **scoping projects**

Conclusions

- On average, work zones lower injury probability by about 1.75 pp
- The benefit disappears at ≥ 50 mph, on freeways, at night and in rear-end crashes
- Location matters most: protection is lost on GSP, I-80, I-287 and NJ 42
- Traffic control needs reinforcement on ≥ 55 mph corridors, especially for rear-end crashes and night work
- Limitations: no traffic-volume or lane-closure data used
- Next step: test warning signs and step-down speed limits

An Explainable AI Framework for Identifying High-Risk Pre-Crash Driver Behaviors, Crash Mechanisms, and Incident Pathways in Heavy Commercial Vehicle Crashes in New Jersey

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Introduction

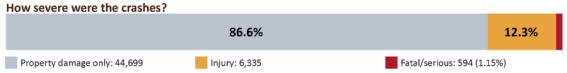
- Across the U.S., **5,472 people died** in crashes involving large trucks in 2023, and 70% of them were people in other vehicles (NHTSA).
- In New Jersey, **62 people died** in large-truck crashes in 2023, and 51 of them (82%) were not in the truck (NHTSA FARS).
- Crash reports record what drivers were doing, what contributed, what happened, and the road setting, but these pieces are **rarely studied together**.
- This study **linked driver actions, causes, crash events, and road conditions** to trace the most common paths from a driver action to a crash event.
- The consistency of the main findings was also assessed after adjusting for **traffic volume, speed limits, and road type** to ensure that the results were not solely attributable to heavier traffic.

Objective

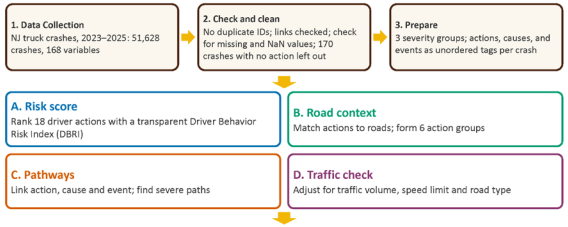
- Find which **pre-crash driver actions** are most often linked to fatal or serious crashes.
- Show **where** these actions happen, by road type, speed limit, and traffic level.
- **Trace common paths** from driver action to the cause of a crash event and spot severe ones.
- Turn the findings into **simple, practical recommendations** that agencies can test to make roads safer.

Data

3 years	51,628	168	77
2023–2025, New Jersey	HCV crashes (rows)	variables (columns)	crash tags: 18 driver actions, 28 factors, 31 events



Methodology



Results

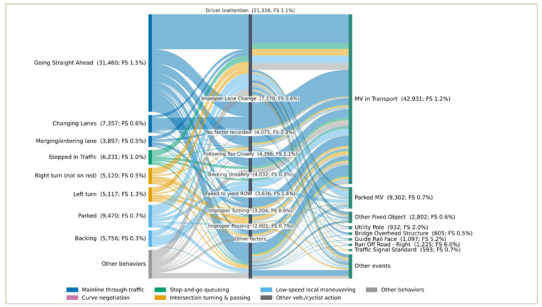


Figure 1. How crashes flow from driver action (left) to cause (middle) to crash event (right). Wider bands mean more crashes.

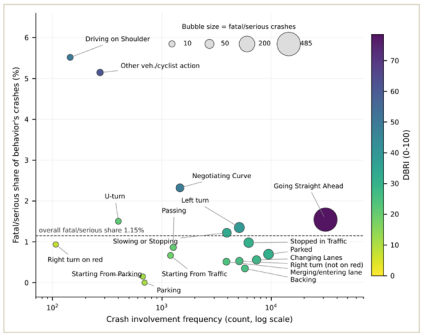


Figure 2. Which driver actions matter most. Higher means a bigger share of severe crashes; further right means more crashes.

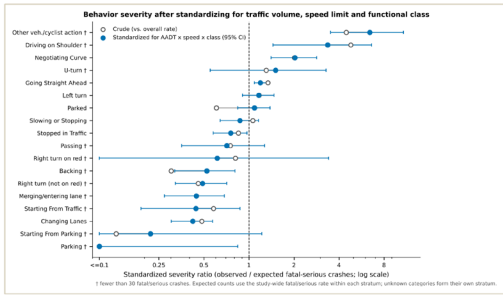


Figure 3. Severity after adjusting for traffic, speed limit and road type. Dots right of 1 mean more severe crashes than expected.

Results (continued)

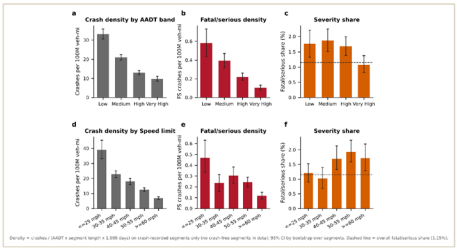


Figure 4. Crashes per 100 million vehicle-miles fall as traffic grows, so busy roads are not riskier per mile driven.

Findings

- Going straight ahead is in **8 of 10 severe crashes**.
  Possible reason: *It is what trucks do most of the time, often on fast roads.*
- After adjusting for traffic and roads, going straight adds only a **small extra risk**.
  Possible reason: *Its high rank mostly comes from how often it happens (Figure 2).*
- **Curves, shoulder driving,** and **other drivers' or cyclists' actions** go with more severe crashes.
  Possible reason: *High speed and little room to recover.*
- **Distraction with leaving the lane** is the worst path: about 1 in 7 crashes is fatal or serious.
  Possible reason: *Leaving the road at speed leads to rollovers and crossing into traffic.*
- **Backing, parking, and lane changes** are common but rarely severe.
  Possible reason: *They happen at low speed.*
- Parked trucks only look safe because they are on **slow local streets**.
  Possible reason: *After adjusting for road type, the safety gap disappears.*
- Busy highways have **more crashes, but not more per mile driven**.
  Possible reason: *They simply carry far more traffic.*

Recommendations

What we found	Idea to test	Severe
Distracted driver leaves the lane	Rumble strips; provide shoulders and barriers; enforcement and education against distraction	13–15%
Speeding on highways	Speed management, enforcement, variable speed limits	7.0%
Speeding into stopped traffic	Queue-warning signs; auto-braking	7.5%
Sharp curves	Curve signs; high-grip pavement	6.9%
Running red lights	Signal enforcement; check yellow timing	6.2%
Other drivers' actions (night, work zones)	Better lighting and work-zone setup	5.2%
Unsafe lane changes	Blind-spot assist; driver training	4.7%
Left turns without yielding	Protected left-turn signals	3.6%

Acknowledgement

- We are grateful to "NJDOT AASHTOwaresafety" for providing us with the data for this analysis.

Enhancing State DOT Work Zone Safety by Integrating Internal Traffic Control Plan

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Introduction

- In 2023, a total of 898 people were killed, and 40,170 were injured in work zone crashes in the United States.
- Work zone crashes are further estimated to result in more than $38.9 billion per year in damages and losses.
- By analyzing worker fatalities at road construction sites from 2011 to 2022, it is found that 12% of the workers are killed by contact with objects or equipment, 47% are killed by being struck by vehicles (2 in 10 workers are killed by dump trucks), and 28% by other transportation incidents, including driving to and from the site.
- Internal Traffic Control Plans (ITCPs) are designed to manage these internal movements and reduce conflicts between workers and equipment.
- This study evaluates the feasibility and potential benefits of integrating ITCPs into state-level work zone safety practices.
- Through a combination of literature review and expert interviews with state agencies, researchers, contractors, and industry leaders, the study investigates current practices, implementation challenges, emerging technologies, performance metrics, and cost-benefit analysis that can enhance internal traffic control.
- The findings contribute to establishing the recommendations associated with this study.

