New Jersey Department of Transportation

2007

RESEARCH IMPLEMENTATION

REPORT

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2007 NJDOT RESEARCH IMPLEMENTATION REPORT

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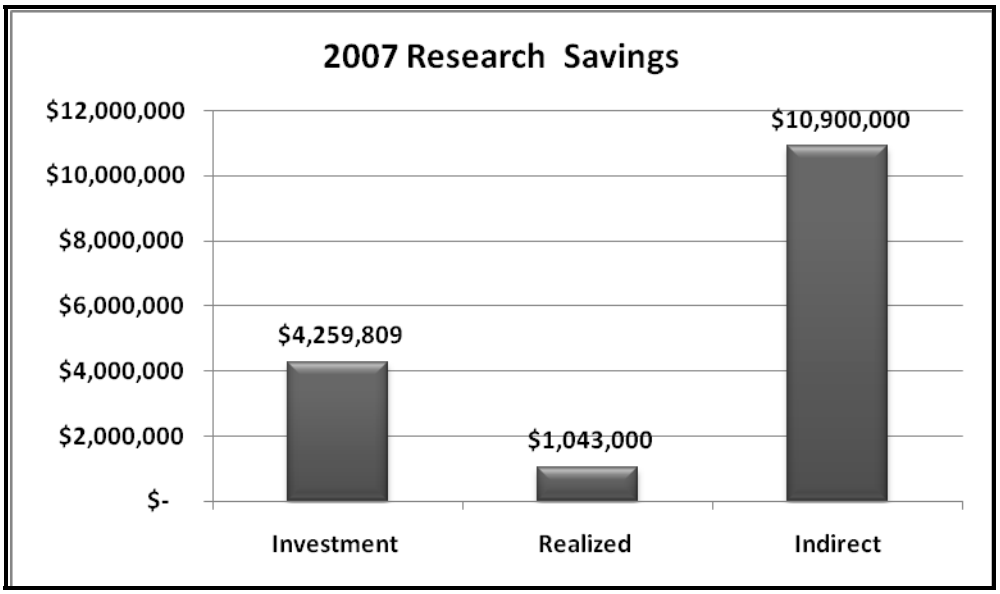
2007 NJDOT RESEARCH IMPLEMENTATION REPORT

Executive Summary

New Jersey Department of Transportation (NJDOT), Bureau of Research, annually funds about 20 research projects that support the transportation industry. Requested by industry customers, many of these projects solve important transportation problems that contribute to long-term impacts in New Jersey. The Bureau is frequently approached by sponsors to justify the value of these projects to a much broader audience; therefore, the intent of this implementation study is to identify the quantitative and qualitative benefits of NJDOT research projects that were completed in 2007.

The scope of this study included measuring technology transfer benefits on four levels: knowledge transfer, marketing efforts, adoption of policy changes, and demonstration of technology to new audiences. Benefits were defined as enhancements, cost savings and economic impact; improvement of safety, and reduction of labor time for the customers, known as champions.

Principal Investigators from universities were interviewed by email, telephone, or in person on the outcomes of their research projects. It was expected that researchers would report on additional studies and projects that had been generated as a consequence of this initial work. Interviews were arranged with the customers to discuss research benefits and follow up activities that happened as a result of the projects.



Nearly half of the projects were computer based decision-making models that had been designed to monitor safety and environmental compliance in New Jersey. Over $1 million was realized from research implementation during this period, while indirect savings were assessed at $ 10.9 million in reduction of utility pole crashes. An additional $103.8 in savings was attributed to the 32 fewer fatal utility pole crashes that occurred during this period. Future savings will be realized from the reduction of bridge material and repair costs that are expected to occur from the implementation of the 2007 Roadway and Bridge Construction Specifications.

NJDOT Realized Savings

Safety projects provided the greatest financial benefit due to the strong economic gain associated with crash reductions. Approximately 10,000 vehicle occupants are involved in utility pole crashes yearly, which results in between 50-60 fatalities and 200 persons being incapacitated. New Jersey is ranked 8th in the country for fatalities due to utility impacts. The research goal was to review and recommend methods of mitigating these types of fatal and injury crashes. The rigid design of the pole, required to survive high winds, was the major reason behind the high fatality rate for this type of crash.

Rowan University and Virginia Tech participated in this utility pole crash mitigation study, which included a comparison of the current NJ Utility Accommodation Policy to national practices. Data was also used to examine the conditions surrounding utility pole crashes and the identification of high risk sites. A cost-benefit procedure was then developed for determining the use of breakaway or energy absorbing utility poles.

The findings confirmed that the New Jersey Utilities Accommodation policy follows national guidelines closely, but focuses primarily on new construction or reconstruction. The 2003-05 crash data analysis confirmed that 40% of all occupants exposed to utility pole crashes were either injured or died. County roads accounted for most crashes and frontal impacts were most common. Also, motorcycle crashes were overrepresented in this category. U.S. Highway 22 was rated as having a serious utility pole impact problem.

After the project was completed, William Beans, Bureau of Safety Projects, obtained $300,000 in federal funds to sponsor a utility pole crash reduction program. The NJDOT Utility Unit and the Bureau collaborated on this effort to reduce fatalities nearly by half.

2007-2008 New Jersey Utility Pole Crashes

Crash Types	2007	2008
Property Damage	4,551	4,293
Injury Crashes	3,444	3,234
Fatal Crashes	72	40

Source: *Plan4Safety 2009.*

The New Jersey Department of Transportation (NJDOT) has long recognized the importance of Crash Reduction Factors in conducting benefit/cost analyses for highway safety improvements. According to FHWA, the average cost of a fatality has been established at $3,246,192 while the cost an injury crash was determined to be $68,170. Plan4Safety showed a reduction of 32 fatal utility pole crashes and 160 utility pole injury crashes had occurred after the relocation of utility poles in high crash areas. Based on these estimates, a total of $103.8 million had been saved through the reduction of fatal crashes and $10.9 million on the reduction of injury crashes. Only injury crash reductions were included in the cost savings, since the cost of fatal crashes may be linked to increased gas prices that affected travel. Most importantly, 32 fewer people died and 160 fewer people were injured from hitting utility poles.

Also, the Police Local Technical Assistance Program project realized additional financial support from National Highway Traffic Safety Administration in the amount of $600,000 that was used to integrate the State's crash data system into one unit. The Implementation of Quality Assurance project generated over $143,000 in savings through the use of processed dredged clay to cover the NJ Meadowlands Landfill. Other savings will be realized by the Department in the future, when TIGER and bridge projects are completed.

2007 NJDOT RESEARCH IMPLEMENTATION REPORT

Introduction

The New Jersey Department of Transportation (NJDOT), Bureau of Research funded 20 research projects that support the advancement of transportation in New Jersey. Many of these projects solve important transportation problems, but limited information has been known about the long-term effects of these research studies. The Bureau is often approached by sponsors to justify the value of these projects to a much broader audience; which is the purpose of this implementation study, the identification of quantitative and qualitative benefits of completed projects.

About the New Jersey Department of Transportation Bureau of Research

The Bureau of Research is responsible for delivering quality research and technology transfer solutions through a customer-focused program. This research is dedicated to identifying new products, improving existing processes, and refining systems that support the transportation infrastructure, enhance public safety, improve mobility, reduce congestion, protect the environment, and introduce innovative technologies to New Jersey based customers. The Bureau serves every unit within the Department of Transportation, Motor Vehicle Commission, and New Jersey Transit (NJDOT, 2007). The Bureau partners with area Universities and consultants to conduct surveys and literature searches, demonstration projects, and research studies on transportation related issues.

Academic Research Partners

New Jersey Institute of Technology

Princeton University

Rowan University

Rutgers, The State University of New Jersey

Stevens Institute of Technology

The College of New Jersey

University Transportation Research Center Consortium

Members of the UTRC Consortium

- City University of New York (CUNY)*
- Columbia University (Columbia)
- Cornell University (Cornell)
- New Jersey Institute of Technology
- New York University (NYU)
- Polytechnic University (Polytechnic)
- Rensselaer Polytechnic Institute (RPI)
- Rowan University (Rowan)
- Rutgers University. The State University of New Jersey*
- State University of New York (SUNY)
- Stevens Institute of Technology (Stevens)
- University of Puerto Rico - Mayagüez (UPRM)

**USDOT University Transportation Centers*

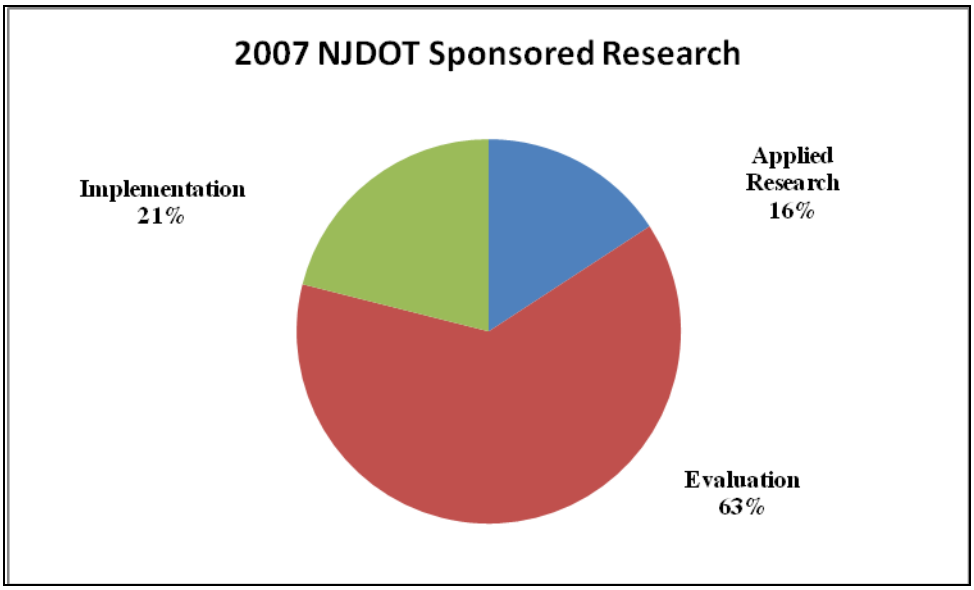
Methodology

The purpose of this follow-up study had been to quantify the outcomes of funded research that was completed for the Department in 2007. Technology transfer benefits were measured on four levels: knowledge transfer, marketing efforts, adoption of policy changes, and demonstration of technology to new audiences. Benefits were defined as enhancements, cost savings and economic impact; improvement of safety, and reduction of labor time for the customers, known as champions (See Attachment A).

Project Investigators were interviewed by email, telephone, or in person on the outcomes of their research projects. It was expected that investigators would report on additional studies and projects that had been generated as a consequence of this initial work. Since the information was not always available, NJDOT customers were identified by Project Investigators. Interviews were arranged with the customers to establish, not only benefits, but follow up activities that happened as a result of the research. When required, NJDOT project managers were also contacted to provide background information.

2007 NJDOT Research Project Reviews

In 2007, the 19 research projects included evaluation of bridge material specifications, transportation modeling, safety crash investigations, pricing of road projects, environmental monitoring, and congestion management. The research methodology included adaptation of pre-existing or new technologies in the focus areas of Intelligent Transportation Systems (ITS), Infrastructure, Safety and Human Factors, and the Environment. Approximately half of the studies addressed ITS or Infrastructure issues (47%); while 37% involved roadway safety and 16% the environment. The studies were evenly divided between using new technologies and adapting best practices from elsewhere to solve a transportation problem. Best practices from elsewhere were applied to meet New Jersey needs with the development of parking guidelines, introduction of rapid transit, tracking of compliance activities, adoption of industry standards, and driver licensing requirements. The following section examines each of the projects that were completed during this period.



FHWA-NJ-2007:001 Safety Audit of Fatalities and Injuries Involving Guide Rail – Dr. H. Clay Gabler, Virginia Tech

Cost: $238,440.

