Annual Implementation Report
Research Completed in 2019

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Submitted by:

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NJDOT Bureau of Research

In cooperation with

New Jersey
Department of Transportation
Bureau of Research
and
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Executive Summary

The **New Jersey Department of Transportation**, **Bureau of Research** supports transportation research necessary in order to provide relevant information, analysis, and value-added solutions to transportation agencies and professionals. The results enhance the quality and cost-effectiveness of the policies, practices, standards, and specifications required when planning, designing, building, and maintaining the State's infrastructure. The funded research results in the discovery of new materials, improvement of processes, refinement of systems, and the generation of innovative ideas that improve the durability and efficiency of infrastructure and the mobility, accessibility, and safety of the State's residents, workers, and visitors. However, the long-term effects, or the next necessary steps required to achieve full-scale implementation, as well as the benefits, are not always known. The Bureau is often approached by sponsors to justify the value of these projects to a much broader audience.

The purpose of the Annual Implementation Report is to review these effects. Where applicable, and where the results were reported or could be obtained, examples of the return on investment or other economic benefits to the State of New Jersey have been noted.

The Annual Implementation Report is also a means to screen for opportunities and document the strategies that have been used for technology transfer of research findings to the State's transportation community, including its transportation agencies, workforce, and the broader community of transportation practitioners.

Introduction

The project team collected information for this report through review of technical briefs, final research reports, and interviews with principal investigators and NJDOT research managers and customers. A summary of each funded project completed in 2019 was developed.

The role and importance of technology transfer within the State transportation research program function has been the subject of continuing study. Several useful definitions for considering the role of technology transfer that were provided in a U.S. DOT Volpe Center study (Cuddy et. at, 2016) help frame and inform the process of considering effects and are shown below:

- Research and Development (R&D): Any activity that aims to create or improve a technology.
- Technology: Any knowledge, process, system, or other tangible or intangible thing that could be used to create benefits. Examples of new technologies include a survey, hiring process, a piece of software or "app", a traffic model, a new road construction technique or an unmanned aircraft.
- Technology Transfer (T2) Activities: All activities designed to help ensure that technologies created or improved through R&D are widely adopted for use outside or within the research-producing organization.
- Adoption: The decision to make a technology available for use in ordinary operational situations. This may or may not involve commercialization.
- Implementation Activities: Activities led by an adopter to make a technology available for ordinary operational use. These activities are generally preceded by adoption, and they often draw on research organizations for technology information and support.

Research Approach

In 2019, the Bureau of Research received 11 final research reports for work that had been authorized in current and previous years. The contracted value of the completed research projects was approximately $2,893,222. As shown in Table 1, Capital Improvement & Infrastructure related research accounted for the most completed research projects in terms of total funding followed by Mobility and Operations and Safety Management related research.

Table 1
Number and Value of Completed Research Reports by Research Category, 2019

Research Category	Number of Reports Completed	Total Contract Value Completed
Capital Improvement & Infrastructure	4	$ 1,179,464
Mobility and Operations	3	$ 556,965
Safety Management	1	$ 450,242
Policy and Organization	2	$ 414,631
Planning and Environment	1	$ 291,920
Multimodal	0	$ -
Total	11	$ 2,893,222

Source: NJDOT Bureau of Research, Database of Final Reports
https://www.njdottechtransfer.net/research/research-projects/

As shown in Table 2, the completed research reports vary in their approach to research and in their treatment of implementation themes. The completed research reports efforts toward implementation can be characterized into several, sometimes overlapping categories:

- Some research were primarily analytical or evaluative studies which result in the reporting of findings to the stated research question with no attention to implementation.
- Some studies made recommendations for future research to further refine technologies or advance research questions to a next stage.
- Some studies made recommendations for implementation that could be pursued in the future.
- Another segment of studies made implementation or technology transfer activities an element of the completed research study, or have since acted on recommendations that were made at the time of the study's completion.

This report provides results from an investigation into steps taken, if any, at the conclusion of the research efforts. Research faculty, consultants, and NJDOT staff (current and former) were sent an online survey to gather information on the results of the research and next steps for implementation. Follow-up interviews were held by telephone, by email or in person to further clarify or expand on responses. The review of implementation activities that have followed from the research shows that some efforts resulted in research papers and presentations at conferences to disseminate key findings, while implementation in other cases may have been realized through specific policy changes or the institutionalization of new standards or tools for doing business. Where available or discovered, potential benefits related to the research study topic were noted. None of these studies would have been possible without public support.