Table 1: Comparison of ITCP, TCP, and TMP

Plan	Area	Focus	Movement	Includes
Internal Traffic Control Plan (ITCP)	Work areas not open to public traffic	Internal movements	Workers, equipment, passengers	Movements in work areas
Traffic Control Plan (TCP)	Areas outside and adjacent to ITCP	Public traffic and pedestrians	Entry and exit through work zone	Safe traveler movement; not internal work patterns
Traffic Management Plan (TMP)	Regional / area level	Impact of TCP	Travelers through or around project	Detours, alternatives, community outreach

Research Methodology

- Three primary components: literature review, expert interviews, and thematic analysis of responses.
- Existing literature related to work zone safety, TCPs, TMPs, and ITCPs, including guidance documents from federal agencies, industry standards, academic research publications, and state DOT manuals was reviewed to understand current work zone safety practices and identify gaps related to internal traffic control planning.
- Structured interviews were conducted with representatives from state DOTs, academic institutions, technology providers, and national safety organizations that can be divided into three sections: interview questionnaire design, reaching out to interviewees, and the interview process.
- The collected data were then analyzed using a qualitative thematic analysis approach, identifying common patterns, best practices, and implementation challenges, and these findings were used to develop recommendations for improving ITCP integration within existing work zone safety frameworks.

State of the Art Practices

- ITCP implementation is not uniformly mandated across states, and enforcement often depends on contractor practices or internal company safety policies.
- Only one state DOT (Michigan DOT) requires ITCP in their work zone safety and mobility manual, indicating that the responsibility of developing ITCP is transferred to the contractor.
- Another state DOT only mentions ITCP as their best practices but has no requirements (Colorado DOT).
- Ajax Paving is one of the contractors that promote and develop ITCP documentation outlining how workspaces are organized to manage the movement of construction vehicles, equipment, and workers safely within a job site.
- Benefits of ITCP can be summarized from the literature: reduction of worker–vehicle conflicts (50 or 60 fatalities every year due to internal work zone crashes), enhanced communication and training (including direct communication between spotters and workers), improving traffic flow (designating safe routes).

Analysis and Results

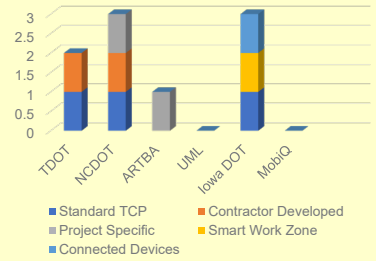


Figure 1: ITCP/TCP models used by agencies

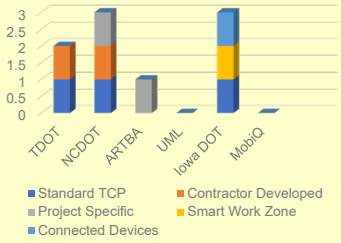


Figure 2: ITCP/ TCP model types implemented by agencies

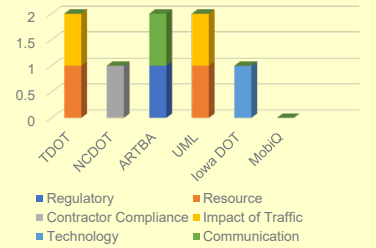


Figure 3: ITCP/ TCP implementation challenges by agencies

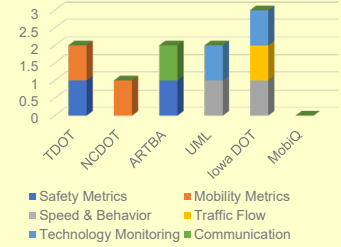


Figure 4: Type of performance metrics used by agencies

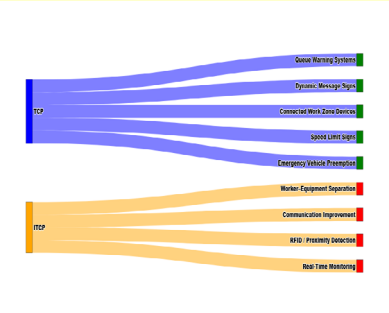


Figure 5: Sankey Diagram of best practices and technologies differentiated for TCP and ITCP

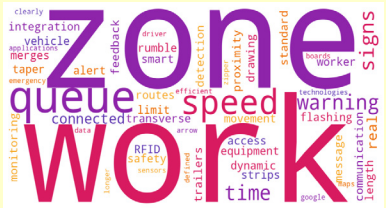


Figure 6: Word Cloud of best practices and technologies of TCP and ITCP

Discussion

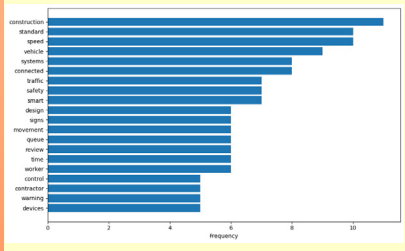


Figure 7: Top content words in responses (technology-enabled traffic control is recurring theme)

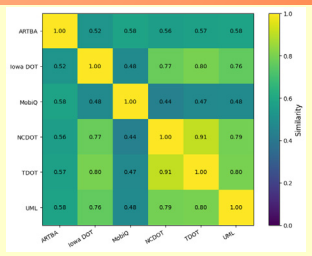


Figure 8: Cosine similarity between responses in different agencies

Recommendations

- Establish policy for ITCP
- Follow FHWA 8-step guidance
- Implement worker detection technologies
- Establish a clear communication protocol

Acknowledgement

- This study is supported by New Jersey Department of Transportation (NJDOT).

From Crash Data to Action: An Agentic AI Framework for Segment-Level Crash Frequency Prediction

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Predict → explain → verify → act: an agentic AI that forecasts monthly crashes on every NJ Interstate segment, tells the engineer why, checks its own text, and learns from feedback.

1 Why X-SAFE?

- **Problem.** Finding and fixing high-crash road segments still takes many separate manual steps.
- **Gap 1: no reasons.** Accurate machine-learning models do not say why a segment is risky.
- **Gap 2: no proof.** AI chatbots write clearly, but can state numbers the data do not support.
- **Gap 3: no link** from a crash forecast to a checked diagnosis and a proven countermeasure.

What X-SAFE adds

1. **One pipeline** from crash records to a countermeasure
2. **The reasons** behind every forecast, variable by variable
3. **A Verifier** that checks every number the AI writes
4. **Engineer feedback** reused as lessons, no retraining
5. **Ready for new data:** AI suggests, analyst confirms

2 Data

862	137	169k	47%
Interstate segments (1 mile, by direction)	months, 2010 – May 2021	crashes matched to segments	segment-months with no crash

- **3.29 million** NJ police crash reports, 2010–2022.
- **Strict matching:** a crash is kept only if its location, route and travel direction all match a segment.
- **61 factors** in 8 groups: road design, traffic, crash history, crash types, season, driver behavior, weather, facility.

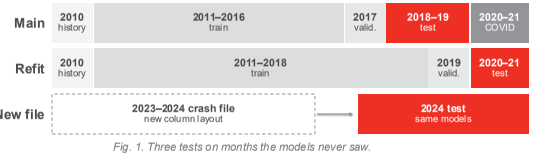


Fig. 1. Three tests on months the models never saw.

3 Models compared

HA	SPF-NB	LightGBM	CGA-NB
12-month crash average	Highway Safety Manual	boosted decision trees	proposed model
simple baseline	road + traffic only	accurate, black box	accurate and self-explaining

$$\ln \mu = \text{offset} + \beta_0 + \Sigma_g f_g(x_g), \quad y \sim NB(\mu, \alpha)$$

- **CGA-NB:** one small neural network per factor group; their effects are added, so each group's share of the forecast is exact.
- **Why CGA-NB:** within 1% of the most accurate model (LightGBM) on validation data, and it explains itself.
- **Reasons as factors:** ×1.45 means 45% more expected crashes than a typical segment-month (SHAP).