Summary

Guide rail protects occupants from the environment, especially with run off road events. In 2005, there were 1,189 fatal crashes and 35,000 injury crashes that occurred in the United States. The goal of the study was to evaluate this type of crash, using crash data, and determine the most suitable application for the job. Despite the success of guide rail applications, there were still several unresolved issues that needed to be addressed including secondary impacts, vehicle rollover hazards, motorcycle to barrier crashes, and side impacts. Guide rail crashes frequently lead to fatalities due to improper installation, impacts with end treatments, unfavorable roadside conditions, soft soil, side impact, improper redirection after a crash wheel snagging, and secondary impacts. Guide rail performance can also be affected by barrier and roadway designs. Poor performance may cause vehicles to overturn on impact with the guide rail, submarine under the guide rail, airbag induced injuries, and conflicts with heavy trucks.

Several trends emerged from the review of New Jersey crash data records. Nearly 10,000 vehicles were exposed to crashes involving guide rail. Between 10 and 12 persons were fatality injured and 100 persons received incapacitating injuries. Guide rails usually performed well to reduce deaths and crashes with 75% of these crashes having no injuries. State highways were over represented in crashes (23%) that accounted for guide rail crashes. New Jersey had ranked 20th for guide rail fatalities in the country.

An in-depth review was conducted of 26 guide rail crashes and investigations that included photographs, detailed field measures of damaged barrier components, as well as roadside conditions. The findings showed that guide rails did perform adequately and occupant injuries were minor. Secondary crashes were problematic with 40% of investigated crashes involved another impact. Unresolved issues included identification of secondary impacts, guide rail as a potential roll over hazard, and site impacts.

Further Recommendations

Guide rails contribute to two percent of New Jersey's roadway deaths. The research findings showed that state highways are overrepresented in serious guide rail collisions. They account for 23% of all guide rail crashes and 30% of all fatal and incapacitating guide rail crashes. Therefore, further consideration needed to be given to preventing guide rail collisions on NJDOT highways.

Implementation

The study was featured on an international website (Switzerland) and referenced in the State of Alaska 2006 Traffic Records Advisory Program. According to the Principal Investigator, this project was an important factor in inspiring the development of the TRB NCHRP 22-23 Report "Criteria for Reduction of Fatalities in Vehicle-Guardrail Collisions", that was presented in 2007 at the 51st Annual Proceedings of the Association for the Advancement of Automotive Medicine (Melbourne, Australia).

Safety Audits of Fatalities and Injuries Involving Guide Rail

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		✓
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

Projected Cost Benefit/Economic Impact

William Beans, NJDOT Bureau of Safety Programs, mentioned that this guide rail study resulted from a national effort to address median cross over crashes and fatalities. The study was useful because it identified where the number of installed guide rails were getting hit. Although property damage crashes increased with the installation of the guide rails, injury and fatal crashes were reduced.

NJ-2007-001: Viability of Personal Rapid Transit in New Jersey – Jon Carnegie, Rutgers University, Voorhees Transportation Center

Cost: $75,000.

Summary

In October 2004, the New Jersey Legislature passed P.L. 2004, Chapter 160 directing the Commissioner of Transportation, in consultation with the Executive Director of New Jersey Transit, to prepare a report evaluating the viability of Personal Rapid Transit in New Jersey. This study was prepared for the New Jersey Legislature to document the current state of Personal Rapid Transit (PRT) development and implementation, in order to explore the potential for adoption in New Jersey.

Personal Rapid Transit (PRT) has been the subject of research and development efforts for over 40 years, but there hasn't been a full scale deployment of this technology. A fully operational system is needed to demonstrate the benefits of PRT and established commercial readiness for the system. Research and demonstration programs were estimated as costing between $50 and 100 million over a three year period, so the product has not been commercially deployed. Therefore, much of the research study was based on engineering and theoretical research from PRT developers, government researchers, or independent consultants.

A comparison was made between PRT and other modes of transportation. The PRT system is estimated to have an average travel speed of 23 miles per hour (mph), which is higher than the national transit average of 14 mph or the heavy rail average of 20 mph. PRT systems could have shorter travel times than conventional transit modes for moderate length trips due to the need to stop at intermediate stations for conventional rail systems. PRT systems have theoretical and expected line capacities that could be equivalent to higher than comparable bus and light rail lines. Cost estimates are favorable to other larger guide way, larger-vehicle modes, actual costs depend on the extent of the guide way network. PRT systems could be expected to offer comparable operating and maintenance cost levels to heavy and commuter rail systems if deployed effectively. Since there is potentially a lower construction impact, noise level, and use of energy compared to other modes of transportation, PRT is an attractive, economic, and political alternative.

A summary of the worldwide history of PRT development was compiled, along with documentation on lessons learned from experts on PRT development. Theoretical benefits were presented and compared to other modes of public transportation, along with the risks related to PRT implementation. A series of options were then presented the Commissioner of Transportation for advancing PRT development in New Jersey and enabling decision makers to consider this transportation option in the future.

Implementation

Although PRT was not implemented in New Jersey, several knowledge transfer activities transpired based on the project. The study was published by TRB, and featured on the Personal Rapid Transit in New Zealand website. The municipality of Tehran and the Virginia Board of Education considered the study for local adoption. The Skyweb Express website acknowledged the state's political interest in piloting PRT as a transportation option.

Further Recommendations

PRT is viable as a circulator service in central business districts and within activity centers, such as airports and campuses. There is sufficient travel demand to support this higher capital cost transit service where automobile use is less efficient. Potential use of PRT systems include areas where there is a need to extend the reach of nearby conventional transit, areas of constrained access, areas of limited or expensive parking, and where connectivity is required between high activity centers.

Aside from public support, other options for advancing this technology include to monitor and support the development of PRT by private developers and reconsider applicability in the future. PRT has the potential to address certain transportation needs in a cost-effective, environmentally responsible, and traveler friendly manner. However, an adequate level of investment and commitment is required to support the full maturation of the technology.

Viability of Personal Rapid Transit in New Jersey

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact	✓	

Assemblyman John Wisniewski, Chair of the New Jersey Assembly Transportation Committee was informed about the potential use of personal rapid transit, but budgetary constraints prevented this technology from being implemented in New Jersey.

Projected Cost Benefit/Economic Impact

No action was taken by the Legislature to adopt the PRT technology. A series of options were presented for future consideration in advancing PRT development in New Jersey and enabling decision makers to consider this transportation option in the future. Recently, an investor had contacted the researcher about the potential of private/public sector investments in PRT systems.

FHWA-NJ 2007-002: Transit Friendly Parking Structure Guidelines: Planning, Design, and Stewardship – Darius Sollohub, New Jersey Institute of Technology

Cost: $293,000.

Summary

Transit friendly parking structure guidelines are required by communities transitioning from surface parking to structural parking facilities. The purpose of this study was to understand and overcome future acute controversies surrounding parking accommodations. All aspects of the process, including planning, design, and stewardship were examined as they related to future parking patterns. The following objectives were completed: a literature review of current practices, consultation with experts, and a field review of parking facilities. When considering parking needs, it was important to identify the broader community becoming engaged for the greatest success. Another important consideration was where to properly locate the facility. Land use patterns were often identified as being complex in downtown areas so mitigation was addressed along with the cost of developing a parking structure. Other considerations for success included the lower parking demands in a downtown structure, best practices, shared spaces, and intermodal travel. Also, design and financing of the project were critical factors to be addressed when implementing structured parking.

Structured parking frequently cannot succeed without proper stewardship, which included maintenance, revenue production, security activities, as well as valet parking. Harsh exposure to the elements required routine and preventative maintenance to be a priority for the community. Cost-effective payment systems enhanced parking structures, while urban communities needed to include the practice of hourly car sharing for future consideration.

The integration of housing and parking facilities was determined to be an effective option for financial and strategic reasons. Housing provided a pool of people as a complementary mix to assure a balanced level of activity throughout the day that promoted urban health. The integration of elements besides parking and housing enabled the community to subsidize the true parking cost. Many cosmetic strategies needed to be deployed to integrate parking facilities with downtown surroundings. It was also important for parking facility size to be considered for community acceptance.

Further Recommendations

Feasibility studies were conducted on four communities for further consideration faced with the development of transit facilities. The study featured a series of planning, design, and stewardship applications that were provided to New Jersey Transit and consultants for future use in constructing urban downtowns. Metuchen and Red Bank had already been officially designated as a New Jersey Transit Village, while East Orange became eligible in 2007 to receive Transit Hub tax credit. This funding was provided by the New Jersey Economic Development to programs making $75 million in capital improvements and employing 250 full-time employees.

Implementation

Since New Jersey Transit and the NJDOT are national leaders in transit planning and context sensitive design, the intent of this research project was to obtain input from a variety of state and local sources. New Jersey Institute of Technology (NJIT) and Rutgers Voorhees Transportation Center (VTC) graduate students were recruited to participate in the study. Five advisory board members provided support during the review process, while two panelist symposiums were held to obtain information from local officials. Also, six community reviews were conducted that involved 31 community officials and 11 community members. This unique research strategy was featured in several publications, such as Parking Matters and Urban Land Institute Advisory Panel. Research findings were also reported on the University of Texas Research Digest and New York Association of Metropolitan Planning Organizations websites.

Transit Friendly Parking Structure Guidelines

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

Projected Cost Benefit/Economic Impact

The research findings provided supported the efforts of NJ Transit in building multiple parking facilities in downtown urban areas. East Orange has been approved by the New Jersey Development Corporation for Urban Transit Hub tax credit. This program offers opportunities for businesses to relocate within ½ mile of the transit facility with tax credit equal to between 80 and 100 percent of the minimum $75 million qualified capital investment made within an eight-year period. At the present time, no activity has occurred in East Orange.

FHWA-NJ-2007-003: Cost of Transporting People in New Jersey, Phase 2 – Dr. Kaan Ozbay, Rutgers University, Center for Advanced Infrastructure and Transportation

Cost: $136,401.

Summary

The highly developed New Jersey infrastructure plays a pivotal role in the tri-state area. There was a need for new tools to estimate the cost related to highway travel for developing road user pricing mechanisms. Full marginal costs (FMC) were developed to identify the overall costs to society for servicing additional units of users. These expenses include capital costs, maintenance costs, highway crash costs, congestion costs, and environmental costs. Previously, there were no available network-wide FMC calculation tools to analyze estimated trip-based FMC values for transportation planners.

The research objectives were to improve the trip-based FMC methodology and develop a replacement to estimate trip-based FMC, considering the shortest travel time set of paths that are attractive to travelers. Transportation cost functions were to be updated, along with the development of a GIS-based interactive computer tool for estimating FMC within the area or the entire network. Also, the short-term impacts of policy implications on the FMC were investigated.

Another project requirement included the development of a state-of-the-art GIS-based interactive computer tool for calculating the network-wide FMC of highway transportation in New Jersey. The tool required the capability to evaluate short-term impacts of policy implications on the marginal costs of different trips. This system was critical to transportation planners because demand patterns included both spatial and temporal variation of supply and demand. An accurate cost estimation tool would help to better quantify the variation effects and better evaluate future transportation investments. This study provided transportation planners with a tool to estimate marginal cost functions, operations, environmental, crash, and other options based on the individual cost component of interest to them and decision makers.

The primary focus of the study was on final outputs. Although trip was not a standard measure like vehicle miles or vehicle hours, there were several related attributes that helped to understand the policy implications of added travelers on the roadway network. Therefore a new methodology was developed to more accurately estimate the system's marginal cost within a highway network.

Highway transportation costs were categorized into three major groups:

User Costs

- Vehicle Operating Costs
- Congestion Costs
- Accident Costs

Infrastructure Costs

- New Construction Costs
- Maintenance and Improvement Costs
- Right of Way Costs

Environmental Costs

- Air Pollution Costs
- Noise Costs

Each of the cost categories were developed from data obtained from the NJDOT and other sources, except for congestion and environmental cost categories. The development of these cost models required comprehensive research that was beyond the scope of the project. Also, appropriate models, found in the literature review, were used in the cost calculations.

The proposed trip-based FMC methodology was illustrated on a Northern New Jersey network and compared to existing methodologies. Results showed that the traditional distance-based planning approach overestimates the marginal cost of the network and provides marginal cost on the basis of distance rather than trip. Short-term impacts of investment choices on the FMC were also calculated based on lane improvements on Route 18, Route 17, NJ Route 3, and the Garden State Parkway. The pre and post changes successfully demonstrated that capacity investments reduce the marginal costs for users, but savings had been related to regional characteristics. The amount of capacity investments depended on excessive demand being satisfied and the reduction of travel delays. If a road section was very congested, improvements may result in an overall higher usage of the same roadway section.