Table 2: 2019 Research Reports by Type of Research and Treatment of Implementation Theme

ID	Title	Implementation Activities	Implementation-Minded Recommendations	Recommendations for Future Research	No Discussion of T2	Research Type	Research Category
FHWA-NJ-2019-001	Defining the Hudson Bergen Light Rail Catchment Area			X		Literature Review, Data Collection	Planning and Environment
FHWA-NJ-2019-002	Real-Time Traffic Signal System Performance Measurement	X		X		Survey, Literature Review, Data Collection	Mobility and Operations
FHWA-NJ-2019-003	Traveler Information Application for Route 1 and Route 18 Corridors	X	X			Data Collection, Software Design	Mobility and Operations
FHWA-NJ-2019-004	Evaluation of Precast Concrete Pavement Systems and Cast In-Place: Phase I: Identification of Accelerated Concrete Pavement Rehabilitation Methods		X	X		Literature Review,	Capital Improvement & Infrastructure
FHWA-NJ-2019-005	The Cost of Roadway Construction and Maintenance in New Jersey		X			Data Collection	Capital Improvement & Infrastructure
FHWA-NJ-2019-006	UAS (Drone) Peer Exchange		X			Testing	Mobility and Operations
FHWA-NJ-2019-007	Calibration / Development of Safety Performance Functions in New Jersey	X	X	X		Survey, Literature Review, Data Collection	Safety Management
FHWA-NJ-2019-008	Evaluation of Semi-Circular Bend Test for HMA Specialty Mixes	X		X		Demonstration and Testing, Materials Engineering	Capital Improvement & Infrastructure
FHWA-NJ-2019-009	Research Library Operations (2018-2019)		X	X		Survey, Data Collection, and Literature Review,	Policy and Organization
FHWA-NJ-2019-010	Detection of Damage Precursors in Steel Components for Life-Cycle Assessments NJDOT Strategic Research Planning	X		X		Demonstration and Testing, Data Collection, Testing, Materials	Multimodal
NJ-2019-001	NJDOT Strategic Research Planning		X	X		Literature Review, Survey, Data Collection	Policy and Organization

FHWA-NJ-2019-001

Defining the Hudson Bergen Light Rail Catchment Area

Research Category:	Planning & Environment
Project Budgeted Cost:	$291,290
Project Customer:	NJDOT
Organization:	Rutgers University

Background

Due to the recent growth of the area that is served by the Hudson Bergen Light Rail (HBLR) system, and the lack of any prior study evaluating the region, this study was initiated to define the full "catchment area" of the HBLR system and its stations. The objective of this research study was to conduct a comprehensive onboard survey of HBLR weekday riders and use the results of the survey and analysis of secondary data to identify the ridership catchment area of the HBLR system, in the context of its interaction with other transportation modes in the area. To achieve these research objectives, the research team employed a mixed methods approach that included a review of available literature, focus groups to collect qualitative impressions of how HBLR riders use the system, primary data collection in the form of a passenger intercept survey and analysis of both primary and secondary data.

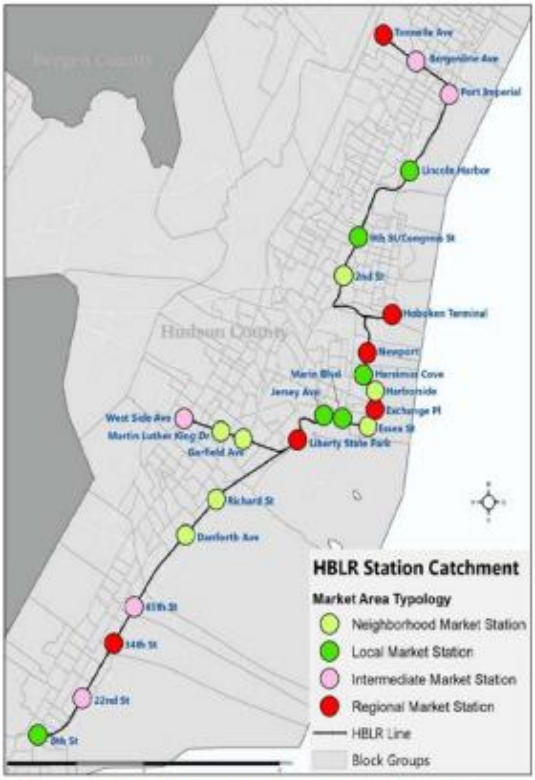


Figure 1. HBLR Catchment Area Station Market Typology

Implementation

This project collected rider origin, destination, demographic and other data about residential choice decisions. Analysis of 3,300 completed surveys found that the vast majority of HBLR riders are frequent users and more than 80 percent of all trips made on the HBLR are for work commute purposes. Evidence from this study suggests that the HBLR plays a dual role in the northern New Jersey transportation landscape. Similar to many light rail systems throughout the world, the HBLR serves an important function as a collector/distributer system. Based on the results of this study, it can be concluded that the HBLR system and many of its stations have both a micro- and a macro-catchment area.

The data collected during the project was important for the research customer at NJ TRANSIT noting that it has multiple uses and applications. The modeling group used the date for NJ TRANSIT's transit model. The travel data and demographic data was used for Title VI compliance; while data about riders with disabilities was recently used by the state of good repair group to determine alternate busing needs while an elevator was repaired at a station. The data was used by the planning group at the NJ TRANSIT when one of the HBRL lines was closed down. The real estate group uses demographics data to determine potential advertising markets. The data has been used also been used for planning for future expansions of the HBLR.

The collected data can be used to inform future decisions about light rail operations and planning for the future northern branch extension of the HBLR as well as future policy changes. The approach taken can improve data collection on future surveys of a similar nature, such as an anticipated Newark Light Rail survey project.