4 X-SAFE agentic framework

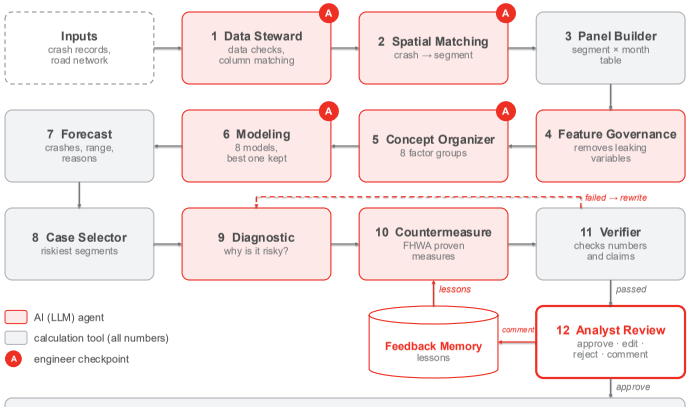


Fig. 2. The AI writes; calculation tools compute and check every number.

5 Example: I-280 WB, MP 14.1–15.1, Dec 2019

13.2	3–27	Top 1%	Very high
predicted crashes	90% range	of all segments	risk class

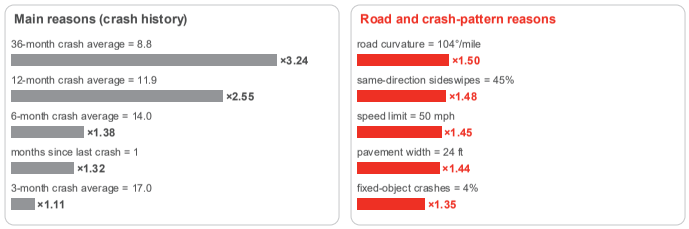


Fig. 3. How much each factor raises the expected crashes at this segment (SHAP).



Learning without retraining: the lesson goes into the AI's instructions; the forecast and its reasons do not change.

6 Results

0.96	0.98	93%	98%
average error, crashes per segment-month	ranking agreement (Spearman ρ)	of the top-5% hotspots found	of outcomes inside the 90% range

CGA-NB, test years 2018–2019, 862 segments

As accurate as LightGBM on 2018–2019 and the most accurate model in every later test, while explaining each forecast.

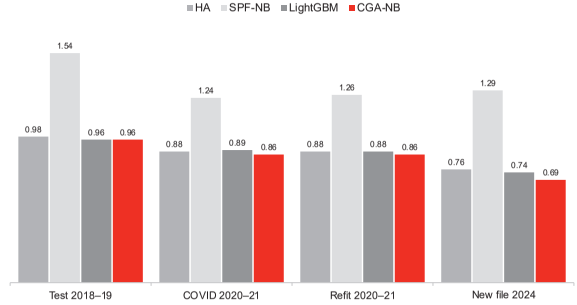


Fig. 4. Average error (MAE) by model and test; lower is better.

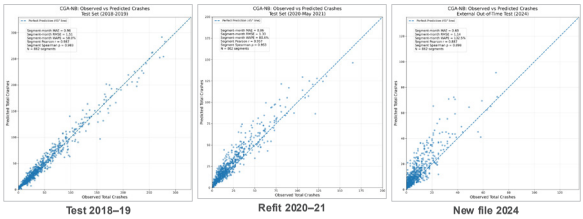


Fig. 5. CGA-NB observed vs. predicted crashes per segment.

- **COVID years:** ranking holds, but hotspots found drop from 93% to 81%; re-estimate after big changes.
- **New 2024 file:** ranking holds (ρ ≈ 0.90), but all models over-predict, as late-2024 reports are still incomplete; recalibrate first.

7 Take-home messages

- **Accurate and explained:** no trade-off between accuracy and reasons.
- **Trustworthy AI text:** every number is checked before an engineer sees it.
- **Next:** recover more crashes, add traffic and weather data, expert review, NJ state highways.

A Visual Driving Rule-Based (VDR) Car-Following Model based on Dynamic Visual Features

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Rutgers, The State University of New Jersey

DIGITAL TRANSFORMATION

Abstract

Conventional car-following models describe driver response using physical variables such as spacing, relative speed, and ego speed, although drivers regulate their motion through imperfect visual perception. This study develops a Visual Driving Rule (VDR) car-following model based on the preceding vehicle's perceived visual width, its expansion rate, optical flow rate, and vehicle class. The model parameters vary across visual perception and across drivers. Camera projection provides interpretable relationships between the visual variables and physical traffic states. The analysis explicitly represents persistent bias and noise in perceived visual width, expansion rate, and optical flow, and examines how these errors interact with model parameters to affect traffic flow stability. Approximately 170 minutes of naturalistic dashcam data from four drivers are used to characterize visual features and to estimate optical flow directly from driving video. 30,000 car-following events detected by roadside LiDAR (Light Detection and Ranging) provide high-quality physical trajectories for camera projection calibration and model parameter estimation. The results show that the proposed model reproduces trajectories for both passenger-car and heavy-vehicle leaders and yields lower speed errors than the reference models. The stability analysis is conducted to explore the impact of visual perceptions on traffic flow stability. This framework connects empirical visual perception, heterogeneous driver response, and traffic stability within one interpretable car-following model.

Keywords: Car-Following Model, Camera Projection

Introduction

Problem Statement

- Car-following models play a foundational role in traffic flow theory. Most car-following models typically rely on three key inputs: the spacing headway, the relative speed, and the ego vehicle's own speed.
- However, human drivers do not perceive spacing and relative speed directly through precise physical measurements.

Research Motivations

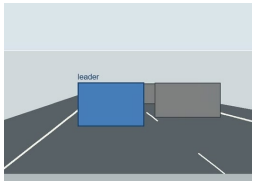
- Advances in Computer Vision technologies and data collection technologies.
- Emerging trend in vision-based self-driving and 3D traffic simulation.

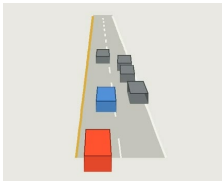
Research Goal

- Develop a human-like car-following model driven by comprehensive visual information, reflecting how human drivers perceive and react to surrounding traffic.
- Seeks to bridge the gap between human perceptual models and machine-driven car-following systems.
- Contribute both to microscopic traffic flow theory and to the development of more human-like, vision-based ADAS technologies and traffic simulations.

Research Contributions

- Advance understanding of vision-based driver perception and its role in car-following behavior.
- Support the development of vision-based collision avoidance algorithms for intelligent vehicles.
- Enable next-generation 3D traffic and sensor simulation through visual information modeling.
- Introduce a novel, low-cost data collection method using dashcams or mobile devices





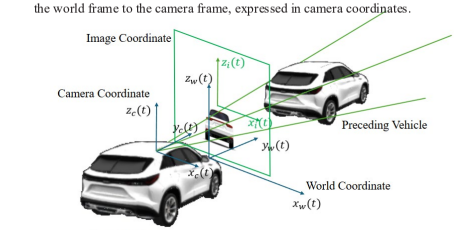
Methodology

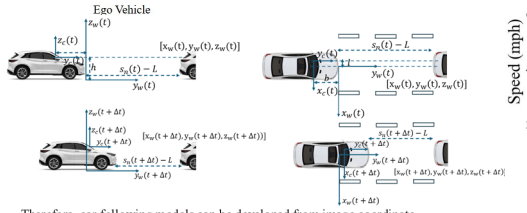
Coordinate Transformation (World Coordinates -> Image Coordinates)

- Every point from 3D world coordinate system has a corresponding point in 2D image coordinate system
- The relationship can be established using the matrix transformation

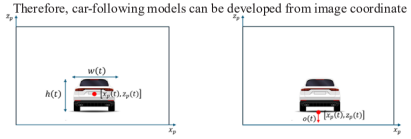
$$X_c = R_{cw}X_w + t_{cw}$$

where X_c is coordinates of a point in the camera coordinate system. X_w is coordinates of the same point in the world coordinate system. R_{cw} is rotation matrix transforming coordinates from the world frame to the camera frame. t_{cw} is translation vector from the world frame to the camera frame, expressed in camera coordinates.





