Center for Advanced Infrastructure and Transportation
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RUTGERS

transportation today

>> Investing in Innovation to Enhance Infrastructure Systems

Virtual Reality and drones gather data faster, smarter, and safer

inside

According to the Federal Highway Administration (FHWA), work zone fatalities are on the rise, and the United States Department of Transportation (USDOT) identified safety and innovation as two of their four goals in its FY 2018-2022 Strategic Plan.

As a result, the Rutgers Center for Advanced Infrastructure and Transportation (CAIT) researchers have developed ways to use Virtual Reality (VR) and Unmanned Aerial Vehicles (UAVs) to prove to transportation stakeholders that they can aid in efficiency and safety.

But when the average person thinks of VR and UAVs, gaming and recreation might be the first things that come to mind. Innovative projects from CAIT aim to change that mindset as they mesh virtual reality and drone technology with the transportation and construction infrastructure needs of today.

Virtual Reality (VR) Makes Workforce Training Safer & More Efficient

A CAIT research team, led by Dr. Jie Gong, an associate professor in the Department of Civil and Environmental Engineering, has developed fully interactive virtual environments that can train roadside crews in activities such as bridge inspection

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director's message >>

Integrating Resilience into Infrastructure Management

As COVID-19 continues to impact transportation, supply-chain, infrastructure projects, and the general workforce in the region and globally, CAIT will continue to monitor the situation and provide updates through our E-news and other channels. However, since this print newsletter was already in production, we will further address the issue in our future print edition.

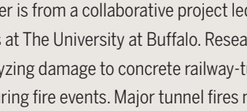
Every region has its own unique characteristics, and Region 2 is no different. Home to some of the busiest and most densely-populated cities across the country, diverse and evolving coastal communities, and infrastructure that supports millions of tons of goods and thousands of jobs each year, it is a complex environment that requires equally complex and diverse solutions. Over many decades the region has evolved to become highly concentrated with infrastructure and building systems that are challenged by fluctuating demographics and shifting environments. Research to make them more resilient, sustainable, productive, and equitable is critically important.

Aging infrastructure, deterioration, severe weather, and dense-built environments can put all systems at risk. The region needs more resilient infrastructure that is built to last and withstand the natural environment, but also the human demands of the area. Subject to sea-level rise, heat, erratic weather, and immense travel demands, our region's infrastructure systems need to rebound efficiently following disruptions in order to protect the safety, economy, and wellbeing of the area. At the Center for Advanced Infrastructure and Transportation (CAIT), we are doing exactly that and using our surroundings as a living test-bed to develop and implement real-world solutions.

CAIT has formed a new Infrastructure Resilience Program that brings together a cluster of researchers in a robust network that leverages expertise in addressing infrastructure impacts due to a variety of reasons. One project that comes to mind is from partners at the Polytechnic University at Puerto Rico who are investigating damage to pedestrian and transportation infrastructure during Hurricane Maria to identify specific causes of failure and help the island rebuild stronger.

Another is from a collaborative project led by partners at The University at Buffalo. Researchers are analyzing damage to concrete railway-tunnel lining during fire events. Major tunnel fires not only result in the loss of lives, but can also cause property damage and long service disruptions that can result in millions of dollars lost and major socioeconomic impacts. While much research has gone into evacuations and safety surrounding fire events in tunnels, less has been done in the areas of risk assessment, damage quantification, and resilience—where CAIT comes into play.

When we gathered for a recent Region 2 Partner Meeting, I discussed the importance of having open lines of communication with stakeholders and customers, so that we can better identify their priorities and the real-world problems they are facing. Today, that message remains true for addressing our resilience needs. Through open communication and forming partnerships that leverage different assets and expertise, we can work together to efficiently address the problems in our region and build toward a more resilient future.



Ali Maher, Ph.D., Director ■

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and work zone setup. "Safety is an important aspect of these projects," Gong said. "And, due to the nature of these jobs, safety is a priority of the transportation workforce too." This innovation gives them hands-on experience from the comfort and safety of their own "home."

Using HTC Vive controllers, headset, and a mobile backpack VR computing system, users can set up in their office and take on a variety of simulated job tasks. For example, construction crews can practice putting down cones to set up their work zone, he said. The cars will interact with the cones accordingly, so users can get an idea of what setups work and what do not in real life. Most variables are customizable too.