Further Recommendations

The GIS-based tool has been designed to help transportation planners to estimate the changes in transportation costs due to a transportation demand management measure or supply change, such as adding new lanes. This was an important feature for transportation planners because demand patterns included both spatial and temporal variations, as well as changes in components of marginal functions of operation, environmental, accident, and other options.

Implementation

The Victoria Transport Policy Institute promoted the research findings, while the Transportation Research Board, Tech Transfer of Berkeley California, and University Transportation Research Center had published either the entire report or findings from the study. Two graduate students were employed on the project. Four presentations were conducted on research findings. The Port Authority, NIMTECH, and the NJDOT Commissioner have adopted methodology that was developed as part of this study.

Cost of Transporting People in New Jersey

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		✓
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Projected Cost Benefit/Economic Impact

Additional funding was provided by the Bureau of Research, in 2008, to modify this model for estimating the cost of Capital Project programs. Currently, the benefit/cost ratio is being used in 2009 to establish the carbon footprint for the New Jersey Department of Transportation. Also, the Department will be tracking benefit/cost outcomes for the TIGER Economic Recovery projects.

FHWA-NJ-2007-004: Transportation Safety Professional Development Clearinghouse (TSPDC) – Janet Hansen, Rutgers University, Center for Advanced Infrastructure and Transportation

Cost: $545,635.

Summary

There is a critical need for New Jersey Department of Transportation (NJDOT) professionals to track safety training in New Jersey. Education has been identified as a 4E countermeasure for reducing roadway fatalities. Additionally, professional expertise is accomplished through employee development, formal education, assessment, job experience and interpersonal relationships (Noe, Hollenbeck, Gerhard & Wright: 2000). The NJ LTAP staff had worked with safety managers to identify training opportunities and track the progress of personnel from the transportation safety industry. Also, a data base was produced for NJDOT managers to use in identifying state, regional and local safety needs of transportation professionals.

Since employee development belongs to Human Resources and Manager-Employee interaction, considerable attention has been given to aligning research with the TSPDC project, and respecting the privacy of the individual and eliminating duplication of effort wherever possible. The TSPDC system was created to serve as a tool to assist managers and members of the transportation community in accessing and leveraging safety training in a timely manner.

A literature review was conducted to determine the current and future state of the workforce in public and private sectors, with particular attention being given to the future of the public transportation workforce. Strategies for retention and development of key personnel were explored.

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Phase II: Transportation Safety Professional Development Clearinghouse Website

The Transportation Safety Professional Development Clearinghouse (TSPDC) website was developed as a data clearinghouse which centralized information about training events and trainees of both the public and private sector. Users logged into the system with a specialized password that allowed different access privileges depending upon their level of membership and the needs of that level. For example, trainees were able to view upcoming course information as well as their own trainee profile and training history, but they were allowed to update only their own information. Training centers were able to update their own training class information and could view reports that indicated where training needs existed, but did not have access to individual trainee records. Agencies such as NJDOT had the highest level of privileges and were able to obtain all reports generated by the system.

Further Recommendations

Since the model featured an independent design, it was not compatible with the system that was selected for use by NJDOT Human Resources. Recently, a need has been identified for safety leaders to track activities of the New Jersey Statewide Comprehensive Strategic Highway Safety Plan. Also, county agencies may be able to use the program for their employees.

Implementation

The Transportation Safety Professional Development Clearinghouse (TSPDC) model contained the capabilities of connecting transportation safety professionals from both public and private agencies with the appropriate training sources. It had the capacity to be used by managers to plan and budget for projected training needs within their departments. This tool identified where targeted training should be conducted to supplement the skills of the transportation work force, promoting safety education, a critical component of the 4E's that reduced highway fatalities.

A modified Learning Management System was developed for transportation safety professionals which contained the following features:

- training received,
- employment goals,
- educational requirements by job classification,
- notification of refresher classes, and
- reporting tool for management.

The system's capabilities were demonstrated to Patricia Ott, Director of Traffic Engineering and Eileen Fitzpatrick, Director of Training. The product was in competition with another Learning Management System that was ultimately selected by NJDOT, so no benefits were realized.

Transportation Safety Professional Development Clearinghouse

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)	✓	
Policy/Process Change		
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Projected Cost Benefit/Economic Impact

The Transportation Safety Professional Development Clearinghouse Model did enhance the efficiency of safety program managers by reducing administrative paperwork associated with workforce training compliance. Since the model was not adopted, it is difficult to evaluate cost savings and safety improvements that are realized from the project. The model may still have the potential to be used as an evaluation tool during the second phase of implementing the Statewide Comprehensive Strategic Highway Safety Plan that involves recordkeeping for a variety of State agencies.

FHWA-NJ-2007-005: New Jersey Police Technical Assistance Program (PTAP) – Dr. Claudia Knezek, Rutgers University, Center for Advanced Infrastructure and Transportation

Cost: $668,075.

Summary

The Police Technical Assistance Program (PTAP) project focused on three goals: assessment of the current police report form, development of new products to enhance the crash data collection process, and the provision of training technical resources to assist in implementation of the new form. Research surveys were conducted to support the revision of the NJTR-1 Form. During the form and guidebook revision process, technical assistance included tracking and reporting on training issues. Afterward, standardized training curriculum and technical resources were developed to reduce reporting errors on the NJTR-1 Form. Also, the E-Learning System was developed and launched on the New Jersey State Police NJ LEARN website.

PTAP project objectives were measured by the distribution of resources and the participation in training activities. A total of 2,313 training resources had been distributed to local police trainers, reviewers, and supervisors. Nearly half of the resources (1,432) were distributed in an electronic format for ease of duplication and local dissemination. In addition to being cost effective, there was a stronger likelihood that these electronic resources would be disseminated and used throughout the entire enforcement community. Also, NDOT supported the distribution of a companion Field Manual by hosting it at their website for officers to download. Lastly, NJ LTAP offered the NJTR-1 Training Kits as technical resources.

Additional actions were taken to enhance training efforts and reach a wider audience than the 716 participants that attended the training programs. After the second training series was conducted, an abbreviated version of the program was presented during the next New Jersey Police Traffic Officers' Association meeting. A total of 165 kits were distributed to the membership. Since the NJTR-1 faculty belonged to this organization, they will continue to serve as in-house experts. Also, the eight (8) regional representatives were supplied with training kits that had been distributed during their local membership meetings. Lastly, the E-Learning System will continue to fill the void for new or veteran officers who require training or retraining on specialized sections.

Further Recommendations

Fatal crash units were housed at the Motor Vehicle Commission, Division of the New Jersey State Police, and the Department of Transportation, so the relocation of the units to one agency would help to facilitate more efficient collection, processing, and analysis of vehicular crash reports. Electronic transfer of crash reports from local police departments to the fatal crash unit would enhance the efficiency of the data collection process. Also, data from Crash Data Retrieval (CDR) Systems can be used to improve the current crash data system's compliance rate (60%) with national data collection standards

Implementation

The project resulted in a complete overhaul of the NJTR-1 Crash Report Form, by bringing together key partners who achieved an increased understanding of each other's needs. Statewide Train-the-Trainer sessions, supplemental training material, and a revision of the NJ Police Guide updated the NJ State Police and traffic officers on changes to the form and new procedures to follow. The administrative, process, and procedural changes resulted in more timely submission of report forms, and included better data – information that satisfied the needs of all partners, such as police, national reporting requirements, engineers, and those involved in legislative initiatives. Several demonstrations of the interactive training were piloted to key partners – members of the advisory group. Feedback from these sessions was taken into account before the software release.

Police Technical Assistance Program (PTAP)

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)	✓	✓
Policy/Process Change	✓	✓
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Projected Cost Benefit/Economic Impact

The improved timeliness and availability of crash data resulted in obtaining additional funding to NJDOT for several data driven projects. In 2008, FHWA and NHTSA funding was increased from $904,500 to $l,500,000 for consolidating three state traffic records units into one agency that was to be housed at the NJDOT. Funding also supported the electronic transfer of police reports, acquisition of GPS technology for local police departments and emergency medical technician reporting efforts.

FHWA-NJ-2007-006: Alternative Performance Measures for Evaluation of Congestion – Congestion Analysis Model Update and Maintenance – Dr. Lazar Spasovic, National Center for Transportation and Industrial Productivity, New Jersey Institute of Technology

Cost: $29,957.

Summary

The Congestion Analysis Model software tool (NJITCAM) estimated congestion costs, congestion related travel delays and mobility indicators for New Jersey highways. This tool was produced during a prior research study, *Alternative Performance Measures for Evaluating Congestion*, in order for NJDOT to evaluate congestion and guide their Capital Investment Strategy. The system was enhanced to link with the New Jersey Congestion Management System (NJCMS) model

The methodology used during this phase of the project included re-calculating or modifying several measures: vehicle recurring delay, vehicle non-recurring delay, person hours of delay, fuel consumption and cost of wasted fuel, travel time index, unproductive time for the traveling public, and the cost of truck congestion. Input was provided from NJDOT users to redesign the interface to give them more flexibility in choosing values, analysis parameters, and generating reports. This enhancement enabled NJDOT employees to better use data generated from their New Jersey Congestion Management System (NJCMS). Also, the calculation for peak hour duration was expanded from a three-hour to a four-hour peak period. Congestion cost rose to 16% based on this indicator changes.

Further Recommendations

The potential now exists for this tool to be linked to NJDOT travel demand models, expand the fuel consumption model, develop a GIS module, add corridor or facility level analysis, integrate it with the New Jersey Congestion Management System (NJCMS) model, and generate link-level priority scores. It is expected that congestion analysis will also play a significant role in identifying the environmental impact of transportation in New Jersey.

Implementation

The Congestion Analysis Model has been implemented by the Bureau of Systems Development and Analysis to improve the quality of their data. The initial NJDOT Project 2004-06 research team, AECOM and Telvent Transportation N.A. received several requests for information on the outcomes of this study. A summary of the project was also featured in the Texas DOT Research Digest and on the Caltrans website "Links to Other States System Performance Measures".

Alternative Performance Measures for Evaluation of Congestion

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	

Also, this study will be referenced in the forthcoming publication, "Port Facilities in New Jersey: A Feasibility Analysis" from the NJDOT Bureau of Freight Services.

Projected Cost Benefit/Economic Impact

NJDOT has continued to work with NJIT to refine the "cost of congestion" aspect of their work. This tool has been particularly useful to the Bureau's Annual Statewide Capital Investment Strategy Plan on the economic impact of congestion, which annually amounts to $8.6 billion in costs (NJDOT, 2008). There were no further marketing activities, enhancements, or cost savings that were identified with this study.

FHWA-NJ-2007-007: Concrete Shrinkage Analysis of Bridge Deck Concrete – Dr. Hani Nassif, Rutgers University, Center for Advanced Infrastructure and Transportation

Cost: $148,696.

Summary

During the past decade, the use of Higher Performance Concrete (HPC) has become an important alternative for dealing with deteriorating infrastructure. The Federal Highway Administration (FHWA) has initiated design and construction programs for HPC bridges and pavements that will reduce construction and long-term maintenance costs. The objective of this project was to evaluate the restrained shrinkage properties of HPC mixes, currently used on bridge deck applications in New Jersey, with the AASHTO-PP34-99 test method and to provide a comparison of their relative cracking potential.

The AASHTO testing method, known as the Passive or Restrained Ring Test, was used to compare the related cracking potentials of concrete mixtures. This cracking tendency was performed on 15 concrete mixes used on NJDOT bridge decks to identify those that would exhibit a high potential for cracking. This study provided a comparative classification of the cracking potential for each mix. A correlation of cracking potential with various parameters was also established. Mixes with high Course Aggregate to Fine Aggregate ratio and a CA minimum weight of 18000 b/cu yard had lower potential for cracking. The rate of free shrinkage correlates directly with the rate of retrained shrinkage, and a limit of 450 micro strains for free shrinkage at 56 days was recommended to reduce the cracking potential of concrete mixes.