Therefore, car-following models can be developed from image coordinate



Traditional Car-Following Formula	Visual Car-Following Formula
$a_n(t+\tau) = f(s(t), \Delta v(t), v(t))$	$a_n(t+\tau) = f(w(t), \dot{w}(t), o(t))$
$a_n(t+\tau)$: acceleration/deceleration of driver n at time $t+\tau$	$a_n(t+\tau)$: acceleration/deceleration of driver n at time $t+\tau$
τ: reaction time	τ: reaction time
$s(t)$: spacing headway at time t	$w(t)$: perceived visual width at time t
$\Delta v(t)$: relative speed at time t	$\dot{w}(t)$: perceived visual expansion rate at time t
$v(t)$: ego speed at time t	$o(t)$: perceived optical flow rate at time t

Proposed Visual Driving Rule (VDR) car-following model

$$a_n(t+\tau) = K_p\left[\frac{1}{w(t)} - \frac{o(t)}{K}\right] - K_d\frac{\dot{w}(t)}{w^2(t)}$$

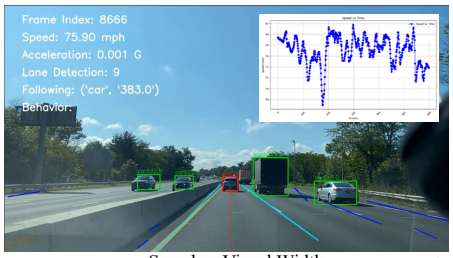
K_p: proportional gains applied to the visual width of the leading vehicle

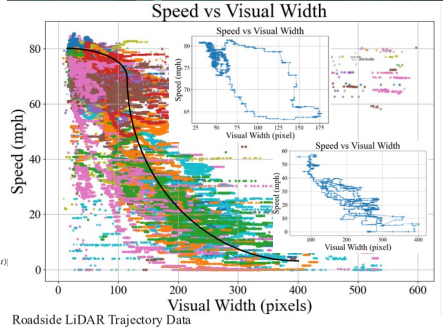
K_d: derivative gains applied to the visual expansion rate of leading vehicle

K: driver's following aggressiveness in perceptual space, determining the desired visual width for a given optical flow rate. Larger K corresponds to more aggressive driving with smaller following spacing, while smaller K corresponds to more conservative driving with larger following spacing.

Real-World Data

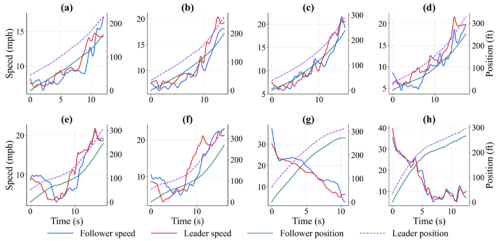
Naturalistic Driving Data (Dashcam + Mobile Sensor)





Roadside LiDAR Trajectory Data





Model Performance

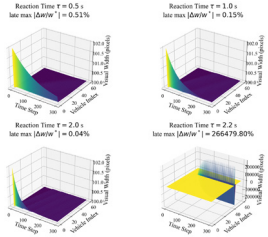
The proposed VDR model was compared with the Intelligent Driver Model (IDM) and the Optimal Velocity Model (OVM)
The proposed VDR model produced the lowest speed RMSE for both following-car and following-heavy-vehicle events

Leader Class	VDR	IDM	OVM
	Speed RMSE (mph)		
Car	2.409	2.960	4.668
Heavy Vehicle	2.092	3.309	4.444

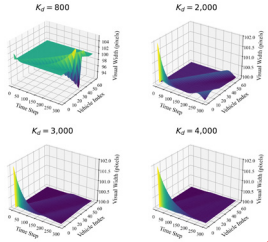
Stability Analysis

We perform stability analysis to evaluate how small perturbations from equilibrium propagate through a platoon and determine whether small perturbations decay or amplify over time

- For example, if the reaction time is large, it tends to lead to more unstable conditions. This aligns with the theory that large delays in driver response can destabilize traffic flow



- If the derivative gain K_d is large, it tends to lead to more stable conditions. As K_d increases, the vehicle becomes more responsive to changes in the visual width expansion rate, reducing perturbation growth and improving traffic stability



Conclusion and Future Work

- Proposed a visual car-following model that models driver perception-reaction using visual cues instead of physical measurements.
- Calibrated the model using naturalistic driving data and LiDAR trajectories.
- Evaluated the model by comparing it to well-known traditional models.
- Conducted stability analysis and numerical simulations to validate the model's ability to reproduce realistic traffic phenomena.
- Future work: expand this model to include more visual inputs, including braking light, neighboring lane traffic, depth perception, etc. Expand the stability analysis to include a nonlinear relationship between visual perception and following distance.

AI-Driven Climate Resilience Scoring for Bridges: A Digital Transformation Framework for the Future of Transportation

Presented at NJDOT 2026 Research Showcase by: Indira Prasad, PhD (C), Department of Civil, Environmental and Ocean Engineering, Stevens Institute of Technology, iprasad@stevens.edu Research Advisor: Dr. Yi Bao

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Context & Motivation

Bridge inspection and climate-resilience assessment are entering a new era of engineering intelligence, where AI systems turn decades of inspection records, climate projections, and geospatial data into meaningful, actionable insights. As extreme weather intensifies and infrastructure ages, agencies face growing pressure to evaluate structural performance not only through traditional inspections but through predictive, data-driven resilience analysis. This motivates the development of an *AI-driven climate scoring pipeline* for resilient infrastructure

Modern AI tools spanning machine learning, computer vision, natural language processing, and digital-twin modeling enable engineers to automatically detect defects, interpret unstructured inspection notes, map hazard exposure, and forecast deterioration under future climate conditions. These capabilities shift the workflow from reactive maintenance to anticipatory planning, allowing agencies to identify vulnerable components early, prioritize interventions, and optimize resource allocation.

This poster introduces an AI-driven climate resilience scoring framework that integrates NBI history, climate hazard layers, and GIS-based exposure mapping into a unified analytical pipeline. It demonstrates how AI-enabled workflows can streamline inspection operations, reduce uncertainty, and support corridor-level resilience planning. By combining engineering judgment with intelligent analytics, we lay the foundation for scalable, climate-smart infrastructure systems that strengthen statewide transportation resilience in the era of digital transformation.

AI-Driven Climate Scoring Pipeline

The climate-resilience scoring pipeline brings together several streams of information that engineers already rely on for inspection history, climate projections, and geospatial hazard layers—and organizes them into a single, practical workflow. Instead of treating these datasets separately, the pipeline aligns them so patterns in deterioration, climate exposure, and structural behavior become easier to interpret.