"VR and AR as immersive computing and visualization technology have seen explosive development, but there is a lack of understanding of how today's technologies mesh with the current transportation needs of infrastructure management," Gong said. "How can we help transportation stakeholders achieve a better understanding of the uses of cutting-edge technologies?"

The first VR environment Gong developed is a bridge modeled after the Stan Musial Veterans Memorial Bridge, which crosses the Mississippi River—linking St. Clair County, Illinois, and the city of St. Louis, Missouri. The geometry model of this bridge was developed in one of the Building Information Modeling classes that Gong teaches and serves many roles—one being bridge-inspection simulations. Users have the option to change the bridge settings, so they can simulate cracks in the bridge, as well as different types and appearances that can then be used for training purposes. With these inspections typically comes lane closures, he said.

ON THE COVER: Using drones equipped with high-quality cameras, researchers were able to inspect different interchanges. Photo ©Michael O'Connell.

> **"The virtual training environments can greatly improve the efficiency and effectiveness of training for the transportation workforce."**
>
> — Dr. Jie Gong

Above: Traffic type, speed, and behavior can all be controlled. Photo ©Jie Gong.

Users are then able to simulate setting up a work zone for their specific needs within the digital environment.

The controls also make movements feel like real life. To pick up a cone in the simulation, users can either physically walk to one a short distance away or use the controller to aim and point to where they want to go. To pick up a cone, stop sign, or other realistic object, users must physically reach out to their target, press the trigger on the controller, and pull it up.

"Looking into the future, we need to really think about how we can use this virtual reality environment—it's much more immersive than traditional training, high-fidelity, and you can play a lot of what-if scenarios, he said. The virtual training environments can greatly improve the efficiency and effectiveness of training for the transportation workforce. Construction crews can use a bridge VR environment to simulate the setup of work zones and experience the traffic flow in a fully immersive environment. Preparing workers for dealing with this type of environment can improve safety, save time, and money. The traditional way of project data analysis and training methods often fall short of helping decision-makers grasp the true complexity of many construction and maintenance tasks."

Gong hopes that through CAIT's research projects and talking with stakeholders, additional work can be done to develop VR technology in this space and can encourage a wider acceptance of VR and AR technology into the life-cycle management of transportation infrastructure systems. Currently, several companies and labor unions have expressed interest in using or funding further development of these models for their training purposes, and conversations are ongoing.

Left: "Wrong-Way" signs and other interchange assets were captured by the drones and evaluated. Photo ©Michael O'Connell.

Rutgers and Rowan Partner to Use Drones to Increase Road Safety

Unmanned Aerial Vehicles (UAVs) can potentially collect and inventory high-quality interchange asset data in a safer, faster, and smarter way than traditional on-the-ground surveys. By leveraging drone data that was collected under a related CAIT UTC research project

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Above: Construction workers operate on a gas pipeline replacement project in Fords, NJ. Throughout the process, Rutgers researchers used drones and LiDAR to collect images and data on the site and eventual location of the new pipeline. Photo ©Ryan Stiesi.

in a new way, researchers are able to inspect interchanges for Wrong-Way Driving (WWD) crash vulnerabilities.

On and off-ramps connect freeways and highways to local roads. When a driver mistakenly enters a highway from an exit ramp, called Wrong-Way Driving, it creates a high-danger situation. These incidents have long been a critical safety issue for transportation agencies.

A collaborative project between CAIT, Rowan University, and other universities, "Application of Unmanned Aerial Vehicles to Inspect and Inventory Interchange Assets to Mitigate Wrong-Way Entries," explored using drones to collect high-quality data from exit-ramps regarding these crashes. It found that when equipped with cameras, drones can be used to inspect and inventory exit-ramp assets to gather information and learn more about the causes of WWD collisions.

Dr. Mohammad Jalayer, lead author of the study and an assistant professor in the Department of Civil and Environmental Engineering at Rowan University, said that the study is a step toward adopting drones for transportation research and safety practices. "Traditional methods of collecting WWD data are time-consuming and expose crews to traffic hazards," Jalayer said. "We showed here that drones have the potential to collect accurate data which could help in reducing WWD crashes and accomplishing the 'Toward Zero Deaths' goal of many transportation stakeholders in the future."

Other researchers involved included Michael O'Connell, a researcher at CAIT; Dr. Huaguo Zhou, a professor in the Department of Civil Engineering at Auburn University; Dr. Patrick Szary, associate director of CAIT; and Dr. Subasish Das, an associate transportation researcher with the Texas A&M Transportation Institute.