The results showed that total coarse aggregate content and the CA/FA ratio had the greatest effect on both free and restrained shrinkage. This was a reduction in free shrinkage mixes with high CA/FA ratios and lower total coarse aggregate content. Free shrinkage prior to cracking was found to correlate directly with the restrained shrinkage rate prior to cracking and time to cracking for a given mix. Other factors, found to increase cracking potential, were high cementitous material content and the properties of the course aggregate used in mix design (Mix G3M1 has deposits of argillites within its course aggregate source, which significantly affected its performances.) It was recommended that the amount of cementitious material be limited to

700-lb/cu yd. Also, the maximum percentage of silica fume utilized in a mix needed to be limited to 5 percent.

Further Recommendations

Although cracking of bridge decks can be attributed to various causes, the study provided a comparative classification of the cracking potential for each mix. Since the mixes with high Coarse Aggregate (CA) to Fine Aggregate (FA) ratio (i.e. CA/FA > 1.48) and a CA minimum weight of 1800 lb/cu.yd had lower potential for cracking, it was important for the NJDOT to revise their 2001 specifications to include lower cracking HPC mixes. Also, the rate of free shrinkage correlates directly with the rate of restrained shrinkage, and a limit of 450 micro strain for free shrinkage at 56 days needed to be included to reduce the cracking potential of concrete mixes.

Implementation

Two graduate students completed Master's degrees while working on this project. Their laboratory and field experiences enabled them to obtain skills that were needed for employment in the Engineering profession. Undergraduate students also served as laboratory assistants for the concrete testing procedures.

The research findings were reported in the Wisconsin Department of Transportation Literature Search of Early Concrete Cracking on Bridge Decks and Overlays. Also, the American Concrete Institute and Research and Innovative Technology Administration (RITA) published the results on their websites. One international publication and the American Concrete Institute (ACI) also featured the research findings.

Concrete Shrinkage Analysis of Bridge Deck Concrete

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		✓
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Projected Cost Benefit/Economic Impact

The 2007 NJDOT Specifications for Road and Bridge Construction reflected the use of mixes with lower potential for cracking (See Attachment B.) Richard Dunne, of NJDOT Structural Engineering, confirmed that the use of lower cracking HPC mixes would enhance the stability of bridge decks, reduce crack repairs that affect maintenance costs, and improve safety conditions. Specifically, the absence of cracks will not allow water and chemicals to penetrate into concrete which increases damage from freeze thaw cycles, leaving the reinforcing steel exposed to corrosion.

FHWA-NJ-2007-011: Technical Solutions to Park and Ride Facilities – Dr. Kyriacos Mouskos, CCNY; Dr. Neville Parker, CCNY; and Dr. Maria Boile, Rutgers University

Cost: $76,414.

Summary

The purpose of this study was to develop the Parking Information and Reservation System (PIRS) for the NJDOT to incorporate into Park and Ride facilities and the Regional Traffic Control Centers. The advantage of incorporating oversight of the facilities within existing Centers was economies-of-scale, specifically the use of the same traffic surveillance/communication infrastructure network. Also, the PIRS system needed to be federated with the main transit operators of the region, including New Jersey Transit, Transcom, TRIPS 123, and other related systems.

The principal framework of PIRS included the following components:

- Monitoring system of traffic flow conditions,
- Parking Guidance and Information System,
- Parking Information and Reservation System, and

- Communications center for warehousing data (routing planning algorithms, traffic flow estimations and identifying parking occupancy estimations etc.).

Further Recommendations

The monitoring system had several components that identified traffic flow of the transportation network, Park and Ride facilities, and surrounding areas. The communications component for this system will need to be both a wireless and wire line network that is connected to the existing systems. The Park and Ride System could be monitored by the Centers, while the communication system would be connected to other traveler information providers.

Parking space technologies were studied for use by NJDOT, which included loop detectors, video imaging, dual axis magnetometers, and radio frequency identification systems. Web site applications with real-time and historical information would enhance the NJDOT PIRS system; while being integrated with New Jersey Transit, TRANSCOM, and TRIPS 123. Also, a reservation, first call system, and cellular-applications for monitoring available parking spaces.

Implementation

Three graduate students worked on the project with two completing their doctoral work and maintaining careers in transportation research. The study was featured on international, Tech Transfer of Berkeley California, and University Transportation Research Center websites.

Technical Solutions to Overcrowded Park and Ride Facilities

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Projected Cost Benefit/Economic Impact

Technology has advanced considerably since the study was conducted. Many of the proposed Park and Ride System features are now available on the NJDOT website through a link to Google Map. The Park and Ride section includes real-time satellite monitoring of all facilities by County. Additional information maintained on the site includes written directions and maps, surrounding traffic patterns, cell phone updates, and links to NJ Transit Bus/Rail Services.

FHWA-NJ- 2007-012: Field Implementation and Monitoring of Bridge Approach Slabs – Dr. Hani Nassif, Rutgers University, Center for Advanced Infrastructure and Transportation

Cost: $963,555.

Summary

The bridge approach slab is a concrete transitional roadway between the bridge deck and the asphalt pavement. It is designed to reduce vehicle dynamic effects when traveling on the bridge. According to bridge officials, a major problem existed in New Jersey with the growing number of rough riding and cracked approach slabs that were in need of heavy maintenance. Motorists had been complaining about the heavy bumps they were experiencing when leaving bridges, so alternative slab designs were examined to solve the rough riding and cracks in approach slabs.

Using ABAQUS software, two new design alternatives, embedded beam and constant thickness were developed during Phase 1 of the study. They were implemented at the Doremus Avenue Bridge and monitored for effectiveness. As a result, transition slabs were eliminated from two of the NJDOT designs and replaced with constant thickness of 18 inches. Top layer reinforcements were used as design alternatives to restrain the concrete from cracking due to thermal stresses. Static load tests and long-term monitoring design alternatives outperformed existing designs used by NJDOT. The embedded beam design had the best performance and did not show any cracks on the Doremus Avenue Bridge, which was recommended for adoption by the NJDOT as part of future design standards.

Research analysis was carried out in two steps: consolidation of the soil due to the dead load of the slab where drainage was allowed to occur in the soil and application of the truckload. In both models, the approach slabs were subjected to multiples of the HS-20 bridge design truck loading. The truck had three axles, 8 kips front axle weight, 32 kips middle axle weight; and 32 kips rear axle weight. The longitudinal and transverse spacing of the truck was 14 ft and 6 ft respectively. The truck was modeled as six point loads.

This study produced several recommendations that were made to NJDOT for adoption, which included adopting the embedded beam approach slabs and elimination of the transition slabs. The department needed to ensure proper compaction of the backfill material below the approach slab to minimize settlement. Other recommendations were extending the length of the wing wall beyond the current practice of 25-30 feet to minimize embankment bulging, and to continue to monitoring approach slabs for longer periods of time to observe soil settlement or embankment bulging.

Further Recommendations

The NJDOT needed to adopt the Embedded Beam design alternative in the 2007 Standard Detail as the new design for approach slabs, while the transition slab had to be eliminated. Backfill material was to be properly compacted below the approach slab to minimize settlement. Wing wall lengths were to be extended beyond the standard 25-30 feet to minimize embankment bulging. Also, performance of approach slabs required monitoring for a longer period of time to observe soil settlement.

Implementation

Two Assistant Professors and one graduate student were employed on the project and several undergraduate students gained considerable engineering field experience. The results of this study were significant, since the findings supported the New Jersey Department of Transportation in adopting the new Embedded Beam (EB) as a design alternative. The NJDOT Standard Details were revised in 2007 to include the new design of approach slabs (See Attachment B.)

Field Implementation and Monitoring of Bridge Approach Slabs

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)	✓	
Policy/Process Change	✓	✓
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Projected Cost Benefit/Economic Impact

The new Embedded Beam application was approved as an alternative design for the approach slab, which reduces cracking and corresponding maintenance requirements for NJDOT staff. Reduction in labor costs will result in savings over time to recoup the initial investment of over $900,000. Richard Dunne of Structural Engineering had recognized the investment in research as a solution for enhancing safety and structural design.

A strong partnership between NJDOT Bridge professionals and Rutgers CAIT faculty developed through a decade of mutual collaborations. As a result of this mutual support, CAIT was recently awarded the Long-Term Bridge Performance (LTBP) program, a $25 million national project over a five year period. According to Richard Dunne, he has provided CAIT with examples of New Jersey bridges to use as candidates on their national project.

FHWA: 2007-013: Medical Review Cases Reporting at the Motor Vehicle Commission – Naomi Rotter, New Jersey Institute of Technology

Cost: $127,480.

Summary

The New Jersey Motor Vehicle Commission (MVC) faced the problem of underreporting high risk and/or unsafe drivers to their Driver Review Unit. As the population ages, drivers are becoming more liable to physical, cognitive, and visual impairment that affects roadway safety. The purpose of this study was to determine how the MVC staff would increase the identification of potentially at-risk drivers. A literature review was conducted to identify how medically at-risk drivers are identified in other states, in order to develop a proactive approach for identifying medically at-risk drivers.

A total of 17 national interviews were conducted with agency representatives to define the at-risk driver identification process. The following methods were used by motor vehicle officials elsewhere:

- self reports,
- referrals by physicians and referrals by other health professionals,
- police or court referrals,
- crash reports,
- analysis of driving records,
- referral upon applying for disabled parking privileges,
- referrals from family members, and
- observations or questions by staff testers.

Two major problems existed with the referral system, which were drivers not being honest about their conditions and fear of losing their licenses. The study confirmed that it was important for the MVC to add health questions on the driver's license application form, especially related to loss of consciousness/epilepsy/seizures, diabetes, and cardiac conditions. MVC staff members needed to be trained on identifying potential at-risk driver during the license renewal process. An advisory committee of representatives from law enforcement and the medical community would

provide input to the MVC on aging-related issues. MVC should consider using medically restricted licenses and add the testing of peripheral vision to the acuity vision test.

STATE	Over 65	Total	Percent over 65	Annual	Rate per million licensed driver	Rate per million license driver over 65
Maine	146,451	932,455	15.7%	49,320	52,893	336,768
Florida	2,468,455	12,905,812	19.1%	102,000	7,903	41,321
Kansas	307,762	1,987,251	15.5%	14,000	7,045	45,490
Washington	583,422	4,407,269	13.2%	25,200	5,718	43,193
Maryland	463,105	3,552,187	13.0%	12,500	3,519	26,992
Pennsylvania	1,451,662	8,369,575	17.3%	27,996	3,345	19,285
California	2,693,836	22,657,288	11.9%	72,000	3,178	26,728
North Carolina	797,657	6,014,782	13.3%	12,000	1,995	15,044
Iowa	340,428	1,977,909	17.2%	3,336	1,687	9,799
Virginia	650,488	5,045,857	12.9%	8,400	1,665	12,913
Wisconsin	565,193	3,765,644	15.0%	6,000	1,593	10,616
Connecticut	464,439	2,659,918	17.5%	3,996	1,502	8,604
Ohio	1,210,205	7,656,362	15.8%	7,068	923	5,840
New Jersey	865,217	5,728,975	15.1%	4,020	702	4,646
Michigan	1,034,762	7,065,438	14.6%	4,500	637	4,349
Texas	1,680,898	13,498,071	12.5%	8,433	625	5,017
Oregon	386,484	2,589,764	14.9%	1,562	603	4,042
Utah	171,116	1,548,456	11.1%	360	232	2,104

Further Recommendations

The identification of best practices yielded information on frequently asked questions about health conditions at the time of application for consideration by the MVC staff.

Frequently Asked Questions About Health Conditions During the Application Process

State	Loss of Consciousness/ Epilepsy/Seizure	Diabetes	Cardiac Disorder	Mental Illness	Strokes	Parkinson's Disease	Other	
California	✓			✓				
Florida	✓	✓	✓	✓	✓	✓	✓	A
Maine	✓	✓	✓	✓	✓	✓	✓	B
Maryland	✓	✓	✓		✓		✓	C
North Carolina	✓	✓	✓	✓	✓	✓	✓	D
Utah	✓						✓	E

Notes:

A. Limb Amputation, Paralysis, Other Disability

B. Cerebral Dystrophy, Schizophrenic Disorder, Congenital Eye Disease, Loss of Limbs, Dementia, Severe Anxiety Disorder, Traumatic Brain Injury, Multiple Sclerosis, Manic Depression

C. High Blood Pressure, any medication taken

D. High Blood Pressure, Pulmonary Neurologic, Learning and Memory, Musculoskeletal/Chronic, Alertness or Sleep Disorder, Hearing and Balance, any medication

E. Any Physical or Mental Condition for which medication is taken, Physical Conditions for which Special Equipment is used.