The research led to the following presentations:

Deka, D., and Carnegie, J. Importance of The Hudson-Bergen Light Rail in Riders' Residential Location Choice. Paper presented at the Annual Meeting of the Transportation Research Board, Washington, DC, January 2018.

Carnegie, J. Hudson Bergen Light Rail - New Jersey's Gold Coast Would Not Be the Same Without You. Paper presented at the 14th National Light Rail & Streetcar Conference by the Transportation Research Board & American Public Transportation Association Jersey City, New Jersey, April 2019.

Deka, D. The Many Catchment Areas of the Hudson-Bergen Light Rail. Paper presented at the 14th National Light Rail & Streetcar Conference by the Transportation Research Board & American Public Transportation Association Jersey City, New Jersey, April 2019.

FHWA-NJ-2019-002

Real-Time Traffic Signal System Performance Measurement

Research Category: Mobility and Operations
Project Budgeted Cost: $298,217
Project Customer: NJDOT
Organization: Rutgers University

Background

This project developed Adaptive Traffic Signal Performance Measurement (ATSPM) processes and considered existing implementation options according to NJDOT agency capabilities and resources. The research team specifically designed the system based on Adaptive Traffic Control System (ATCS) and ATSPM open-source software to develop an economically justifiable ATSPM for arterial traffic management in New Jersey. The overall goal of this project was to recommend and develop performance metrics, system architectures, data management, and strategies for deploying ATSPM systems using existing and planned NJDOT arterial infrastructure and technologies. The research team recognizes that the deployment of various adaptive traffic control systems such as InSync and SCATS systems on major NJ corridors and networks have extended the capability for building realtime performance measures. This study's primary perspective is twofold: 1) how to utilize existing field data and equipment to establish Signal Performance Measures (SPMs) for real-time monitoring, and 2) what additional data and equipment may be employed to generate additional SPMs while automating the real-time traffic signal monitoring process.

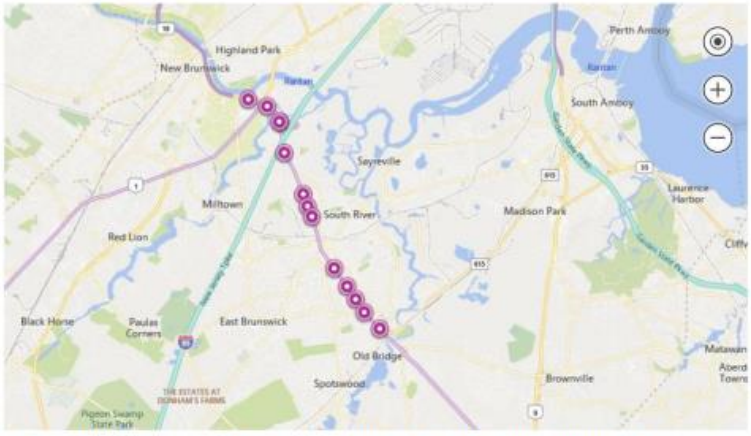


Figure 34 Intersections for Case Study of SCATS Along Route 18

Implementation

ATSPM has many advantages over traditional traffic signal monitoring and management processes. When considering implementation of Automated Traffic Signal Performance Measures (ATSPM), it is important to take into account existing, forthcoming and planned infrastructure. Considering that NJDOT is actively deploying adaptive signal control technology on major NJ corridors, the incorporation of various adaptive traffic control systems such as InSync and SCATS systems have created a foundation for building real-time performance measures. The research created an inventory of existing NJDOT arterial management systems, identified performance metrics, developed guidelines and a concept of operations, and developed strategies for large scale deployment.

The research project has resulted in multiple implementations and plans for future research projects. The team conducted a case study of system deployment and implemented the process of pulling one month data into The College of New Jersey ASTPM platform. The research team also worked with NJDOT to gain access to the traffic signals from different intersections along the selected testing corridor.

The study laid out recommendations for significant future work activities that were planned for Phase II implementation. The team will create automated environments adapted to ATSPM data, where specific goals are listed for future work. The team will work with automated traffic signal control vendors/contractors more directly and make this project a standard ATSPM solution. The project will enable automated traffic signal control to generate ATSPM-like data such as Q/wait time, degree of saturation, predicted volumes, etc. into the ATSPM software.

The main beneficiaries of the research and implementation activities will be transportation users, as people who are travelling on major arterials monitored by ATSPM will have the benefit of efficient and faster signal timing management, and traffic planning departments which can utilize this system to predict and evaluate travel time status to make better transportation plans.

In addition to a final report, the research team created a data management manual for adaptive traffic signal processing. The team also established metadata table for the test signal controllers and validated the algorithm results through comprehensive debugging process.

In assessing areas of needed assistance to advance implementation, a member of the research team noted the need for additional coordination between OIT, NJDOT and the research team to address technical barriers and abide by networking rules.

Presentations have been given on the Phase I and subsequent Phase II implementation research:

In May 2019, the NJDOT customer gave a briefing presentation, Automated Traffic Signal Performance Measures, to the NJ STIC explaining the purpose and key findings of the study.