According to data from the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) database, in 2018, there were 598 WWD crashes in New Jersey, which caused 215 serious injuries and 13 fatalities. "Past studies have shown that exit-ramp terminals are the most common location for drivers to enter a highway going the wrong direction," he said. "If we do not have the proper signs or features, the risk of a WWD crash could increase."

Right: A 3D point cloud As-Built model from a static LiDAR scan put together by Rutgers researchers after scanning a construction site in Fords, NJ. Photo ©Sun Ho Ro.

Right: Using drones equipped with high-quality cameras, researchers were able to inspect different interchanges. Photo ©Michael O'Connell.

A Wrong-Way Entry Checklist was developed to act as a tool for ranking an exit-ramp in terms of its signs, pavement markings, or design features. Researchers used data collected from the drone evaluations to fill out checklists and document the exit ramps. O'Connell said that UAVs have a lot of safety applications. In this case, they can safely gather data about exit ramps that can be used to inform stakeholders quickly.

"Given the rapid expansion of drone technology, UAVs are likely to play a key role in addressing this important issue as well as many other safety concerns," he said. "Field surveys are time-consuming, labor-intensive, and sometimes hazardous. Investing in drone technology and expanding this research to larger test locations can save time, money, and improve safety."

Drone Team Helps Engineers Develop As-Built Models

A Rutgers drone team used Unmanned Aerial Vehicle (UAV) technology to map an on-going construction site in Fords, New Jersey, as part of a project to develop As-Built 3D models that stakeholders can use to locate the underground infrastructure in the future accurately.

This drone mapping project is tied into Dr. Gong's related UTC work on delivering maintenance and repair actions using automated and robotic systems. He said that when a construction project is planned, often, the final product is different than what the engineers had initially designed. This is due to real-world factors that force construction workers to adapt to the project while on the job. "As-Built drawings are an essential part of construction projects as they are used to replicate how the contractor completed the project and identify the changes that were made throughout the project," expressed Dr. Gong.

Environmental Engineering at Rutgers and a CAIT-affiliated researchers scanned the pipeline trench using UAV and Light Detection and Ranging (LiDAR) technology with the goal of ultimately generating accurate and geo-referenced As-Built 3D models. Sun Ho Ro, a Doctoral student in the Department of Civil and Environmental Engineering at Rutgers and a student of Dr. Gong, led the drone flight. The data collected will help the team develop enhanced As-Built models that are vital for informing stakeholders in the area so that they can act confidently in the event of future emergencies, digging or construction projects.

He explained that conventional As-Built models are manually drafted 2D Computer Aided Design (CAD) drawings that can be inefficient and have limitations when it comes to documenting specific details and characteristics of a new asset. Some cons of conventional CAD As-Built drawings include that they can take an average of 45 days to develop, are more susceptible to human error, and often lack geo-referencing.

The 3D models that the Rutgers team created are geo-coded to have accurate GPS points and can provide a variety of information and data such as a change in plan, XYZ-coordinates, Geographic Information System, and map overlay, he said. "Data collection from UAV and LiDAR, as well as the 3D models, were successful. We were happy to use our technology and expertise to work on this initiative with Elizabethtown Gas," Ro said. ■

Left: A Rutgers drone team scanned a construction site in a residential area of Fords, NJ this September to collect important data that helped them develop 3D As-Built models. Photo ©Ryan Stiesi.

>> p6 Technician Credits for Drones

UTC Partners Develop Technician Credits for Drones and More

Atlantic Cape Community College (ACCC) taps into a multi-billion-dollar industry with new degree programs designed to certify students as field technicians of small UAVs. The training will help students find jobs in this emerging field and develop the drone workforce.

This program helps students enter the industry in two ways: with micro-credentials offered through a new degree program, and by establishing the college's drone-pilot certification program as the industry standard. Since federal regulations were approved in 2016, 140 students have gone through the program.

In a growing field, having the right qualifications can help students find jobs and advance their careers. To make that possible, the associate degree has a lot of hands-on experience built into its curriculum. The end goal is to help students in the program stand out when they move into the industry.