Implementation

One assistant was employed on this project. The research information provided guidance on the approach for Motor Vehicle Commission to pursue in modifying their current policy on medical provisions that have been in place for the past several decades. According to Donald Borowski, MVC has changed administration and this priority will be revisited in the future.

Medical Review Case Reporting at MVC

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact		

Projected Cost Benefit/Economic Impact

The study was able to provide knowledge to the MVC staff on medical conditions to be monitored on the Driver License Renewal form. Borowski noted that the information will better enable the MVC leadership to champion this change in reporting procedures through the state's administrative process. Once reporting medical conditions becomes a requirement for license renewal, the expected outcome will be a reduction in driver caused crashes.

FHWA-NJ-2007-017: The Development of an Airport Obstruction Identification System (Loc Altitude Mapping System) – Dr. Patrick Szary, Rutgers University, CAIT

Cost: $210,000.

Summary

The New Jersey Department of Transportation (NJDOT) Division of Aeronautics is obligated to identify and remove all obstructions to the State's public use airports and heliports. The objective of this research project was to develop a prototype system to easily acquire data, at fixed intervals or over time, and establish a tree removal or trimming plan for discretized trees or tree areas. Several technologies were examined, which led to the use of radio-controlled aircraft was used to collect data.

A custom-built model was selected for the project, since it was less expensive and more versatile than a semi-commercial system. In the past, this type of low altitude mapping technology was cost prohibitive and not as accurate as the current models. After successful development, the system was integrated and used to acquire sample data. Once the data was analyzed for accuracy, full scale implementation and automation occurred. Flying lessons were required for the team to successfully use this technology that became easier to navigate over time.

The project was successful in proving that low altitude mapping technology would benefit the Division of Aviation in accurately identifying and removing trees that posed a danger to arriving and departing aircraft at state owned airports. It also enabled NJDOT to initially remove obstructions without having to repeat the process. Potential uses for this technology includes search and rescue operations and crash investigations.

Further Recommendations

The study successfully demonstrated that this prototype system has the potential to be used to enhance safety; especially as low altitude mapping technology continues to improve. After the project was completed, representatives from several state agencies inquired about the potential use of low altitude technology to support rescue operations and crash investigations. Also, inquiries were made to the Bureau on the application of low altitude mapping technology for homeland security purposes.

Implementation

Since the technology was not adopted by the Bureau of Aeronautics, knowledge transfer was a benefit for the NJDOT and project team members. One of the graduate students gained considerable field experience that enabled him to be hired by the FHWA - New Jersey Division as a staff member.

Knowledge was gained on several technologies considered for implementation. System vibration was a universal problem in the use this technology, which resulted in blurry images, loss of GPS satellite tracking, and line of sight while flying the unit needed to be addressed in the future. Use of vibration dampers and "auto-pilot" stabilization units helped but didn't completely eliminate the problem. GPS technology has evolved over the duration of the project, so that L5 frequency signal was projected to bring higher levels of accuracy that had not been previously attainable. At the time of the study, software was being developed to more accurately locate obstructions obtained from the helicopter flight; but there was only a projected 75 to 87 percent accuracy level.

The Development of an Airport Obstruction Identification System

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	
Cost Savings/Economic Impact	✓	

Projected Cost Benefit/Economic Impact

The study was able to successfully provide knowledge to the Bureau of Aviation on the application of low altitude mapping technology in transportation. Field demonstrations enabled the Bureau to locate tree obstructions for removal at the State's airports and heliports. In the future, the potential exists for the Bureau to realize increased efficiency, safety enhancements, as well as potential cost savings.

FHWA-NJ- 2007-018: Breakaway Utility Poles – Dr. H. Clay Gabler, Virginia Tech

Cost: $123,497.

Summary

Approximately 10,000 vehicle occupants are involved in utility pole crashes yearly, which results in between 50-60 fatalities and 200 persons being incapacitated. New Jersey is ranked 8th in the country for fatalities due to utility impacts. The research goal was to review and recommend methods of mitigating these types of fatal and injury crashes. The rigid design of the pole, required to survive high winds, is the major reason behind the high fatality rate for this type of crash.

Rowan University and Virginia Tech participated in a study of utility pole crash mitigation programs, in order to conduct a comparison of the current NJ Utility Accommodation Policy to national practices. Data was also used to examine the conditions surrounding utility pole crashes and the identification of high risk sites. A cost-benefit procedure was then developed for determining the use of breakaway or energy absorbing utility poles.

The findings confirmed that the New Jersey Utilities Accommodation policy follows national guidelines closely, but focuses primarily on new construction or reconstruction. The 2003-05 crash data analysis confirmed that 40% of all occupants exposed to utility pole crashes were either injured or died. County roads accounted for most crashes and frontal impacts were most common. Also, motorcycle crashes were overrepresented in this category. U.S. Highway 22 was rated as having a serious utility pole impact problem.

Further Recommendations

Research recommendations included the need for NJDOT to initiate a formal program to mitigate high risk pole crash sites. There was justification for updating the NJ Utility Pole Guidelines to reflect current national best practices. Other issues to be addressed included formally identifying U.S. Highway 22 as a candidate for utility pole crash mitigation. NJDOT needed to also be conducting demonstration projects on new technologies, such as the

Shakespeare energy absorbing poles. Also, the state's design standards must enable breakaway utility poles to be installed in high risk areas.

Implementation

In addition to sharing research findings with the Bureau of Safety, this information was presented by Frank Pinto, Office of Utilities, during the NJDOT sponsored Utility Industry Summit. According to William Beans, Bureau of Safety, the study results were used to relocate utility poles in high risk crash areas. NJDOT has established a utility pole crash pilot program starting with 10 sites to be investigated for replacement of standard wood poles with breakaway poles.

Breakaway Utility Poles

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		✓
Policy/Process Change	✓	
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

Projected Cost Benefit/Economic Impact

William Beans obtained $300,000 in federal funds for the utility pole crash reduction program. The NJDOT Utility Unit and Bureau of Research collaborated on the utility pole crash reduction program. When comparing the 2007 and 2008 crash rates, there was a decline in injuries and fatalities that appear in the following chart.

2007-2008 New Jersey Utility Pole Crashes

Crash Types	2007	2008
Property Damage	4,551	4,293
Injury Crashes	3,444	3,234
Fatal Crashes	72	40

Source: *Plan4Safety 2009.*

The New Jersey Department of Transportation (NJDOT) has long recognized the importance of Crash Reduction Factors in conducting benefit/cost analyses for highway safety improvements. According to FHWA, the average cost of a fatality had been estimated at $3,246,192 and cost of an injury was determined to be $68,170. Plan4Safety showed a reduction of 32 fatal utility pole crashes and 160 utility pole injury crashes for the period after relocation of utility poles in high crash areas. According to these estimates, a total of $103.8 million had been saved based on the reduction of fatal crashes and $10.9 million for the reduction of injury crashes. Most importantly, 32 fewer people died and 160 fewer people were injured from hitting utility poles.

FHWA-NJ-2007-019: Implementation of Construction Quality Assurance (CQA) Measures for Harbor Sediments and Processed Dredge Material (at Encap Golf Site Meadowlands, New Jersey) – Dr. Ali Maher, Rutgers University Center for Advanced Infrastructure and Transportation

Cost: $31,988.

Summary

New Jersey Department of Environmental Protection (NJDEP) approved the beneficial use of processed dredged material as a grading and barrier layer fill for closure of four landfills in the Meadowlands. Site remediation included using 2 feet of clay/silt soil on a synthetic liner as a low permeability barrier layer. As part of the NJDEP Remedial Action Work Plan conditions, the site operator beneficially used processed dredged material as grading fill and a lower permeability cover system.

This project supported NJDOT, Office of Maritime Resource through the performance of Quality Assurance inspections for placement of processed dredged material at the site. The inspections provided information to the agency on the feasible use of processed dredged material as construction fill at the upland sites. Since dredged sediments were saturated and difficult to handle, the addition of Portland cement reduced moisture content and improved workability. Proper placement required further moisture reduction, which was accomplished by spreading processed dredged material in thin layers, exposing it to the sun and air.

The study objectives included the provision of quality assurance services for activities related to processed dredged material placement. Oversight of closure activities, involved placement of the processed dredged material cap and ensured that field operations were in compliance with the approved Closure Plan. The revised Plan was then submitted to DEP for approval. These specifications included a permeability layer not to exceed 1x105 centimeters per second, an unconfined compressive strength of 2,000 lbs/sq ft, which was in compliance with the January 2008 NJDEP AUD and all current NJDEP regulations on chemical analysis and 72 hours of final processed dredged material placement. Also, quality assurance oversight provided information on preparation of the subgrade prior to material placement conformed to the approved Closure Plan. The processed dredged material was above engineering specifications following the final placement. Sampling and testing conformed to the approved procedures and necessary corrective measures were taken to satisfy the Closure Plan requirements.

Further Recommendations

In cold seasons, cement hydration and processed dredged material solidification needed to slow down which contributed to costly placement. Stock piling processed dredged material was not preferred and double handling resulted in the breaking of soil-cement bonds, which reduced strength. Optimal use required processed dredged materials to be placed in layers and sloped to allow for drainage before compaction.

Implementation

One graduate student was employed on this project. The associated cost for transportation, unloading, moisture conditioning and placement was estimated to be $13.60 per cubic yard. The market price of mined clay from upland sites is $15 per cubic yard, and $2.30 in placement costs that total $17.30 per cubic yard of mined clay. It was cost effective to use dredged red clay instead of mined clay. Since 12 acres x 2 feet deep (38,716 cubic yards) of dredged clay was processed and used instead of mined clay at the landfill, the realized savings amounted to $143,250.

Implementation of Construction Quality Assurance

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		✓
Demonstrations	✓	
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact	✓	✓

Projected Cost Benefit/Economic Impact

Scott Douglas, Office of Maritime Resources, confirmed that the project was beneficial to his operation, as well as many municipalities that bordered the New Jersey Turnpike. The proper closing of the landfill site positively impacted the quality of life for residents. In addition to improving the environment, cost savings of over $140,000 was realized by the use of dredged material.

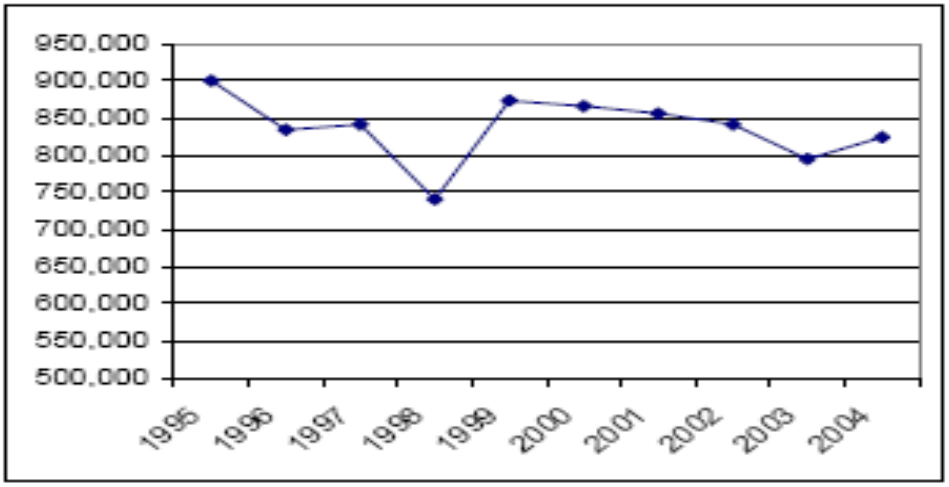
NJ-2007-020-I and II: Driver's Licenses Suspensions, Impacts, and Fairness Study – Jon Carnegie, Rutgers University, Voorhees Transportation Center

Cost: $240,500.

Summary

In New Jersey, there are many reasons for driver's license suspension and it is no longer only used to punish poor drivers, but is a deterrent for behaviors unrelated to driving. Court appearances are required in addition to payment of fines, fees, and financial obligations. Suspension patterns have shown that certain segments of the driver population are more likely than others to lose their license, specifically male drivers living in urban and low income areas.