- Brings together NBI history, climate projections, and GIS hazard layers.
- Aligns multi-source data so deterioration trends and climate exposure can be compared consistently.
- Uses **machine-learning** models to spot early climate-sensitive components.
- Applies **computer-vision** tools to highlight defect patterns in imagery
- Interprets inspector notes with **natural language processing** methods to capture details beyond numerical ratings.
- Produces structure-level resilience scores and hazard-specific indicators

DATA + AI + ENGINEERING = RESILIENT BRIDGES

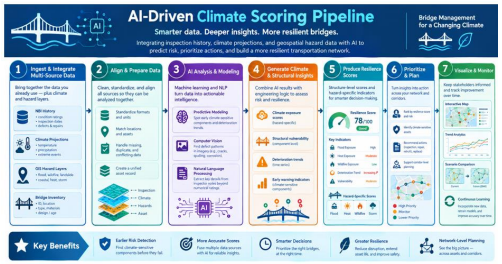


Figure 1: AI-driven Climate Scoring Pipeline integrating inspection, climate, and geospatial data for resilience analysis.

Climate and Geospatial Data Integration

- We bring climate projections together with GIS hazard layers to show how these datasets directly shape exposure assessments at the structure level.
- Temperature extremes, freeze–thaw cycles, heavy rainfall, storm surge, and mapped flood zones are tied back to actual bridge locations.
- Spatial analysis helps capture things like hazard proximity, elevation, land cover, and watershed context.
- These climate and geospatial layers are then translated into features the AI models can interpret.
- The results support corridor-level resilience mapping and statewide vulnerability assessments.

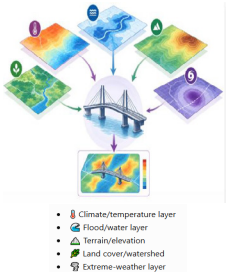


Figure 2. Conceptual illustration showing how climate and geospatial hazard layers integrate to create bridge-level exposure maps. Legend: temperature, flood, terrain, land cover, extreme weather.

Smarter Decisions, Stronger Resilience

Integrating AI and digital transformation is reshaping how transportation agencies manage climate risk. Instead of reacting to damage, agencies can anticipate vulnerability, prioritize interventions, and strengthen bridge networks through data-driven foresight. The framework integrates machine learning, computer vision, and NLP models to translate inspection and climate data into predictive resilience insights.

The following strategies illustrate how smarter decisions support stronger resilience:

- **Identify early deterioration** using AI models trained on climate, GIS, and inspection data
- **Centralize inspection and climate datasets** to enable unified, analytics-ready workflows
- **Prioritize maintenance** with predictive scoring from fused AI inputs
- **Automate alerts** for high-risk corridors and structures crossing climate-risk thresholds
- **Develop resilience-focused strategies** informed by long-term hazard projections.

AI-Driven Resilience Scoring Framework

Objective: Transform climate, infrastructure, and geospatial data into an interpretable resilience score that support proactive transportation decision-making.

The AI-driven framework integrates climate exposure, infrastructure characteristics, and geospatial hazard data to generate consistent, interpretable resilience scores for transportation assets.

Table 1: Example Resilience Scoring Output

Resilience Factor	Description	Exposure	Score
Extreme Heat	Temperature-related expansion and material fatigue	High	4 / 5
Freeze–Thaw Cycles	Repeated freezing causing cracking and stress	Moderate–High	4 / 5
Wind Stress	Potential impacts on bridge and elevated structures	High	5 / 5
Storm Surge / Flooding	Vulnerability to coastal and riverine flooding	Moderate	3 / 5
Precipitation Intensity	Drainage load and corrosion risk	High	4 / 5
Traffic Load Stress	Operational demand and network importance	Very High	5 / 5
Infrastructure Age	Potential deterioration associated with aging assets	High	4 / 5

OVERALL AVERAGE RESILIENCE SCORE 4.1 / 5.0



ustrative Transportation Infrastructure Asset.:
limate, infrastructure, and network indicators are integrated to an AI-driven resilience assessment framework to support roactive transportation planning and risk-informed decision-aking

Human-AI Collaboration for Climate-Resilient Planning

Objective: Combine AI-driven resilience assessments with expert judgment to support transparent and informed transportation planning decisions.

AI systems rapidly analyze climate, infrastructure, and geospatial datasets to identify vulnerabilities and resilience risks. Transportation professionals then evaluate these insights using engineering expertise, local knowledge, policy and regulatory requirements, and operational priorities.

Benefits of Human-AI Collaboration:

- AI rapidly processes large, complex, multi-source datasets.
- Experts validate recommendations using real-world context.
- Human oversight improves transparency and accountability.
- Collaborative workflows support infrastructure investment and adaptation strategies.
- Explainable insights enable more confident resilience decisions



Figure 6. Human-AI Collaboration Framework for Climate-Resilient Transportation Planning.

AI-Powered Pathways to Climate Resilience

Climate change is intensifying stresses on bridge infrastructure through extreme temperatures, heavy precipitation, freeze-thaw cycles, and severe weather events. By integrating multi-source infrastructure data with AI-driven analytics, transportation agencies can identify vulnerabilities, prioritize risks, and improve resilience planning. The resulting decision-support framework enables proactive maintenance, optimized resource allocation, risk-informed mitigation, corridor-level planning, and long-term adaptation of transportation assets.

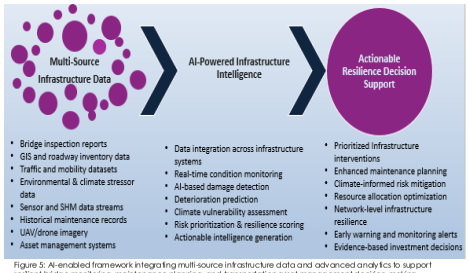


Figure 5: AI-enabled framework integrating multi-source infrastructure data and advanced analytics to support resilient bridge monitoring, maintenance planning, and transportation asset management decision-making.

Digital Transformation for Climate-Smart Infrastructure

Digital transformation is reshaping how transportation agencies monitor, assess, and manage critical infrastructure. By integrating artificial intelligence, digital twins, remote sensing, connected sensors, and advanced analytics, agencies can shift from reactive maintenance to predictive, data-driven decision-making.

Modern transportation operations centers provide a centralized environment where diverse infrastructure datasets are continuously monitored and analyzed in real time. These digital capabilities improve situational awareness, optimize maintenance planning, enhance climate resilience, and support more efficient allocation of limited resources.

As transportation networks face increasing climate-related risks, these emerging technologies enable infrastructure managers to anticipate disruptions, prioritize interventions, optimize investments and build safer, smarter, and more resilient transportation systems.

Enabling Technologies for Climate-Smart Infrastructure

- Artificial Intelligence (AI) and Machine Learning
- Digital Twins
- GIS, GPS, and Geospatial Analytics
- IoT and Smart Sensor Networks
- Remote Sensing, UAVs, and Earth Observation Technologies
- Cloud-Based Data Platforms
- Real-Time Decision Support Systems

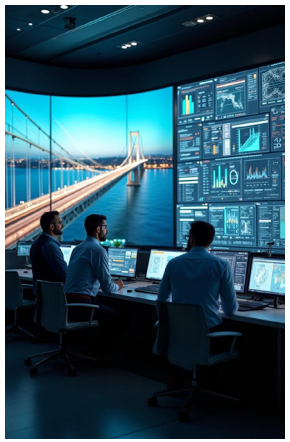


Figure : Modern Transportation Operation Center: Visual Courtesy of Freepik.com

Note: References supporting this synthesis are listed in the separate reference document.

The Road Ahead: AI and the Future of Transportation

As transportation infrastructure evolves into a data-driven ecosystem, artificial intelligence is transforming how agencies monitor, assess, and manage critical assets. By integrating AI with geospatial technologies, digital twins, connected sensors, and advanced analytics, transportation agencies can move from reactive maintenance to proactive, resilience-focused decision-making.