The study's findings and subsequent implementation activities were presented to NJDOT in the form of a Lunchtime Tech Talk webinar, Automating Traffic Signal Performance Measures for NJDOT Adaptive Traffic Signal Control Systems, on June 29, 2021. The presentation was led by Dr. Peter Jin, of Rutgers-CAIT, Dr. Thomas Brennan, from the College of New Jersey, and Kelly McVeigh from NJDOT's Mobility Engineering Unit.

The paper was also presented at the 2020 Transportation Research Board Annual Event - https://trid.trb.org/view/1681169

Zhang T., Jin P., Brennan, T., McVeigh, K. and Jalayer, M, Automating the Traffic Signal Performance Measures for Adaptive Traffic Signal Control System. ITS World Congress. 2020.

Tianya Zhang, Peter Jin, McVeigh, K., Brennan, T. and Jalayer, M, Automating the Traffic Signal Performance Measures for Adaptive Traffic Signal Control System. TRB 100th Annual Meeting, Washington, D.C., January 2021.

In June 2020, a research spotlight article, Development of Real-Time Traffic Signal Performance Measurement System, was posted on the NJDOT Tech Transfer Website that highlighted the researchconducted to that date and subsequent implementation activities.

In November 2021, the Intelligent Transportation Systems Joint Program Office (ITS JPO) of the U.S. Department of Transportation (USDOT) featured the project in a lessons learned ITS Lessons Learned Knowledge Resource, Leverage Existing Adaptive Signal Control Systems Data to Create a Foundation for Building Real-Time Performance Measures to Better Manage Operations

FHWA-NJ-2019-003

Traveler Information Application for Route 1 and Route 18 Corridors

Research Category:	Mobility and Operations
Project Budgeted Cost:	$232,055
Customer:	NJDOT
Organization:	SUNY Albany

Background

This project was created as a means to develop a hands-free Mobile Application (app) platform to aid travelers by offering travel information that utilizes the data it currently collects from its real-time transportation information systems and includes additional travel-related information such as transit and shuttle schedules and availability of parking. Before conducting this project, the only way New Jersey travelers could obtain travel time information was through Dynamic Messaging Signs (DMS), the 511 NJ website or through commercially available sources such as Google Maps and Waze. These traveler information technologies, however, have their own deficiencies.

Implementation

The final product of this research was an enhanced mobile computer application platform that receives travel time information, parking information and transit/shuttle schedule information in real time for the Routes 1 (from I-295 to Garden State Parkway) and 18 (from New Jersey Turnpike to Rutgers University – Piscataway, NJ) corridors, specific to certain destinations such as colleges and/or large employment destinations. The application was designed so that other corridors and/or destinations could be added to the system by the owner of the application. This mobile application enhancement provided auditory and visual information related to corridor-specific travel time as well as transit/shuttle and parking information in the study area. Currently the app is not in use, pending a decision on who will host the platform.

The study's findings and the resulting application were presented by Dr. Lawson at the ITS-NYS 26th Annual and Technology Exhibition and Conference, June 13-14, 2019, in Saratoga Springs, NY entitled "Assistive Intelligence: Advancing the Value of Mobile Apps”.

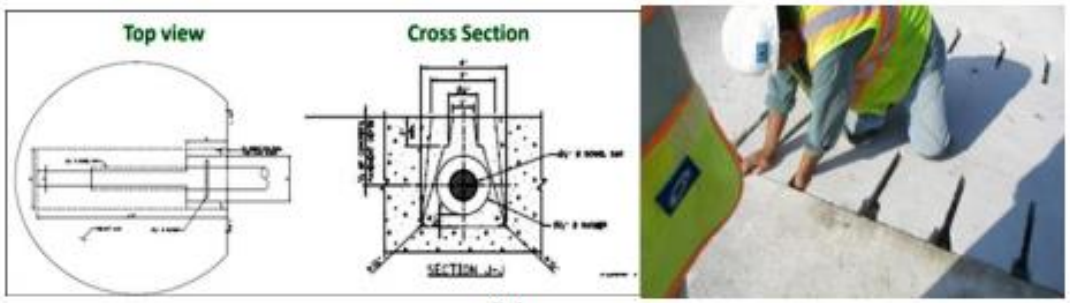
FHWA-NJ-2019-004

Evaluation of Precast Concrete Pavement Systems and Cast In-Place: Phase I: Identification of Accelerated Concrete Pavement Rehabilitation Methods

Research Category:	Capital Improvement and Infrastructure
Project Budgeted Cost:	$54,896
Project Customer:	NJDOT
Organization:	Rutgers University

Background

NJDOT has the ability to rehabilitate and open Portland Cement Concrete (PCC) pavements to traffic within a short period of time and minimize road closure effects using rapid concrete pavement repair methods. The goal of this study was to evaluate current accelerated concrete pavement rehabilitation technologies and their respective construction standards for use and implementation in New Jersey. Currently, NJDOT has one approved Precast Concrete Pavement (PCP) system and a limited number of accelerated Cast In-Place (aCIP) materials. Although the approved sets of materials have provided satisfactory performance for their intended uses, consideration of alternative materials would be beneficial. Additionally, more PCC rapid repair technologies could lead to even shorter repair times, greater cost-efficiency, and reduction in traffic congestion. Thus, it is crucial to identify and evaluate rapid PCC pavement rehabilitation technologies. This study aims to address these needs by identifying other PCP and aCIP rapid repair technologies that can potentially be employed in NJ.