CAIT Researcher Wins NJDOT Implementation Award for Overcoating Project

Announced every year at the NJDOT Research Showcase, this award honors someone who worked with the Department on a research project that has been implemented to solve a relevant problem. This year, Dr. Perumalsamy N. Balaguru, a Distinguished Professor in the Department of Civil and Environmental Engineering at Rutgers School of Engineering (SoE) and a Center for Advanced Infrastructure and Transportation (CAIT) affiliated researcher won the award. He worked with NJDOT on developing a new protocol for accepting paint systems for over-coating steel surfaces.

"Over-coating" is a common term used to describe bridge maintenance painting where existing paint is only partially removed, and a new coat is applied over the leftover paint, bare steel, and rusted surfaces.

"An efficient and economical acceptance protocol is needed to encourage innovation of coating systems," he said. "I am glad that our efforts to advance the state of the art in accelerated testing for reducing the time and resources needed for approval of new coatings is being recognized. This recognition and the nationwide selection as one of the "Sweet 16 Research Projects" will be of great help for the fast implementation of this research by not only NJDOT but also by other states."

The NJDOT Bureau of Materials initiated the research project to help improve the NJDOT program for accepting over-coating paint systems, and researchers were tasked with identifying a test method and road map for accomplishing this. Other collaborators on the project included co-PI Dr. Husam Najm, a professor at the Rutgers Department of Civil and Environmental Engineering, and NJDOT Bureau of Research project manager, Dr. Giri Venkiteela.

Notable differences include that the current testing takes two years to complete, while the method developed by Dr. Balaguru reduces the timeframe to six months. The test chamber also is very economical to build, costing approximately $30,000 compared to quotes that have gone as high as $250,000.

In the end, NJDOT found that the research team did develop an efficient test method incorporating key parameters of the current ASTM and American Association of State Highway and Transportation Officials (AASHTO) test methods. The results were presented at Transportation Research Board (TRB) meeting in January 2018. Also, The Research Advisory Committee of AASHTO selected this NJDOT project as one of the winners in the 2019 AASHTO Sweet 16 Competition. ■

Above: (Left to Right) NJDOT Assistant Commissioner Michael Russo presents Dr. Balaguru with the 2019 NJDOT Research Implementation Award, alongside NJDOT Bureau of Research Manager Amanda Gendek. Photo ©Larry Levanti Photography.

Right: David C. Woessner, Executive VP – Corporate Development and Regulatory Affairs, LM Industries + Local Motors, gave the keynote speech on connected vehicles at the 2019 NJDOT Research Showcase. Photo ©Larry Levanti Photography.

p7 Drone Story Headline

Transportation Infrastructure Workshop Encourages Tech Transfer

Emerging robotics solutions for growth

On May 30, 2019, CAIT brought together more than 70 researchers, agency officials, and private industry leaders to discuss the seemingly endless applications for robots in the transportation infrastructure sector, and how to overcome inertia in a portion of the market that has been reticent to adopt the technology.

Above: One innovative technology developed by CAIT, THMPER, could revolutionize how bridge load ratings are determined. It delivers a forceful impact to the bridge, causing it to vibrate. That vibration response reveals a lot about the bridge's load capacity. Photo ©Drew Noel Photography/Rutgers CAIT.

From flying drones to creepers, and from rigid machinery systems to soft robots, these technologies have a mix of mobility, strength, and configurability that can make them valuable tools for infrastructure maintenance, condition monitoring, and construction projects.

The workshop, "Emerging Robotic Solutions for Infrastructure Management," began with a keynote speech from Carl Haas, Ph.D., a professor of civil engineering at the University of Waterloo and fellow of the Canadian Academy of Engineering. The theme for his talk was robots, risk, and rework.

Following the keynote speech, researchers from CAIT and partner universities shared the vision for the workshop, and a panel of experts discussed both current and emerging solutions in robotics. The experts included; Dr. Frank Moon, a civil engineering professor at Rutgers School of Engineering and a lead bridge researcher at CAIT, Carson Carney, Vice President of TyBot, Dr. Nenad Gucunski, professor and chair of Rutgers Department of Civil and Environmental Engineering, and Dr. Jie Gong, associate professor in the Department of Civil and Environmental Engineering at Rutgers.

Throughout the day, tours explored the recently-opened Richard Weeks Hall of Engineering, including the CAVE Visualization Lab and CAIT's Bridge Evaluation and Accelerated Structural Testing lab (The BEAST). The day concluded with a series of lightning presentations of researchers' latest work, and a discussion wrapping up opportunities identified in the workshop and ways to move forward.