These technologies enable earlier risk detection, optimized resource allocation, and improved climate adaptation strategies. Looking ahead, AI will play a central role in building safer, smarter, and more resilient transportation systems while empowering the workforce through intelligent decision support.



From data to decisions to resilience, AI is redefining the future of transportation.
The future lies at the intersection of AI, geospatial intelligence, climate resilience, and human expertise.

Autonomous Systems Validation Platform: A Scaled Urban Testbed for Networked Decision-Making

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Motivation

- **Cost & risk:** Full-scale AV testing is costly and hazardous, and proving safety through road testing alone would take hundreds of millions of miles.
- **Data need:** AV developers need repeatable, well-labeled data from realistic signalized urban scenarios.
- **Early validation:** A 1/10-scale urban track lets teams prove out sensors, V2I, and decision logic cheaply, cycling vehicles through testing, logging, and CNN retraining quickly.
- **Gap addressed:** NEMA phasing and a camera–V2I handshake run on real hardware, exposing degraded-link, hazard, and fleet-coordination edge cases that simulation misses.

Testbed Overview

- **Fleet:** Eight Waveshare JetRacer AI Kits with Jetson Nano or Raspberry Pi, camera, and LiDAR.
- **Track:** Modular 40” × 50” urban track with lanes, crosswalks, and NEMA-phased signalized intersections.
- **Network:** Raspberry Pi hosts the signal controller and MQTT broker; vehicles share one Wi-Fi router.
- **Cost:** About $300 per vehicle kit.

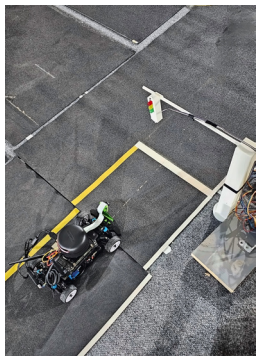


Fig. 1. JetRacer at a signalized intersection.

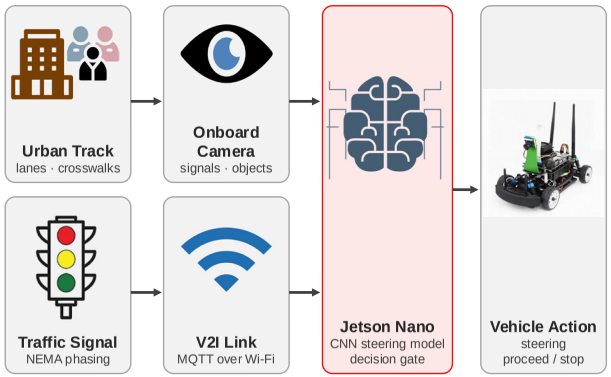


Fig. 2. System block diagram.

System Architecture

- **Sense:** The onboard camera detects lane markings, objects, traffic lights, and pedestrians on the urban track (Fig. 2).
- **Connect:** Each vehicle receives its intersection’s phase state from the Raspberry Pi signal controller over MQTT (V2I).
- **Decide:** The Jetson Nano lane-keeping model and signal detector feed a decision gate that fuses camera and V2I inputs.
- **Act:** The vehicle steers to hold its lane and proceeds or stops at the intersection; steering and throttle run in Docker under ROS 2.

Validation Data

- **Per-frame logs:** Camera frames with lane-keeping and signal-detection outputs.
- **V2I records:** ID-tagged phase states, time to next change, and link availability.
- **Decisions & control:** Time-stamped decision-gate outcomes with steering and throttle commands.
- **Use:** Repeatable datasets for benchmarking new sensors, perception models, and V2I equipment.

Implementation & Results

- **Lane keeping:** CNN trained on a 3,013-image dataset; a tuned Stanley controller gives stable driving at reasonable speed.
- **Signalized intersections:** NEMA ring-barrier controllers publish ID-tagged phase states over MQTT with configurable phase budgets.
- **V2I handshake:** Each vehicle subscribes to its intersection ID and receives the phase state and time to next change (Fig. 3).
- **V2I reliability:** >99.9% V2I availability over a 5,669-frame run of the full perception–decision–actuation loop.

8+	3,013	>99.9%	~$300
vehicle fleet	training images for CNN model	V2I availability (5,669 frames)	per vehicle kit

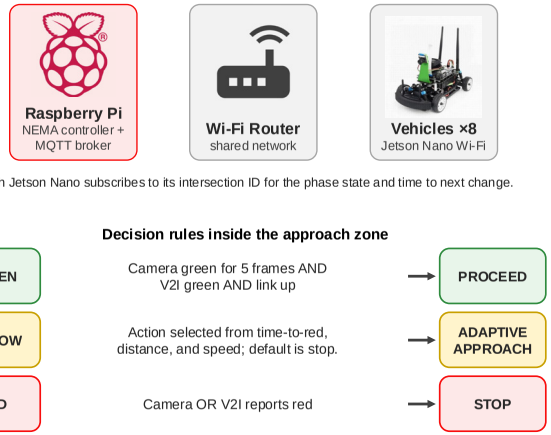


Fig. 3. V2I network and default decision rule.

Future Work

- **Network dependency:** Inject packet loss on the V2I link and measure its effect on vehicle decision time.
- **Yellow-phase decisions:** Use V2I time-to-red and distance to the stop line to decide whether to proceed or stop.
- **Localization:** LiDAR mapping and localization so each vehicle resolves its correct intersection ID.
- **Pedestrian hazard:** A two-wheel robot crosses at crosswalks or jaywalks; vehicles must detect it and stop or avoid a collision.
- **Multi-vehicle coordination:** Eight-vehicle fleet, with vehicle acknowledgments sent back to the intersection.
- **Platoon-level advisory speed:** JetRacers use the V2I link to adjust speed ahead of signal changes, reducing stop delay and travel time across the fleet.

Conclusion

- The testbed closes the loop between signal infrastructure and vehicle autonomy at 1/10 scale, producing repeatable V2I and driving data for autonomous systems validation.
- Lane keeping, signal-aware decisions, and V2I messaging run together on low-cost hardware with >99.9% link availability.
- It offers a low-risk bridge between simulation and full-scale deployment for networked decision-making research.

Enhancement of LiDAR-based Traffic Counting Accuracy Using a Trajectory Reconstruction Technique

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NJIT New Jersey Institute of Technology | iTSRC Intelligent Transportation Systems Resource Center

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Introduction

- Roadside LiDAR provides lane-level vehicle trajectories for traffic monitoring and vehicle counting.
- Occlusion, partial detection, or tracking interruption can split one physical vehicle into separate temporary identifiers within the same sensor.
- A tracklet is a continuous measured trajectory segment carrying one temporary identifier.
- Fragmentation can distort travel time, headway, lane-level movement, traffic-flow and safety measures



Figure 1 Same-sensor LiDAR vehicle occlusion and tracklet reassignment scenario.

Objectives

- Support LiDAR-based traffic counting by restoring continuity between fragments of the same vehicle through correct tracklet association and reconstruction of only the missing intervals.
- Preserve all measured observations and evaluate ID-association accuracy and trajectory-reconstruction accuracy separately..

Methodology

Trajectory-repair stages for the traffic-counting application: associate same-sensor tracklets, reconstruct accepted gaps, and validate identity and geometry.

1. Data Preparation	2. Candidate Generation	3. Evidence Scoring and Weighting	4. Assignment and Reconstruction	5. Validation
LiDAR trajectory input	Disappearing tracklet identification	Eight-channel evidence	Candidate ranking	Association accuracy
Local metric projection	Same-sensor candidate enumeration	Baseline weight loading	One-to-one assignment	Point and roadway error
Tracklet extraction	Physical gate filtering	Per-tracklet reliability	Kalman gap fill	Curve similarity
Broken-trajectory construction	Candidate set assembly	Adaptive weight normalization	Output assembly	Consistency audit

Figure 2. Analysis framework for association and trajectory reconstruction.