(b)

Implementation

Based on a review of available rapid concrete pavement repair systems and contact with other State Highway Agencies (SHAs), the following conclusions were drawn:

- Several PCP systems were identified; however, only four PCP systems were considered available for use in NJ.
- The most critical component, based on the observations of SHAs that utilize PCP systems, is the installation of the PCP system.
- Most DOTs that use rapid PCP repairs allow for the acceptance of new PCP technologies through a trial installation procedure. In this, the contractor and system must demonstrate the ability to install precast concrete pavement panels according to the DOT's specification and obtain an adequate Load Transfer Efficiency (LTE).
- Modifications to aCIP materials are available to further improve and adapt for pavement repair.

These findings resulted in generic construction specifications for precast concrete pavement repairs based upon the results of consultations with other state transportation agencies and review of state specifications. Due to the complexity of the precast system approval process and the involvement of various bureaus at NJDOT in the process, a streamlined approval process was described.

The research team recommended a follow-up project to allow NJDOT to evaluate multiple vendors for precast systems. The research team recommended future research to finalize specifications for PCC and installation and to prepare a more comprehensive study in the development and evaluation of CIP systems including specific CIP mixtures recommended for further study.

The findings were presented in a poster session at the 2020 Transportations Research Board Annual Meeting, and a paper, Developing Specifications for Precast Concrete Highway Pavements, was published in the International Journal of Pavement Engineering in September 2020.

A Lunchtime Tech Talk! webinar presentation, Evaluation of Precast Concrete Pavement Systems and State Specifications, was made on June 10, 2020 by the Principal Investigator and Research Associate.

FHWA-NJ-2019-005

The Cost of Roadway Construction and Maintenance in New Jersey

Research Category: Capital Improvement and Infrastructure
Project Budgeted Cost: $84,452
Project Customer: NJDOT
Organization: Rutgers University

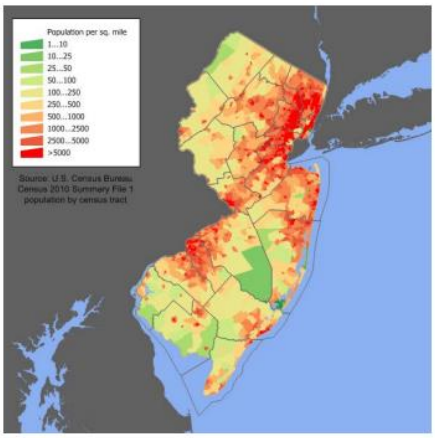


Figure 3. Map of New Jersey Population Densities

Background

New Jersey's transportation systems comprise a vast array of infrastructure. The costs associated with planning, constructing, operating and maintaining New Jersey's transportation infrastructure is significant. This research study estimated the average cost per-lane mile for roadway construction projects on State-owned roadways during a four-year analysis period; benchmarked New Jersey roadway construction costs against those of other states; identified factors that appear to influence construction costs; and identified leading practices that can improve the cost efficiency of roadway construction projects. To achieve these research objectives, the Rutgers research team conducted a two-phase study. Phase 1 of the study, which was completed in May 2016, involved analysis of annual NJDOT expenditures for various activities related to administration, planning and research, capital construction, operations and maintenance, and debt service to provide a base-line understanding of costs associated with roadways under NJDOT jurisdiction. Phase 2 of the study found that the statewide average total project cost per lane-mile was $191,175, which is in line with costs estimated in other states.

Implementation

The analysis showed that projects funded using Federal funding were, on average, more expensive than those funded with 100 percent State funding. Costs were also higher when projects were constructed on Interstate highways, other freeways and expressways as well as two-lane, lower-volume roads. Longer projects were much more likely to be low or very low cost while projects that were less than six miles long tended to be higher cost. Given these findings, NJDOT should further examine projects constructed on two-lane, lower-volume, undivided roadways to determine why project costs are higher on these roads and if bid specifications can be adjusted to reduce costs. Further, NJDOT should examine how project limits are currently defined to determine if there are opportunities to extend the length of projects to increase the total lane-miles of pavement addressed in each project. This can optimize the value received from construction mobilization efforts under each contract.

While the findings of the report were not presented at any seminars or showcases, data from the report was used by NJDOT in response to media inquiries related to the findings of a report that compares the cost of roadway construction in all 50 states, and which dramatically overstated the costs in New Jersey. The results of this study provided the NJDOT with a basis for rebutting the findings of the national report, and as a result was covered in the news and on social media. One example is listed below:

NJ Advance Media, NJ.com Does it cost $2 million or $212K a mile to build roads in N.J.?. Larry Higgs, August 2019.