Rutgers CAIT is home to many cutting-edge technologies, a leader in innovation, and a firm believer in using robotics and other technologies as part of the practical solutions they develop for infrastructure management.

CAIT plans to schedule more workshops and meetings with user groups and owners in the future to find new ways to implement robotics into infrastructure management further. The center also invites other interested stakeholders to join as well, so that this initiative can continue to grow. ■

p10 Pedestrian Safety

Collaborative Research Improves Pedestrian Safety

StreetSmart NJ Program has positive impact

Left: The observational study found a 60 percent reduction in vehicles failing to stop before turning right at a red signal or stop sign, among other safety improvements. Photo ©NJTPA.

It might seem evident that safety should be a priority for everyone. Still, when it comes to following the rules of the road—rules that can prevent fatalities and injuries—sometimes people need reminders.

That's what collaborative research from the Rutgers Center for Advanced Infrastructure and Transportation (CAIT) and Rowan University found in an analysis of the *Street Smart NJ* campaign's impact on pedestrian safety at intersections in eight communities in 2018 and 2019.

Since its inception in 2013, *Street Smart NJ* has grown from five pilot locations to more than 100 municipalities across the state. The program partners with law enforcement, community groups, local officials, NJ Transit, the New Jersey Division of Highway Traffic Safety (NJDHTS), and the state's eight Transportation Management Associations (TMAs), among others. *Street Smart* was modeled after other successful behavioral change campaigns, including "Click it or Ticket" and "Drive Sober or Get Pulled Over," which combine enforcement with public education.

The two-part study, *The Street Smart New Jersey Observational Pedestrian Safety Study* and The Street Smart New Jersey Behavioral Pedestrian Safety Study, was completed in June. It compared rates of unsafe pedestrian and driver behaviors before and after *Street Smart NJ* campaigns were implemented. The North Jersey Transportation Planning Authority (NJTPA) regularly evaluates its *Street Smart NJ* program to ensure it remains effective in improving safety. The NJTPA contracted with Rutgers CAIT and Rowan University to evaluate campaigns in 2018 and 2019. Dr. Pat Szary, associate director of CAIT and contributing author of the study partnered with Dr. Mohammad Jalayer, a professor at Rowan University and lead author of the study.

"The NJTPA asked us to examine the behavioral change of pedestrians and motorists through observational data at various high-risk intersections," said Dr. Mohammad Jalayer. "These types of measurements are important, as they allow agencies to use their resources better when deciding what programs to continue and how to continue them."

The observational study tested for behavioral change by noting behaviors at high-risk intersections in Asbury Park, Garfield, Morris Plains, Newark, Princeton, Rutherford, Teaneck, and Woodbridge, NJ. Researchers looked at the failure of vehicles to stop before a right turn at a red signal or stop sign, turning vehicles failing to stop for pedestrians, vehicles running a red light or stop sign, and pedestrians crossing unsafely (against the signal or outside the crosswalk). The study team found improvements across the board after these communities implemented *Street Smart NJ* campaigns.

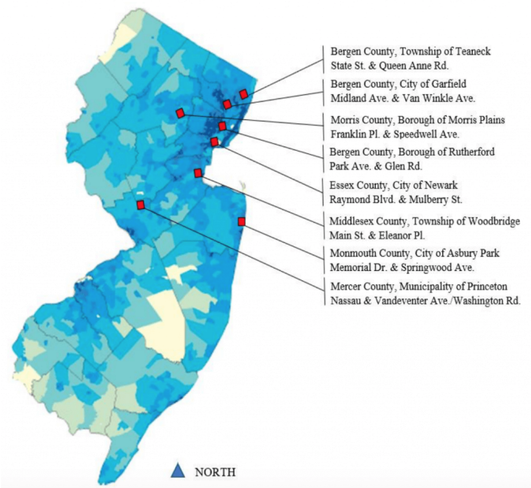
"These results illustrate that *Street Smart NJ* is helping make our roads safer for everyone," said Union County Freeholder Angel Estrada, Chair of the NJTPA Board of Trustees. "By combining education and enforcement, we can make a difference and help New Jersey work toward its goal of zero fatalities."

In addition, surveys were promoted throughout the communities—on municipal websites and via social media—and in-person at target intersections. In total, 2,241 people completed the survey. Survey respondents were asked to report on their actions and observed behaviors of others.