The most direct impact of license suspension is the loss of personal mobility, but frequently it leads to job loss, difficulty in finding employment, and reduction in income. Other financial consequences include increased car insurance premiums, psychological and social impacts, loss of freedom, and personal stress. A related area of needed reform is re-examination of the insurance surcharge program, assessment of the Parking Offenses Adjudication Act, and issues that contribute to licenses suspension.



History of suspensions ordered by MVC

It was estimated that fifty percent of people with suspended licenses were for failure to pay fees, fines, surcharges, and other financial obligations. This cycle frequently affected poorer individuals, who needed a personal automobile for work. The purpose of this study was to document the extent of driver's license suspension in New Jersey, identify the impacts of license suspension, and examine methods for reducing or eliminating unintended consequences of driver's license suspension. This study included a national literature review, analysis of driver history data, and an inventory of restricted-use license programs.

The number of suspension had remained relatively constant at about 800,000 per year. Only five percent of all drivers had their privileges suspended or revoked. Approximately 40% of the drivers lived in urban areas, 20% resided in suburban areas, and 19% were from rural areas. Only 17% resided in low income areas and 12% were from high income areas. Initially, the suspension of licenses had been considered as punishment for "bad" driving behavior, but the sanction became more complex over time and included an array of violations that ranged from not paying parking tickets to insurance surcharges. New Jersey did not have conditional or restricted driver's licenses, like several other states.

Further Recommendations

In order to implement a restricted driver's license program in New Jersey, it needed to be created by statute. Administrative codes would help to guide implementation of the program for time delimited suspensions, such as those imposed for a first-time offender. In most States, conditional or restricted-use licenses were not available to drivers suspended/revoked for multiple DUI offenses, negligent vehicular homicide, habitual offenders, and for failure to render aid. Permitted travel restrictions varied by state, while penalties for violation involved the cancellation of the license and reinstatement of the original suspension.

Implementation

According to Donald Borowski, MVC representative, the study had provided background information to the agency on best practices for initiating a restricted license. Specifically, the national survey identified best practices for the MVC to adopt for implementing restrictive licenses. Although unable to acknowledge the benefits at this time, the MVC agency was awaiting official approval to implement a restricted licensing policy in the near future.

Driver's Licenses Suspensions, Impacts, and Fairness Study I & II

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change	✓	✓
Demonstrations		
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

Projected Cost Benefit/Economic Impact

As found in other states, the implementation of this program reduced the number of habitual offenders and improved roadway safety. Participants of the occupational licensing program adopted in Wisconsin, reported that the program was successful because the license reduced unemployment and helped families to avoid serious hardships. Also, occupational license holders tended to be involved in fewer crashes while holding this license. It was expected that a change in policy would enhance roadway safety and would possibly reduce enforcement costs in New Jersey.

FHWA-NJ-2007- 021: Self Consolidating Concrete – Dr. Hani Nasif, Rutgers University, Center for Advanced Infrastructure and Transportation

Cost: $55,301.

Summary

Self-consolidating concrete (SCC) is a high viscosity concrete that flows freely under its own self-weight without compaction and with minimal segregation. It becomes consistent with equal dispersion of cementitious paste and aggregates. This application nets a lower energy cost, lower stress on the formwork, reduced labor coast, and elimination of human error in consolidation of the cement. Adoption of this technology is lagging in the United States due to absence of formal guidelines and specifications, mix design criteria, established test results, and a skilled labor force in the use of this technology.

The purpose of this study was to develop recommendations for the New Jersey Department of Transportation on the use and implementation of SCC. The project included two phases: Phase I was the field assessment of SCC mixes for nonstructural Class I precast concrete and Phase II was to assess the ready-mix SCC implemented in the construction of drilled shaft.

During Phase I, testing included a series of tee-wall and noise walls made by two precast plants. Although the slump flow, using the spread test of both mixes, were in acceptable limits of the SCC standard specification, both companies applied slight vibration to ensure proper finish and consolidation, which caused them to fail the L-Box and J-Ring tests. Therefore, it was recommended that these tests be performed in conjunction with the spread test to determine the fresh concrete properties of SCC.

The applicability of SCC mixes in drilled shaft applications was thoroughly tested in Phase II. Performance of the SCC obtained from the drilled shafts in Phase II was found to be satisfactory. All mixes passed the 28-day requirements, but segregation due to high slump flow was observed in cylinders during testing that restricted the slump flow. SCC in drilled shafts should not be dropped from heights of more than 6 feet, or a tremmie should be used to avoid segregation. Test results from the cross-hole sonic logging indicated that there are no air pockets in any of the shafts.

Research showed that there were no significant changes in compressive strength between SCC and conventional concrete. The elasticity of SCC had been slightly lower than conventional concrete, but its tensile splitting strength was higher. SCC had higher drying shrinkage than conventional concrete and HPC. The performance of SCC under rapid chloride permeability testing (ASTM C1202) was greatly enhanced with the addition of fly ash and silica fume. Also, performance was satisfactory for the SCC obtained from the drilled shafts, which enabled the ASTM Standard J-Ring Test (C1621/C1621M-06) to be successfully used as a quality control measure.

Further Recommendations

Performance of the SCC obtained from the drilled shafts in Phase II was satisfactory, but the slump flow was measured at over the upper specified limit of 28 inches. Additionally, there is a need to examine various mixes for segregation by applying the Visual Stability Index (VSI) as a screening tool. The research findings suggested that the ASTM Standard J-Ring Test (C1621/C162 1M-06 Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring) be used as a part of a quality control measure along with regular slump flow test, when a more quantitative result was needed.

Implementation

A Self-Consolidating and High-Performance Concrete Workshop was sponsored by Dr. Nassif in 2006. Several articles were published in two international journals (TRB and RITA), plus two professional journals (ACI and Portland Cement Association). One doctoral student was employed on the project, who has since graduated and is employed as a faculty member at Florida International University

Self-Consolidating Concrete (Phase I & II)

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)	✓	
Policy/Process Change	✓	✓
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)		✓
Cost Savings/Economic Impact		✓

In addition to the 2007 NJDOT Specifications, the project caused the New Jersey Turnpike to change their specifications and include the use of Self Consolidating Concrete (SCC) in bridge repair.

Projected Cost Benefit/Economic Impact

Richard Dunne of NJDOT Structural Engineering confirmed that previous specifications were cut and pasted from a variety of national standards and the 2007 specifications are now consolidated into a solid drilled shaft and design specifications. (See Attachment D). The use of SCC provided better efficiency in construction, instead of casting pilings in a laboratory and transporting them to the site for installation. Extensive consideration needed to be given to the soil conditions in order to effectively use this technology. Also, SCC has aesthetic value relative to context sensitive design that was demonstrated with the application of a seascape design on a bridge project located in Atlantic City.

FHWA-NJ- 2007-022: A Comparison and Analysis of KA-Band Radar vs. X-Band Radar – Dr. Allen Katz, The College of New Jersey

Cost: $49,837.

Summary

The New Jersey State Police were using the approved X-band traffic radar as standard practice, which needed to be replaced with updated technology. In order for the proposed Ka-band radar unit to be accepted by the courts, a scientifically-based test requirement had to be completed. This study included developing a program for testing the new Ka-band radio unit, monitoring and assisting in the development of a testing program, reviewing and validating the results, and completing a report that would be accepted by the New Jersey courts.

Ka-band radar equipment, developed by two leading manufacturers (Stalker DSR 2X and an MPH BEE-III), was selected and field tested for approval. The units were mounted side-by-side with MPH K55 and a standard comparison was made with the currently approved program. The

results confirmed that Ka-band radar speed functions correlated closely with the X-band measurements. Over 1,000 measurements in all types of weather had a minimal affect on the equipment and speeds while being within NHTSA standards.

Further Recommendations

The state of development for laser speed detection was also examined with 200 independent laser measurements being taken that supported earlier work in New Jersey and proved the accuracy of speed laser measurements. A list of specifications and complimentary data proved that the accuracy and reliability of Ka-band radar measurements were acceptable and enabled the New Jersey State Police to enhance their speed enforcement program for motorists traveling on New Jersey highways.

Implementation

Two graduate students were employed on the project, which contributed to their knowledge base and field testing experience in electrical engineering. A technical review of the project was accepted by IEEE and presented during the 2008 Sarnoff Symposium. Another outcome of the study was that Principal Investigator had been recruited by the Army Research Labs to provide technical assistance on a non-linear radar project.

A Comparison and Analysis of KA-Band Radar vs. X-Band Radar

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		

Projected Cost Benefit/Economic Impact

According to Eric Heitmann, NJ State Police representative, the study confirmed that Ka-Band is a form of Doppler Radar and was already approved by the New Jersey Court System, the State Attorney General's Office, and the NJ State Police. Ka-band technology is currently being used by enforcement agencies on the New Jersey Turnpike.

FHWA-NJ- 2007-023: Stormwater Management Rule Implementation Process – Dr. George Guo, Rutgers University, Center for Advance Infrastructure and Transportation

Cost: $246,033.

Summary

The New Jersey Department of Environmental Protection (NJDEP) adopted the Stormwater Management Rules as a more stringent standard for land development in the state, which includes roadway and other transportation projects. A best practice manual was developed by the NJDEP to assist regulated agencies with guidance on rule compliance. However, the New Jersey Best Management Practices (NJBMP) Manual lacked sufficient guidance on leading engineers to identify regulations and select appropriate stormwater management measures for transportation projects.

NJDOT planners, designers, and maintenance personnel required a simplified process to navigate the Stormwater Management Rules and facilitate the selection of appropriate stormwater management measures. NJDOT personnel required this information during the early stages of a project, in order to determine if the rules can be met for a specific project or if hardship waivers were necessary.

The following research objectives guided this project:

- Develop an electronic decision process to assist planners, designers, and maintenance staff
- Determine applicable stormwater rules,
- Identify the appropriate treatment of non-structural and structural stormwater strategies and measures including manufactured treatment devices to comply with the Rules.
- Consider treatment capacity, footprint, cost, frequency of maintenance and operating cost.

A computer program was developed from an extensive literature search of stormwater management standards and Best Management Practices (BMPs) with special attention given to roadway and other linear transportation projects. The search addressed state regulations, manuals, and research papers. Findings confirmed that the NJ BMP Manual had been technically sound, but provided limited guidance on roadway projects. However, the California handbook did offer good decision making tools for use as the framework for the proposed computer model. The Washington Highway Runoff Manual contained helpful guidance in the selection of the BMP, while the Western Washington Stormwater Management Manual provided information on the establishment of a detailed plan. Also, the Georgia Stormwater Volume 2 contained a useful checklist.

A questionnaire was also developed and distributed to consultants and technical representatives to obtain information on design issues. Responses indicated that the two major design problems were the shallow depth to the Seasonal High Water Table and the right of way (ROW) included the right of way to locate a BMP. Most BMPs require a large amount of land, which needs acute planning attention relative to limited ROW. Other problems with BMPs were the limited space available in urbanized areas,

This decision-making tool was then developed using Microsoft Excel. NJDOT planners, engineers, and managers tested the model. It was found that this tool aided staff in complying with NJDEP stormwater regulations required for NJDOT projects. Since this excel application was operating at full capacity, adjustments may be needed if the program is to be used by designers and engineers.

Further Recommendations

This decision-making tool was then developed using Microsoft Excel and distributed by the NJDOT Drainage Bureau to agency planners, engineers, and managers. The tool has proven to benefit the agency in complying with NJDEP stormwater regulations on NJDOT projects.

However, the program was running at full capacity and needed to be adjusted to support additional functions used by designers and engineers.

Implementation

In November 2008, the principal investigator gave a research presentation during the International Symposium on New Technologies for Urban Flood Management. Research findings were also presented at the NJDOT sponsored 2007 and 2008 Research Showcases and the Sustainable Transportation in a Changing Environment Workshop.