FHWA-NJ-2019-006

UAS (Drone) Peer Exchange

Research Category:	Mobility and Operations
Project Budgeted Cost:	$26,693
Project Customer:	NJDOT
Organization:	Rutgers University

Background

The use of drones by public sector agencies such as the NJDOT is progressing at an exponential rate. States are funding groundbreaking research and expanding their UAS program with limited funding and guidance. The UAS Peer Exchange sought to explore successful policies, procedures, and practices for drone technology in transportation and was designed to leverage the lessons that could be drawn from research and by sharing best practices and management innovations. The 2017 NJDOT Peer Exchange was held on October 3rd-5th in Trenton, New Jersey. The panelists included state DOT UAS leaders from Delaware, Kansas, Massachusetts, New Jersey, North Carolina, and Pennsylvania, as well as UAS leaders from the FAA, New Jersey State Police, and the NJ State Forest Fire Service,

Implementation

The basic approach was to invite UAS leaders from other state DOTs to meet in New Jersey to discuss and review its process for a specific focus area. The host agency shared policies and procedures prior to the meeting. During the peer exchange, panel members met with managers, staff, stakeholders, and customers to gain further insight into the host agency's program. The peer exchange successfully shared UAS experiences, research, and best practices among the panelists. Each state presented an overview of their UAS initiatives and explained the rationale and “lessons learned” in developing their program.

On October 25, 2017, UAS Coordinator, Glenn Stott spoke on the topic at the NJDOT Research Showcase. The presentation highlighted the new guidelines and takeaways that were gained from the peer exchange, namely safety and jurisdictional questions that would need to be answered.

The importance of the peer exchange was also featured in a video, Drone Technology at NJDOT, that highlighted various initial funding sources used for standing up a UAS Program at NJDOT. The video featured several use cases for how UAS is advancing innovation at NJDOT. The peer exchange was a catalyst for various other research and use case investigations featured on the NJ STIC Innovative Initiatives page, Unmanned Aerial Systems.

FHWA-NJ-2019-007

Calibration / Development of Safety Performance Functions in New Jersey

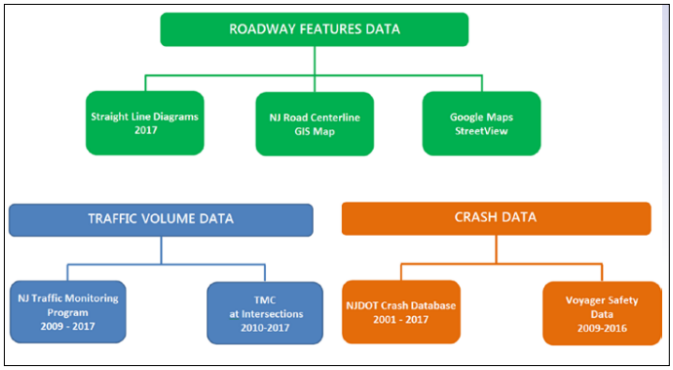
Research Category:	Safety Management
Project Budgeted Cost:	$450,242
Project Customer:	NJDOT
Organization:	New York University

Background

Safety Performance Functions (SPFs) in the Highway Safety Manual (HSM) were developed using historic crash data collected in different states. To make the SPFs better accommodate the local data, two strategies are usually undertaken: the first strategy is to calibrate SPFs provided in HSM so that the contents of HSM can be fully leveraged, and the second strategy is to develop location-specific SPFs regardless of the predictive modeling framework in the HSM. The main objective of this research project is to (1) calibrate the SPFs provided in the HSM using New Jersey (NJ) data and (2) develop new NJ-specific SPFs as appropriate.

Implementation

This report gathered and processed New Jersey specific data. The research team estimated calibration factors for 13 facility types, including rural two-lane two-way segments and intersections, rural multilane highway segments, urban and suburban segments and intersections. The Calibrator tool developed by the FHWA was utilized to calculate the calibration factors and measure how well they fit. Using the same data used for calibration, the research team developed NJ-specific SPFs for 11 facility types, including rural two-lane two-way segments and intersections, urban segments and intersections with a sufficient number of data points using the Voyager Safety crash data from 2011 to 2015. SPFs were estimated based on the negative binomial model suggested by the HSM. The team used the R statistical package to estimate the model parameters and their statistical significance. The research team also modified the spreadsheets developed by the HSM, which are currently being used by NJDOT staff. The calculated calibration factors and the developed SPFs are embedded in these spreadsheets. The users can now select whether to use the HSM SPFs with the calculated calibration factors or to use the New Jersey-specific SPF in their analyses.



The research project itself utilized several workshops to develop and test the technology. While there are no further pilot projects or demonstrations planned, the NJ-specific calibration factors, or NJ-specific SPFs, that were developed and evaluated during this project are now being used statewide by MPOs and consultants and required to be used in HSM analyses submitted to NJDOT's Bureau of Safety, Bicycle and Pedestrian Programs (BSBPP). HSM practitioners in NJ like the MPOs, were advised to use them and was required after the research results were finalized in 2019.

The findings were presented via webinar hosted by C2Smart on September 10, 2020.