"Overall, the observation results demonstrate the positive impact of the *Street Smart NJ* campaign on changing pedestrian and driver behaviors," Szary said. "We hope that the NJTPA will use this information to continue to run the campaign effectively and that in the future, more stakeholders will reach out for assistance with evaluating their safety initiatives."

"At CAIT, we deal with issues of transportation safety all the time," Jalayer said. "What's notable about this report is that we were able to use our research expertise to quantify the benefits of the *Street Smart NJ* program and assist the NJTPA. We were happy to put our research expertise to good use here and hope the reports can spawn future safety initiatives. ■

Examples of some of the graphical messages that have been used in Street Smart NJ campaigns to change driver and pedestrian behaviors. Photo ©NJTPA.



Right: Eight Street Smart NJ evaluation sites on a map of population density in New Jersey. Photo ©NJTPA.

>> Researchers Create Environmental Infrastructure Solutions

Porous parking lots help relieve flooding

Flooding is a constant concern for residents living in the approximately 275 homes located in Linden, NJ's Tremley Point. A low-lying area bordered by the Rahway River and Marshes Creek, anything from storm surges to regular rainfall, can put the area at risk.

By using Stormwater Green Infrastructure such as rain gardens and more recently porous parking lots, Dr. George Guo, a professor in the Department of Civil and Environmental Engineering at the Rutgers School of Engineering (SoE) and a CAIT-affiliated researcher is leading the way in building and implementing these environmentally friendly measures to help control flooding events for at-risk neighborhoods.

"Managing stormwater runoff is a huge challenge for many municipalities due to pooling and potential flooding, especially with municipalities near the waterfront," said Derek Armstead, the mayor of Linden.

Porous parking lots, which use an innovative type of pavement that can drain and then store water runoff, are part of the infrastructure solutions needed to protect this region, and others like it. When rain or runoff hits the pavement, it seeps through the pavement down to a layer of gravel, Dr. Guo explained. This acts as an underground reservoir before the water eventually is drained back out to the original catch basin. As a result, it helps address the rainfall sources: ocean high tides and storm surges. In addition to flood management, the porous pavement might have some environmental benefits as well. By the time the runoff flows through the porous pavement, it will be filtered of most solids, for example.

"This project is a great example of how communities can use green stormwater infrastructure to decrease flood risks and improve resilience, while also improving water quality and wildlife habitat," said Amanda Bassow, NFWF's Northeastern Regional Director. "It is exciting to see Rutgers and Linden team up to get more of these innovative solutions on-the-ground that are wins for both people and wildlife."

Thanks to the NFWF-DOI grant in fall 2014, they later began implementing some of the Stormwater Green Infrastructure that predates the most recent porous parking lots. Through this funding, Rutgers and multiple project partners have employed different solutions to help the area deal with flooding. These include rain gardens and rain barrels, conveyance improvement, wetlands restoration, and more. To date, the teams have built six rain gardens that accompany the porous parking lots and other mitigation efforts in the area. ■

Above: Linden, New Jersey's Tremley Point region is surrounded by the Rahway River and Marshes Creek, putting the area at a high risk for flooding events. Photo ©Anthony Biancella.

> **"It is exciting to see Rutgers and Linden team up to get more of these innovative solutions on-the-ground that are wins for both people and wildlife."**
>
> — Amanda Bassow

Left: The same porous parking lot during another stage of construction. Photo ©George Guo.

Below: The larger of the two porous parking lots while being constructed in Linden, NJ in April 2019. Photo ©George Guo.

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Permeable Concrete Can Help Cool Sizzling Cities

Today, permeable concrete is mainly used in lightly trafficked areas, such as sidewalks, parking lots, and rest areas. A Rutgers-led team is studying how to make it stronger and more durable so it can be used in urban streets. Special permeable concrete pavement can help reduce the "urban heat island effect" that causes cities to sizzle in the summer, according to a Rutgers-led team of engineers.

Impermeable pavement made of concrete or asphalt covers more than 30 percent of most urban areas and can exceed 140 degrees Fahrenheit in the summertime. It heats the air, posing human health risks, and surface runoff, threatening aquatic life. In cities with 1 million or more people, average air temperatures can be 1.8 to 5.4 degrees Fahrenheit higher than in less densely populated areas. The difference can be up to 22 degrees at night. The heat can increase peak demand for energy in the summertime, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and deaths, and water pollution, according to the U.S. Environmental Protection Agency.