Stormwater Management Rule Implementation Process

T/2 Measures	Researcher	Customer
Knowledge Transfer (Findings/Dissemination)	✓	✓
Marketing/Media (website)		
Policy/Process Change		
Demonstrations	✓	✓
Implementation Benefits		
Enhancement (Efficiency, Environment, Safety)	✓	✓
Cost Savings/Economic Impact		✓

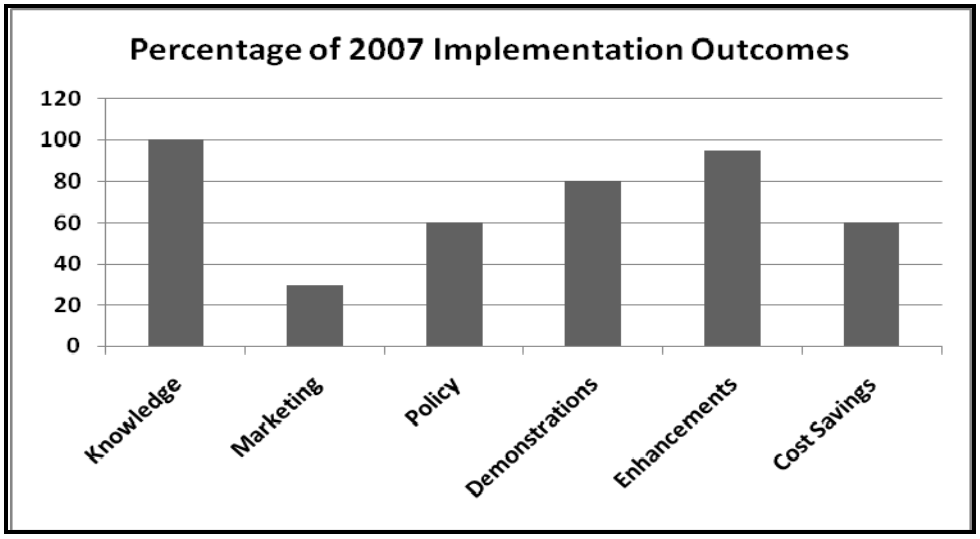
Projected Cost Benefit/Economic Impact

As a result of this project, knowledge transfer had occurred through presentations given at international and statewide conferences on the system. Members of the research team were recruited to participate with other universities on stormwater management projects. Research articles had been published in industry and academic journals. However, cost savings from the project was unable to be established at the present time.

Summary

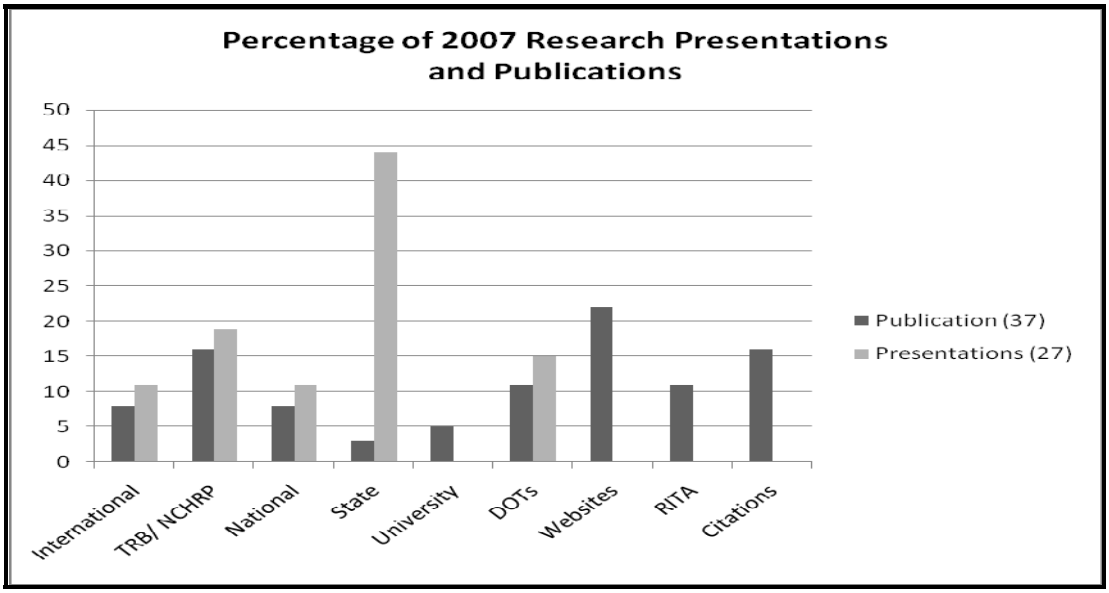
The twenty research projects were evenly divided between applied research studies, development of computer tools, creation of new specifications and procedures, and identification of safety needs. All of the projects were successfully implemented except for four, which were due to technology issues and the reduced need for monitoring activities (e.g. TSPDC and medical records). As in the past, safety applications yielded the most cost effective outcomes.

Knowledge transfer (20) and enhancements (16) were the direct benefit of most research studies. Over 60% of the studies yielded cost savings for the Department, only one year after the projects were completed.



Knowledge Transfer

The research projects provided practical engineering experience for 16 graduate students, as well as several undergraduate classes. Three students received their doctoral degrees as a result of participating in the projects. The impact of the NJDOT research studies reached Switzerland, China, New Zealand, Tehran, and Australia where presentations and publications were presented on stormwater, personal rapid transit, and guiderail applications. One NCHRP Report was generated from the research on guiderails. Technical assistance was provided by the researchers to the Virginia Board of Education, the U.S. Army Research Laboratory, and several state and local agencies. In addition to appearing in several research journals and on technical websites, citations were made in the New York Times newspaper on the transit friendly parking structures.



Marketing/Media

The implementation phase of projects frequently involves marketing of products within the Department or other state agencies. For example, internal approval was sought for including the bridge construction procedural changes in the 2007 NJDOT Specifications for Road and Bridge Construction Specifications. The Transportation Safety Professional Development database was marketed within the NJDOT to Human Resources, but was not approved. Another external marketing effort occurred with the NJ Police Technical Assistance Program, which was required to be adopted by the state and local law enforcement agencies. Also, external cooperation was sought from the utilities industry for the pole relocation program.

Policy and Procedures

As noted, successful marketing of research recommendations and products resulted in the implementation of policy and procedural changes on the following applications:

- Guide rails
- NJTR-1 Crash Data Form
- High Performance Concrete
- Embedded Beam for bridge approaches
- Breakaway utility poles
- Self Consolidating Concrete I & II

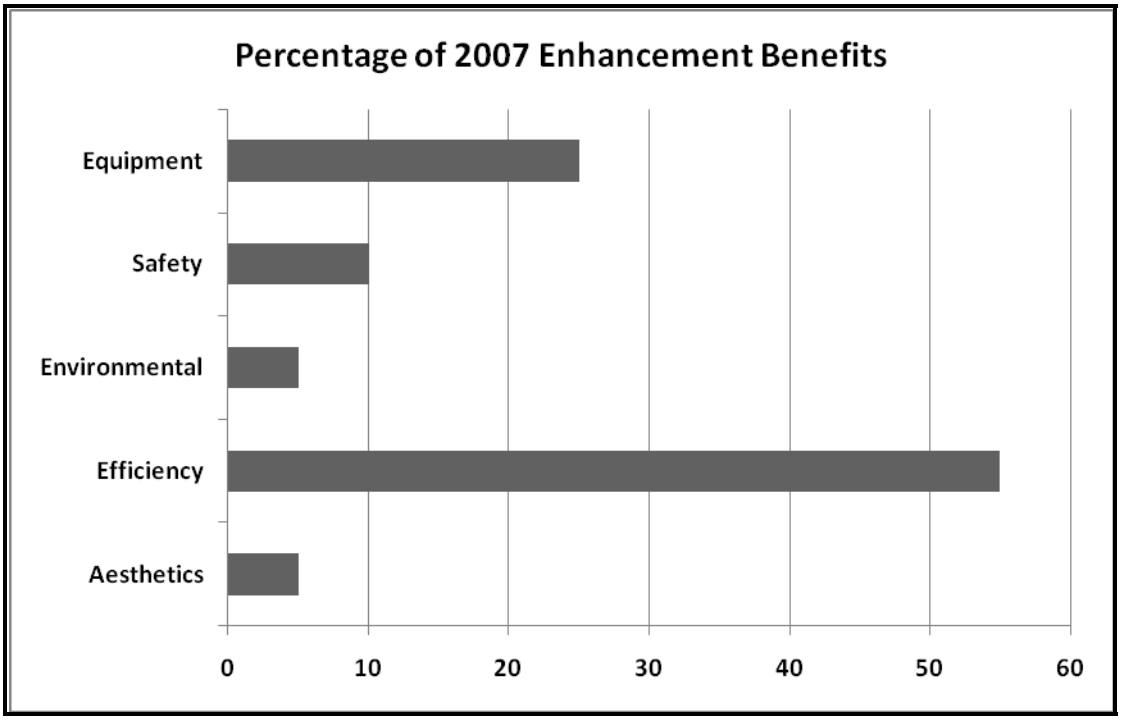
Most recently, the Department has adopted the model, developed for the Cost of Transporting People in New Jersey study, to track the success of the federally funded TIGER projects that are due to be federally funded shortly.

Demonstrations

In addition to the projects identified in the previous section, demonstrations were used by all researchers to seek internal approval of the customer during the developmental phase of their projects. The research team and customers met on a quarterly basis with the NJDOT Research Bureau representative to monitor the progress of research and development. At that point, adjustments were made by the research team to the satisfaction of the customer and the Research Bureau. This process has greatly improved the implementation rate of research projects. In 2007, nearly 70% of the projects were implemented one year after the studies were completed.

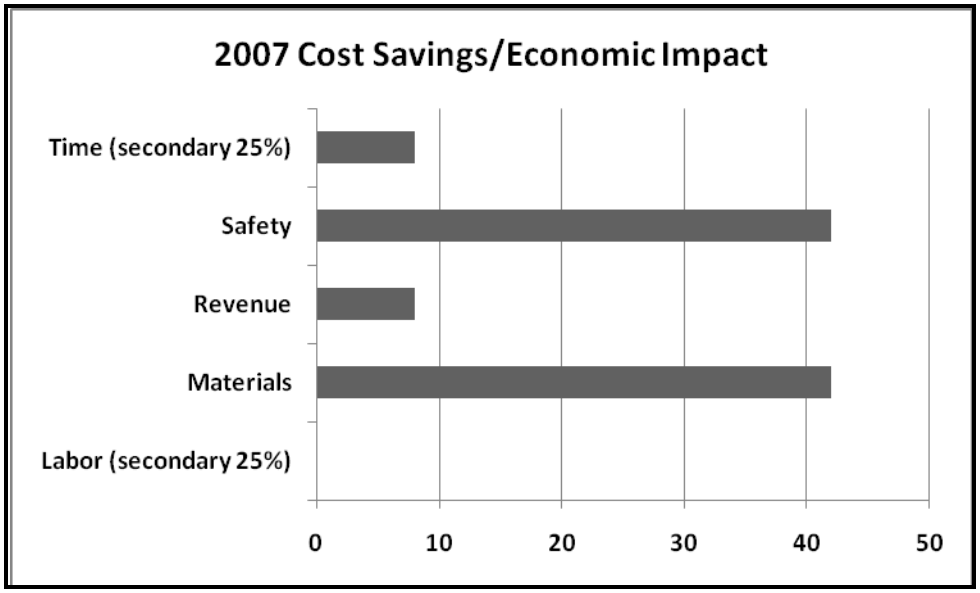
Enhancement Benefits

The primary function of research requested by the customers was to improve the efficiency of their operations (55%). There were two aesthetic enhancements realized from the projects: transit friendly parking structure guidelines and the use of SCC on bridge decks. Fewer studies focused on safety improvements than in the past, while new technology (e.g. personal rapid transit, computer programs, state of the art utility poles, and radar) had been reviewed as options to enhance the NJDOT approved resource tools.