FHWA-NJ-2019-008

Evaluation of Semi-Circular Bend Test for HMA Specialty Mixes

Research Category: Capital Improvement & Infrastructure
Project Budgeted Cost: $530,565
Project Customer: NJDOT
Organization: Rutgers University

Background

Mixture Type			Min. Cycles in Overlay Tester	Min. SCB Flexibility Index (Rounded)
HRAP	Surface	76-22	275	10.0
		64-22	200	9.0
	Intermediate/ Base	76-22	150	8.0
		64-22	100	6.0
BRIC	Mixture Design		700	17.0
	Production		650	16.0
HPTO	Mixture Design		600	15.0
	Production			

The Semi-Circular Bend (SCB) Flexibility Index (FI) test is a new and promising test procedure proposed for evaluating the fatigue cracking resistance of asphalt mixtures. The test method shows improved testing speed over the Overlay Tester, which is currently used by NJDOT for the performance testing of High Performance Thin Overlay (HPTO), Binder Rich Intermediate Course (BRIC), and High Recycled Asphalt Pavement (HRAP) asphalt mixtures. NJDOT has little experience with the test method, and therefore required additional information regarding its sensitivity to test parameters, influence by asphalt mixture characteristics, and general repeatability. NJDOT was interested in evaluating the SCB FI test in the hope that it ranks fatigue cracking performance in the same manner as the Overlay Tester, yet reduces the time to complete the performance testing. The purpose of this project was to research and evaluate the different variations (temperature, notch dimensions, load rates, etc.) of the Semi-Circular Bend (SCB) Flexibility Index (FI) test.

Implementation

To fulfill the objectives, the methodology utilized in the research study first consisted of a modified ruggedness study to evaluate the different test parameters of the SCB FI test and how they affected the final test results. Companion testing between the Overlay Tester and the SCB FI was then conducted to develop a robust relationship between the two test methods in an effort to propose a fatigue cracking criteria for the SCB FI test for NJDOT asphalt mixtures. This research study was conducted to evaluate the SCB Flexibility Index as a potential test method that could be implemented by NJDOT with their performance related specifications. The advantage of using the SCB Flexibility Index over the NJDOT's current test procedure, the Overlay Tester (NJDOT B-10), is the improvement in testing speed.

Besides the improvements found during the project, several recommendations for future research to improve calibration and follow-up testing, including field evaluation, were made. Testing methods should be provided to the industry for evaluation and potential adoption.

A paper summarizing the study was submitted to the 2020 Transportation Research Board's Annual meeting.

FHWA-NJ-2019-009

Research Library Operations (2018-2019)

Research Category:	Policy and Organization
Project Budgeted Cost:	$277,971
Project Customer:	NJDOT
Organization:	New Jersey State Library

Background

Since 1998, the NJDOT Research Library has operated as a branch of the New Jersey State Library (affiliated with Thomas Edison State University) to provide onsite library services to NJDOT, to support the research and technical work of the Department and its affiliated agencies, and to provide stewardship of the Research Bureau's collection of technical reports and other materials. The main objectives of this research project were to operate and improve the Research Library as a major resource for transportation knowledge sharing and technology transfer. By partnering with NJDOT staff and Department units whenever possible, and with other transportation libraries and entities, Library staff sought to provide support to the organization and the industry, to assist people in their professional endeavors, and to fill gaps in the body of knowledge within the Department and externally. This report examines research library operations from July 2018 through June 2019. The number of requests received remained relatively stable. The vast majority of requests came from NJDOT requesters.

Implementation

Because the library was in the process of moving to a new location for much of the last quarter of calendar year 2018, usage by NJDOT requesters dipped significantly during that time. That said, the Research Library continued to operate without permanently assigned staff onsite. Supervising librarians from the State Library Reference Services section were onsite 3-4 hours, usually four days a week to work on collection maintenance, respond to reference requests, or follow through on administrative needs of the library. The research concluded that newly hired library staff should be trained and mentored to understand how to manage a technical library as a solo librarian. Furthermore, additional information was gathered to determine best practices for library management going forward. A library brochure has been regularly updated for dissemination among DOT staff to inform them of resources and services available through the DOT Research Library.

After documenting the research library operations conducted as a research project with the NJ State Library through Thomas Edison State University, it was deemed that a physical library was not in alignment with the changing needs of NJDOT employees in the 21st Century. Therefore, the footprint of the library has been reduced, hardcopy book purchases have been limited, and the operation of the library is more electronic resource oriented. Currently, the Technology Transfer project supports an on-site research librarian for assistance and a Research Library landing page with various links and resources to support research activities.

FHWA-NJ-2019-010

Detection of Damage Precursors in Steel Components for Life-Cycle Assessments

Research Category:	Capital Improvement & Infrastructure
Project Budgeted Cost:	$509,551
Project Customer:	NJDOT
Organization:	Stevens Institute of Technology

Background

Up to 90 percent of failures of in-service metallic structures happen due to fatigue cracks. A fatigue crack starts as a damage precursor at unperceivable levels (such as molecular dislocation or micro cracking) when the material is subjected to repeated loading. A new technology based on Nonlinear Vibro-Acoustic Modulation (VAM) has been developed and is one of the prevailing nonlinear methods of structural-damage evaluation. This research sought to develop and test a monitoring method that works for various materials with complicated geometries, and is quick, accurate, and interfaces with simple data output.