The engineering team at Rutgers developed designs for permeable concrete that is highly effective in handling the heat. Permeable pavement contains large connected pores, allowing water to drain through and reduce pavement temperature. Water in pores will also evaporate, reducing pavement surface temperature. Moreover, permeable concrete pavement does a better job reflecting heat than asphalt pavement.

"Highly efficient permeable concrete pavement can be a valuable, cost-effective solution in cities to mitigate the urban heat island effect while benefiting stormwater management and improving water quality," said corresponding author Hao Wang, an associate professor in the Department of Civil and Environmental Engineering in the School of Engineering at Rutgers University.

The lead authors of the studies are Jiaqi Chen, a former postdoctoral researcher at Rutgers, and Xiaodan Chen, a Rutgers doctoral student. Co-authors include Professor Husam Najm and engineering researcher John Hencken at Rutgers and collaborators at the New Jersey Department of Transportation and Central South University in China. Their studies appear in the *Journal of Cleaner Production.* ■

Above: A permeable concrete specimen. Photo: Hao Wang/Rutgers University-New Brunswick.

>> p14 Partner Meeting

USDOT Region 2 University Transportation Center (UTC) Partner Meeting

Solutions for pressing infrastructure issues

As the Region 2 UTC lead institution, Rutgers CAIT gathered its consortium partners and high-level industry leaders on May 31, 2019, to discuss the next round of UTC projects, agency clients' priorities, and collaboration.

CAIT director Dr. Ali Maher said that the meeting aimed to give the consortium more insight into their customers' needs. UTC consortium partner universities are Atlantic Cape Community College, Columbia University, Cornell University, New Jersey Institute of Technology, Polytechnic University of Puerto Rico, Princeton University, Rowan University, Farmingdale State College, and University at Buffalo.

"It's critical to have open communication with our stakeholders so that we can better identify their priorities and the problems they are facing," Maher said. "CAIT works to solve the most acute operational transportation problems in the region. We need to understand what our customers are grappling with to develop applicable and appropriate remedies. By bringing everyone together, we were able to accomplish that."

NJDOT Commissioner Diane Gutierrez-Scaccetti was the first of many speakers to address the group of about 100 attendees. "I think the most important thing that we can do in terms of changing our message is to not refer to new technology as disruptive … it's not disruptive, it's transformative," she told the group.

In addition to Commissioner Gutierrez-Scaccetti, several stakeholders shared their agency's ongoing projects, gaps research could fill, and their longer-term goals. The common theme they all touched on was the importance of adopting new, transformative technology. Speaking of transformative, the Innovation Hub that CAIT proposed to the New Jersey Economic Development Authority was a highlight of the meeting. The Innovation Hub is envisioned as a living laboratory and smart-mobility testing ground in downtown New Brunswick. It will be equipped with a variety of sensors that will collect and process real-time, high-resolution mobility data from vehicles, pedestrians, and infrastructure in the city.

Above: Ali Maher (CAIT).
Photo ©RoyGroething/RutgersCAIT.

At the end of the meeting, partners and stakeholders both left with a clearer picture of the top issues facing the region and new opportunities to work together.

Maher said that what was learned will help spark meaningful projects in the next several years. "We have massive amounts of infrastructure in our region, so being able to learn from the key people in charge of it was important," he said. "I was happy to see that every UTC project mentioned had a key stakeholder involved. As we move forward, we'll continue to emphasize innovative technology that solves the problems of our region." ■

>> p13 Infrastructure Solutions

Right: Key speakers such as NJDOT Commissioner Diane Gutierrez-Scaccetti (Bottom Left), and PANYNJ Chief Engineer Jim Starace (Bottom Right) provided news and insights that inspired conversation among the attendees. Photo ©Roy Groething/Rutgers CAIT.

Above: Jim Starace (PANYNJ).
Photo ©RoyGroething/RutgersCAIT.

Above: Diane Gutierrez-Scaccetti (NJDOT).
Photo ©RoyGroething/RutgersCAIT.

Above: Consortium partners and high-level industry leaders gathered at CAIT's latest Partner Meeting to discuss and listen to presentations on the next round of UTC projects, agency clients' priorities, and collaboration. Photo ©Roy Groething/Rutgers CAIT.

>> transportation today

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