Baseline weights come from grouped Extra-Trees feature importances; runtime weights adapt to observed/measured per-tracklet reliability.

- Runtime score: 85% model-derived match probability + 15% adaptive physical-evidence score.
- One-to-one assignment prevents reused continuations. Kalman filter predicts only missing timestamps from pre-gap measured behavior.

Evidence channel	Baseline weight
Movement direction	72.07%
Reachability	17.53%
Time gap	6.93%
Speed	2.03%
Vehicle dimensions	0.73%
Motion / Kalman prediction	0.47%
Vehicle class	0.13%
Heading	0.09%

Case Study

- One roadside LiDAR sensor on a multi-lane mixed-traffic road in New Jersey (US Route 1); detection zone approximately 163 m × 157 m.



Figure 3. Study site and mounted roadside LiDAR sensor.

Dataset	Records and purpose
Training input	52,632 rows; 1,173 temporary IDs. 599 verified pairs; 574 two-sided matchable.
Test input	122,647 rows; 2,544 temporary IDs. 31,580 frames; one hour at 10 Hz.
Reference data	1,293 induced continuations; 15 points per gap.

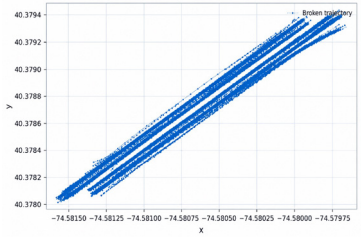


Figure 4. Observed/measured object-level LiDAR tracklets.

Validation

- Reference data are withheld from runtime prediction and used only after the repaired output is produced for validation.
- **ID association:** precision, recall and F1-score identify whether the correct temporary IDs were linked.
- **Reconstruction:** aligned point, roadway-direction, kinematic and Discrete Fréchet errors evaluate only reconstructed gaps.

Evaluation consistency check: 1,252 accepted gaps × 15 reference points = 18,780 aligned pairs

Results

ID-association accuracy

Metric	Value
Reference continuations	1,293
Accepted continuations	1,252
Wrong accepted matches	0
One-sided cases not accepted	41
Precision	1.000
Recall	0.968
F1-score	0.984

All accepted matches were correct. The 41 one-sided cases were not forced into two-sided associations.

Reconstruction accuracy

Metric	Value
Aligned evaluation pairs	18,780
ADE / MAE position	0.2558 m
RMSE position	0.3631 m
FDE position	0.1190 m
95th-percentile position error	0.6169 m
Maximum position error	5.0498 m
Longitudinal MAE	0.1805 m
Lateral MAE	0.1363 m
Heading MAE	2.2082°
MAE speed	0.9193 m/s
Mean Discrete Fréchet distance	0.9553 m

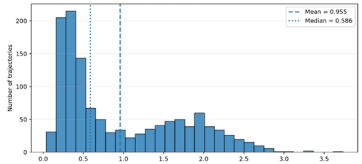


Figure 5. Distribution of per-trajectory Discrete Fréchet distance.

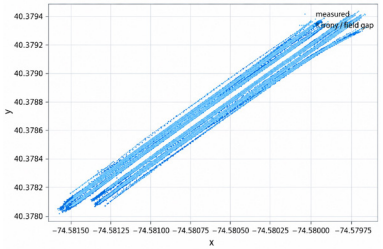


Figure 6. Reconstructed trajectory: observed measured tracklets with KF model gap-fill estimates.

Conclusion

- The technique restored same-vehicle continuity across fragmented LiDAR identifiers and preserved measured points, providing repaired trajectories for the intended traffic-counting application.
- In the controlled case study, 1,252 of 1,293 continuations were correctly linked with no false accepted matches: precision 1.000, recall 0.968 and F1-score 0.984.
- Kalman-filter reconstruction achieved ADE 0.2558 m, lateral MAE 0.1363 m and mean Discrete Fréchet distance 0.9553 m over the evaluated short gaps.
- The 41 one-sided cases lacked complete before and after observations. Such cases can occur when vehicles are initially visible but become occluded without reappearing within the detection zone, or enter while occluded and become visible later.

From Recorded Traffic to Steering and Acceleration: A Gated Hybrid of Convolutional and Vision-Language AI

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NJIT New Jersey Institute of Technology

ITSRC Intelligent Transportation Systems Resource Center

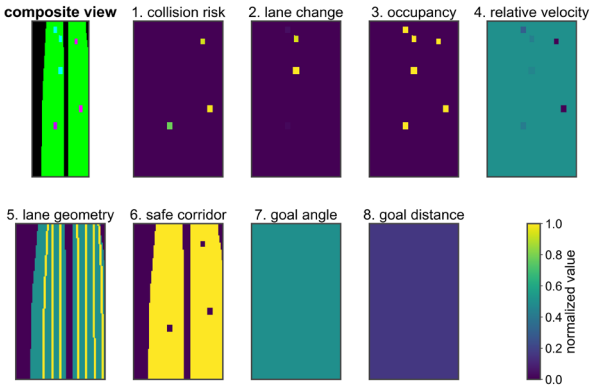
DIGITAL TRANSFORMATION

1. WHY THIS STUDY?

- Recorded human driving holds millions of examples of how people actually behave in traffic.
- Most trajectory models predict which maneuver comes next, not the control commands a vehicle executes.
- Instead of:
  - Keep lane | Change lane | Brake
- We predict directly:
  - **Acceleration (m/s²) + Steering angle (°)**
- **Goal: learn continuous vehicle control directly from real human driving.**

2. DATA FROM HUMAN DRIVERS

- 2.66 million driving samples
- 93 highway recordings of human drivers, filmed from a drone (exiD)
- 8-channel ego-centric bird's-eye view, 2-second prediction horizon
- Training and test sets split by recording, so no scene appears in both
- Each scene becomes a compact bird's-eye image of vehicles, road geometry, risk, relative motion, and route context.



What the model sees: the eight input channels

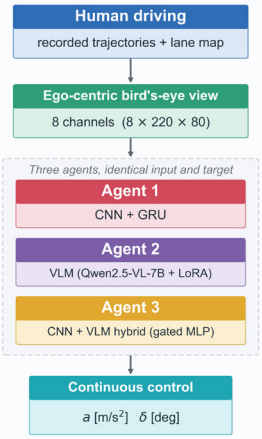
3. THE MAIN METHOD

- **Same scene. Same target. Three different models.**
  - **Agent 1 - CNN + GRU**
    - Five scenes in, acceleration and steering out.
  - **Agent 2 - Vision-language model**
    - Fine-tuned Qwen2.5-VL-7B writes control commands.
  - **Agent 3 - CNN + VLM hybrid**
    - Corrects the CNN only where the VLM helps.

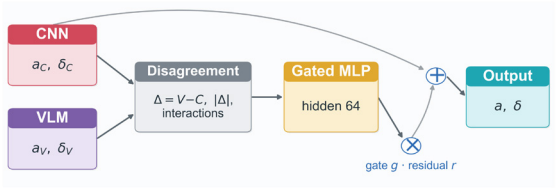
THE BOTTOM LINE

A compact CNN matched human control on 95.6% of unseen samples, and 76.7% on a highway it never saw.

The 7B model was weaker alone, but a learned gate turned it into a 14.4% error cut on the hardest cases.