Implementation

A new VAM system, trade name FN-Scan©, capable of data collection in the field utilizing bridge ambient vibrations, has been developed and fabricated. The system consists of a 3D accelerometer for acquiring bridge vibrations for triggering, extracting resonance frequencies and amplitude normalizing; at least two ultrasonic broadband transducers for transmitting and receiving high frequency signals; signal pre-amplifier with variable gain and band-pass filter; ultrasonic power amplifier; multi-channel high speed digital acquisition system (DAQ); and a laptop computer with in-house developed software which generates signals, controls DAQ, processes received signals and stores the data.

The research recommended further testing and research of this new tool, including large-scale laboratory testing, a field test and a steel bridge, and development of an end-user-friendly system that can be taken into the field.

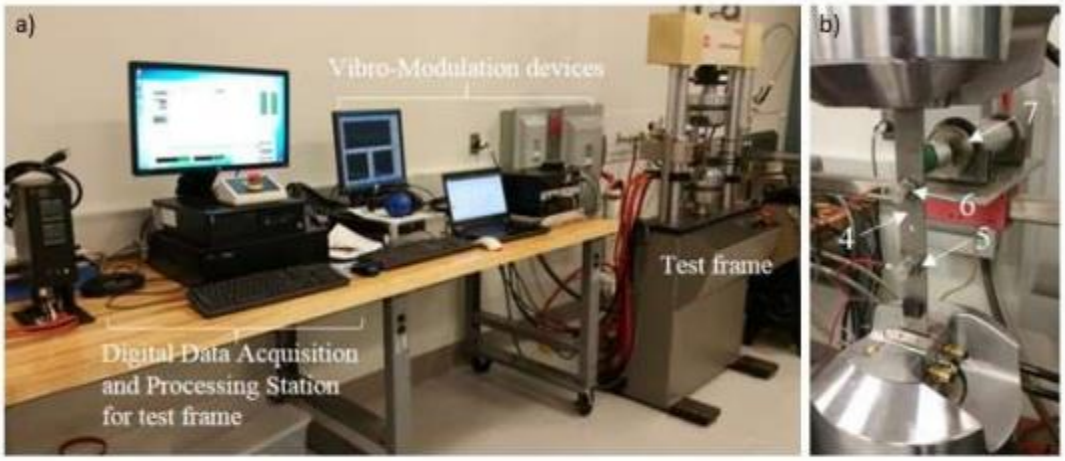


Figure 10. (a) Test setup and (b) a specimen mounted in fatigue testing machine

NJ-2019-001

NJDOT Strategic Research Planning

Research Category:	Policy and Organization
Project Budgeted Cost:	$136,660
Project Customer:	NJDOT
Organization:	Cambridge Systematics

Background

NJDOT is responsible for the complex task of managing and maintaining New Jersey's multi-modal transportation system. Simultaneously, the Department needs to accurately forecast and plan for shifting travel demand, new technologies, funding, external factors such as severe weather, and internal factors such as talent acquisition, retention and knowledge transfer. While these various factors add a further layer of complexity, they are also necessary to best positioning NJDOT to perform its core functions. The purpose of this project was to develop a strategic research plan, based on a foundation of insight into national best practices and internal agency employee knowledge, in order for NJDOT to best understand constantly shifting needs and travel demand. The objective of this research was to develop an implementation and prioritization plan to address current and future research needs.

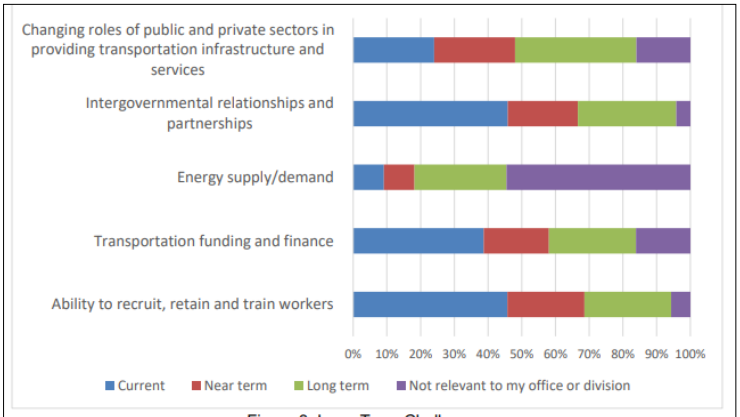


Figure 3. Long-Term Challenges

Implementation

In summary, this report aimed to provide the NJDOT Bureau of Research with the framework for a strategic plan that lays out priorities for future research. The primary conclusions reached were that NJDOT will be influenced by a wide range of global, domestic, and local factors; talent and Knowledge Management are key organizational issues faced by NJDOT; infrastructure and technology have comprised the largest proportions of recently conducted research; and key research needs include technology and staffing.

The implementation strategy provides recommendations on how NJDOT should prioritize future research based on this overall planning process. In particular, the primary and secondary research needs and corresponding gap assessment provide the basis for this strategy. Critically, it was recommended that NJDOT should consider formalizing a plan and process for knowledge transfer, conduct outreach to ensure technology research directly responds to the needs of NJDOT staff, and identify technologies that will further enhance NJDOT's infrastructure management operations.