Study design: one input, one target, three agents



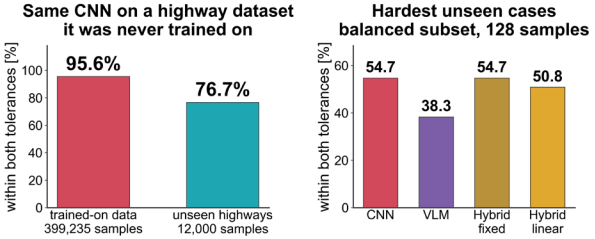
Agent 3: a learned gate decides how much VLM correction to apply

4. WHAT HAPPENED?

- **Result 1 - The compact CNN is the accurate one**
  - 0.161 m/s² and 0.18° average error on 399,235 unseen samples
  - 95.6% inside both tolerances at once
- **Result 2 - Bigger is not automatically better**
  - Alone, the 7B model was the least precise
  - Reasoning ability ≠ precise low-level control
- **Result 3 - But the VLM still helps**
  - Hardest cases: 14.4% less acceleration error
  - +5.1 points more inside both tolerances



Harder balanced subset (3,994 samples): the gated hybrid leads



average error on the unseen data: acceleration 0.16 → 0.35 m/s², steering 0.18 → 0.21 deg

Transfer to an unseen highway dataset (highD)

5. WHAT THIS MEANS

Trajectory data agencies already collect can train human-like controllers for traffic simulation, driver-behavior models, and AV evaluation.

Model size is not the deciding factor: the small model was both more accurate and far cheaper to run.

Limits and next steps: highway scenes, evaluated offline. Urban intersections and closed-loop testing come next.

Transforming Existing NJDOT Traffic Cameras into Autonomous Congestion Detection Systems by Utilizing Video Vision-Language Models

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ITSRC Intelligent Transportation Systems Resource Center

DIGITAL TRANSFORMATION

Introduction

- State DOTs run hundreds to thousands of CCTV cameras, but congestion is still **spotted by people** watching video walls.
- Current automated methods need **manual engineering** per camera: drawn zones, calibration, vehicle boxes.
- **Goal:** turn existing cameras into **automatic congestion sensors**, with no new hardware and no camera calibration.
- **Idea:** a **vision-language model** (Qwen2.5-VL-7B) watches a 30-s clip, answers **Low**/**High** per direction.
- Hand-labeling tens of thousands of clips is too costly, so labels come from **probe travel-time data** instead.

Methodology

- **Record:** 30-s clips, 3 NJDOT cameras, peak hours, 41 days.
- **Auto-label:** travel time above threshold = High (**51,344** clips).
- **Correct:** humans fix labels for ~2 weeks per site.
- **Compare 3 versions** of the model (Fig. 1):
  - **(1)** off-the-shelf Qwen2.5-VL-7B, no training
  - **(2)** trained on automatic labels, one model for all sites
  - **(3)** trained on corrected labels, one model per camera

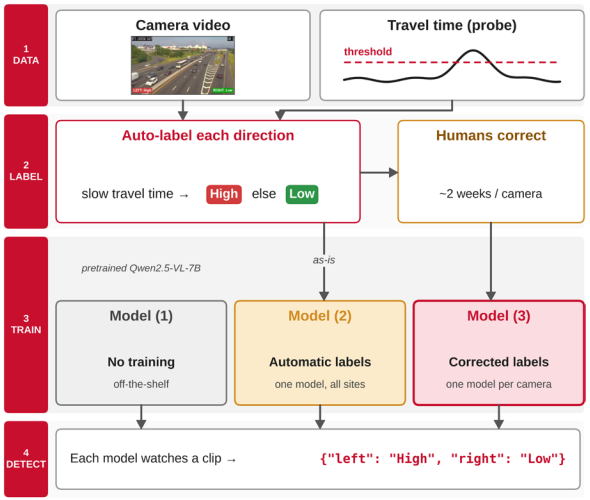


Fig. 1 Pipeline and the 3 compared models

Descriptive Analysis

- **3 sites:** NJ-3 @ NJ Turnpike ramp, I-80 @ Garden State Pkwy, I-80 @ NJ-20.
- Each view shows **2 directions**, each classified separately (Fig. 2).
- **Test:** 4 unseen days per site, **14,450** hand-checked labels.
- **Peak-hour** congestion builds mostly in **one direction**.

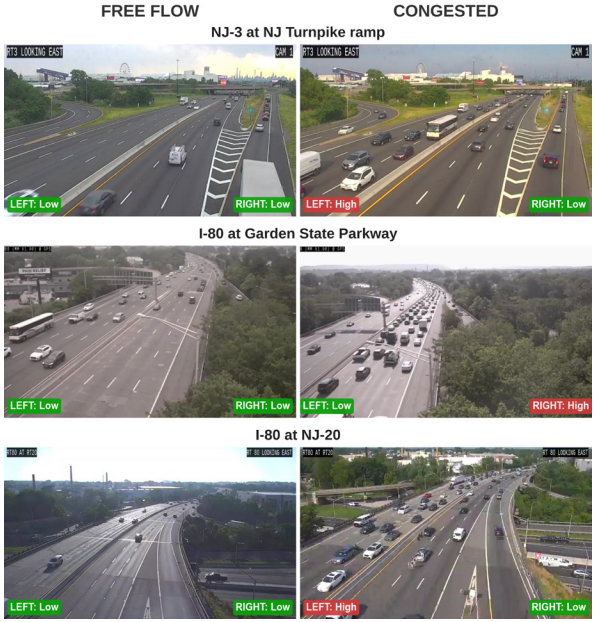


Fig. 2 Free flow vs. congested views

Model Result

Model	Accuracy	Precision	Recall
(1) No training	62%	50%	69%
(2) Automatic labels	78%	98%	54%
(3) Corrected labels	**90%**	**96%**	**83%**

Accuracy: both directions right · Precision: "High" calls correct · Recall: congestion caught

- Model (2) learned from noisy labels and became **too cautious**: few false alarms, but it **misses about half of real congestion**.

Model Result (cont'd)

90% accuracy

using cameras NJDOT already has, with no new hardware

- Model (1) works at GSP (**86%**) but **fails** at NJ-20 (**38%**).
- Model (3) has the **highest accuracy at every site**; NJ-20 rises to **81%** (Fig. 3a).
- Congested direction: model (3) **catches 91%** (NJ-3) and **79%** (NJ-20) vs 41% and 50% for model (2) (Fig. 3b).

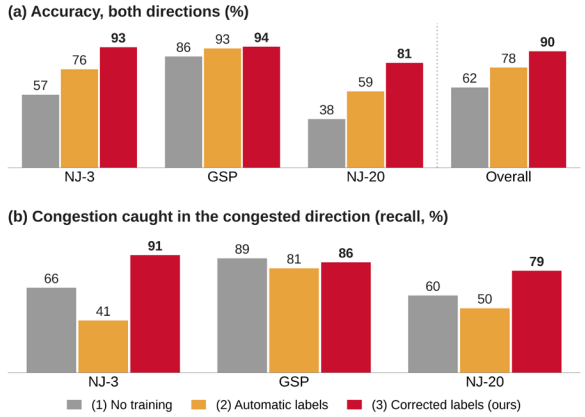


Fig. 3 Results on held-out test days

Conclusion & Recommendations

- **No new sensors:** existing cameras can spot congestion on their own.
- **Small, corrected data won:** ~2 weeks of corrected video per camera outperformed a 5–8× larger noisy set.
- **Lightweight per camera:** a small add-on to the shared model, trained in under a day on one GPU.
- **How to use it:** label automatically from travel-time data → fix the labels briefly → train one model per camera.
- Already running live on 3 NJDOT cameras. Next: more cameras, night and bad weather, more congestion levels.

- Funded by NJDOT ITS Resource Center, CY2025 (TO-119).

Organizing Team

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