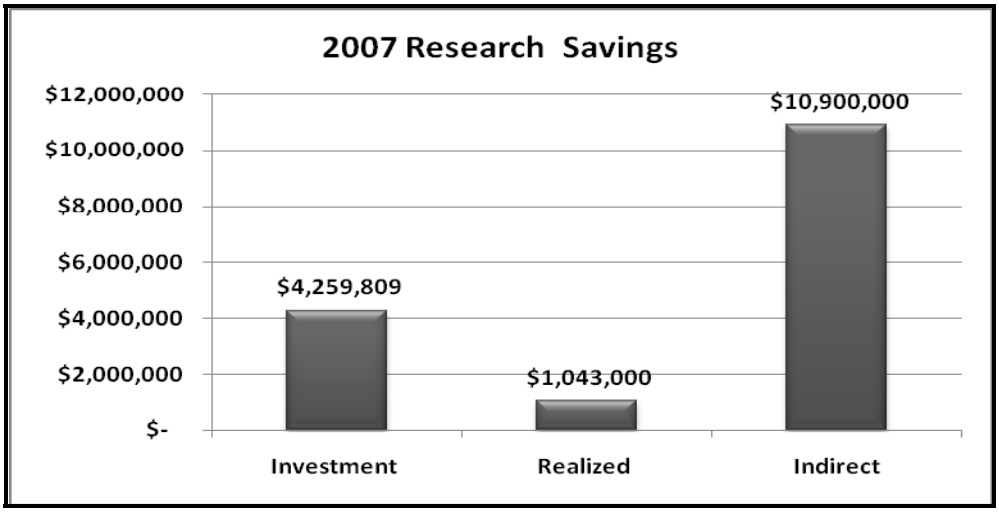
Cost Saving/Economic Impact Benefits

Although it is too early to confirm benefits from the implementation of 2007 Specifications for Road and Bridge Construction, it is expected that considerable savings will be realized in labor, material, and time costs. Several factors will contribute to these savings: reduction of cracking on bridges, the EB application on approaches, and the use of SCC will help to improve the quality of bridge work. The use of processed clay sludge in covering the Meadowlands landfill increased worker efficiency, as well as lowered the cost of this process. Worker and highway user safety was improved by the assessment of guide rail and breakaway utility pole applications, improvement of crash data, and the use of aerial mapping technology to clear airport obstructions. Lastly, the benefit/cost model will be used to track benefits realized by the forthcoming TIGER projects.



NJDOT Realized Savings

Nearly half of the projects were computer based models for monitoring safety and environmental compliance in New Jersey. Over $1 million was realized from research implementation during this period, while indirect savings were assessed at $ 10.9 million in reduction of utility pole crashes for the NJDOT. An additional $103.8 in savings had been assigned to the 32 fewer fatalities from utility pole crashes that occurred during this period. Future savings will be realized from the reduction of bridge material and repair costs that are expected to be generated from the implementation of 2007 Roadway and Bridge Construction Specifications.



Safety projects provided the greatest financial benefit as a result of the strong economic gain associated with crash reductions. Approximately 10,000 vehicle occupants are involved in utility pole crashes yearly, which results in between 50-60 fatalities and 200 persons being incapacitated. New Jersey is ranked 8th in the country for fatalities due to utility impacts. The research goal was to review and recommend methods of mitigating these types of fatal and injury crashes. The rigid design of the pole, required to survive high winds, is the major reason behind the high fatality rate for this type of crash.

Rowan University and Virginia Tech participated in a utility pole crash mitigation study, to compare the current NJ Utility Accommodation Policy to national practices. Data was also used to examine the conditions surrounding utility pole crashes and the identification of high risk sites. A cost-benefit procedure was then developed for determining the use of breakaway or energy absorbing utility poles.

The findings confirmed that the New Jersey Utilities Accommodation policy followed national guidelines closely, but focused primarily on new construction or reconstruction. The 2003-05 crash data analysis confirmed that 40% of all occupants exposed to utility pole crashes were either injured or died. County roads accounted for most crashes and frontal impacts were most common. Also, motorcycle crashes were overrepresented in this category. U.S. Highway 22 was rated as having a serious utility pole impact problem.

After the project was completed, William Beans obtained $300,000 in federal funds to sponsor a utility pole crash reduction program. The NJDOT Utility Unit and Bureau of Research collaborated on this effort to significantly reduce fatalities, although other factors such as

increased gas prices may have impacted this reduction in lives lost. Therefore, it is more important to base gains on injury crashes for this period.

2007-2008 New Jersey Utility Pole Crashes

Crash Types	2007	2008
Property Damage	4,551	4,293
Injury Crashes	3,444	3,234
Fatal Crashes	72	40

Source: *Plan4Safety 2009.*

The New Jersey Department of Transportation (NJDOT) has long recognized the importance of Crash Reduction Factors in conducting benefit/cost analyses for highway safety improvements. According to Meyer (2008) FHWA has established the average cost of a fatality at $3,246,192 while the cost of an injury crash was determined to be $68,170. Plan4Safety showed that a reduction of 32 fatal utility pole crashes and 160 utility pole injury crashes had occurred after the relocation of utility poles in high crash areas. Based on these estimates, a total of $103.8 million had been saved due to the reduction of fatal crashes and $10.9 million for the reduction of injury crashes. Only injury crash reductions have been included in the cost savings, since the cost of fatal crashes may have been attributed to reduced travel. Most importantly, 32 fewer people died and 160 fewer people were injured from hitting utility poles.

Other Realized Savings

The Police Local Technical Assistance Program project realized additional financial support from National Highway Traffic Safety Administration in the amount of $600,000 that was used to integrate the State's crash data system into one unit. The implementation of the Quality Assurance project generated over $143,000 in savings through the use of processed dredged clay to cover the NJ Meadowlands Landfill. Other savings are expected be realized by the Department in the future, especially when TIGER and bridge projects are completed.

Conclusion

Nearly 70% of the projects, requested by the NJDOT customers, were implemented one year after the studies were completed. Almost $1.5 million was immediately regained from the research efforts, while 32 lives were saved due to the reduction of utility pole crashes. A majority of the projects were requested to improve efficiency, reduce labor, and material costs, which support the Department in maintaining standards for producing quality work.

References

European Road Safety Observatory (2006). Cost-Benefit Analysis. January 18, 2008 http://www.erso.eu.

FHWA (2008). The Corporate Master Plan Shapes R&T Practices. Public Road, January/February, p.p. 30-36.

Meyer, M. (2008). Crashes vs. Congestion – What's the Cost to Society? Bethesda, Maryland: Cambridge Systematics, Inc.

NJDOT (2007). 2007 New Jersey Department of Transportation Specifications for Road and Bridge Construction.

ATTACHMENT A

Project Title:

FHWA Project Number_____ Start Date:_____ Completion Date:_____

Principal Investigator: _____ University/Consultant:_____

Bureau of Research Project Manager:_____ Customer/Unit:_____

Implementation Follow Up: 1 year ___ 2 year___ 3 year ___

Implementation/T2 Measure			**Est. Cost**	**Champion**	**Completion Date**
Knowledge Transfer	Findings/Report Dissemination	☐			
	Seminar	☐			
	Training	☐			
Marketing/Media	Brochure/Publication/article	☐			
	Electronic Media/Website	☐			
Policy/Procedure/Process Change	Admin/Process/Procedure Change	☐			
	Policy Change	☐			
	Specification/Standard Change	☐			
Demonstration	Pilot Project	☐			
Implementation Benefits					
Enhancement	Aesthetic	☐			
	Efficiency/Effectiveness	☐			
	Environmental	☐			
	Safety	☐			
Cost Savings/Economic Impact	Equipment	☐			
	Labor	☐			
	Materials	☐			
	Revenue Increase	☐			
	Safety	☐			
	Time	☐			
TOTAL					

How useful were the research findings/products/outcome? The research study resulted in:

☐implementable **changes** with **quantifiable benefits. Please Specify:**_____

☐implementable **changes** with **no quantifiable benefits. Please Specify:**_____

☐**knowledge** transfer with **no quantifiable benefits. Please Specify:**_____

☐no implementation. Explanation:_____

Can the Bureau of Research or NJ LTAP provide further assistance in implementing the findings of the study?
Yes ☐ No ☐ Comments:

Attachment B.

NJDOT 2007 Roads and Bridges Specifications

507.03.07 Concrete Bridge Approach

Prepare the underlying surface as specified in 405.03.01.

Set forms as specified in 504.03.02.B, place reinforcement steel as specified in 504.03.01, and set joint ties for the entire area to be paved at least 1 day before placing concrete. Set forms at grade in full contact with the underlying surface. Install longitudinal joint ties through the forms and secure in place. Ensure that concrete does not seep around the bar. If longitudinal joint ties cannot be installed before placing concrete, install as specified in 405.03.02.C.

Check the alignment and grade elevations of the forms and joint ties and make corrections before placing the concrete. Ensure that the forms do not deviate from the required alignment by more than 1/4 inch. Reset, or remove and replace forms that settle or deflect under the spreading and finishing equipment. Clean the top and face of forms, and oil the face before placing concrete.

Comply with the limitations of placing specified in 507.03.02.F. Place concrete as specified in 507.03.02.H. Apply the surface texture as specified in 507.03.02.I. Cure the concrete as specified in 507.03.02.J. Saw cut the surface as specified in 507.03.02.L.

Follow the loading restrictions as specified in 507.03.02.M. Do not allow vehicular traffic of any kind on the approach until the it has been saw cut grooved finished.

(BDC08S-01 Start)
Ensure the concrete conforms to the surface requirements as specified in 507.03.02 N, except each lot will be equal to the number of cubic yards of approach concrete placed in the lane
(BDC08S-01 End)

903.05.02 Mix Design and Verification

Design an HPC mix that conforms to the requirements in Table 903.05.02-1. Submit a report documenting these results to the ME. Obtain the results of these standard tests from an AASHTO accredited testing agency that is accredited for the test being performed. Design mixes according to the HPC-1 criteria for use in bridge decks, parapets, and bridge sidewalks. Design mixes meeting the HPC-2 criteria for use in pier column protection.

Table 903.05.02-1 Design and Verification Requirements for HPC

Performance Characteristic	Test Method	Requirements	
		HPC-1	HPC-2
Scaling Resistance[1] @ 50 cycles (visual rating of the surface, maximum)	ASTM C 672	3	–
Abrasion Resistance (average depth of wear in inches, maximum)	ASTM C 944	–	0.04
Freeze-Thaw Durability (relative dynamic modulus of elasticity after 300 cycles, minimum)	ASTM C 666 Proc. A	80%	80%
Chloride Permeability[2] @ 56-days (coulombs, maximum)	AASHTO T 277	1000	1000
Compressive Strength[3] @ 56-days (pounds per square inch, minimum)	AASHTO T 22	5400	5400
Water-Cement Ratio (maximum)	–	0.40	0.40

[1] For the scaling resistance testing, moist cure specimens for 14 days and then air cure for 14 days.

[2] If the chloride permeability requirement has been achieved in 28 days, consider the chloride permeability acceptable. If the required chloride permeability is not achieved in 28 days, test the HPC sample at 56 days.

[3] If the compressive strength requirement has been achieved in 28 days, consider the strength acceptable. If the required compressive strength is not achieved in 28 days, test the HPC samples at 56 days.

At least 90 days before the planned start of the concrete placement, submit the mix design to the ME for approval and verification as specified in 903.03.02. Include the results of the required performance testing in the submission.

In addition to verifying the compressive strength of the HPC mix, the ME will verify the chloride permeability testing according to AASHTO T 277. Submit 4 additional cylindrical samples, having a 4-inch diameter and a length of at least 8 inches, to the ME for this verification testing. The ME will average the values of tests on 2 specimens for each mix design.

903.05.03 Mixing

Mix HPC concrete as specified in 903.03.03. During production, do not change the components of the mix in any way from the approved mix design. If the components must be changed, redesign and re-verify the mix.

903.05.04 Control and Acceptance Testing Requirements

With the exception that the ME may perform compression testing at 56 days, the ME will enforce the requirements specified in 903.03.05 for control and acceptance testing of non-pay adjustment Class A concrete in the fabrication of the HPC elements.

Produce HPC that conforms to the acceptance testing criteria in Table 903.05.04-1.

Table 903.05.04-1 Acceptance Requirements for HPC

Performance Characteristic	Test Method	Requirement
Percent Air Entrainment[1]	AASHTO T 152	6.0 ± 1.5 (No. 57/67 Aggregate) 7.0 ± 1.5 (No. 8 Aggregate)
Slump (inches)[1, 2]	AASHTO T 119	3 ± 1
Chloride Permeability @ 56-days[3, 4] (coulombs, maximum)	AASHTO T 277	2000
Compressive Strength @ 56-days[5] (pounds per square inch, minimum)	AASHTO T 22	4400

[1] If using a Type F or G admixture, change the Slump and Air Content values for the HPC as follows:

[1.1] Slump: 6 ± 2 inches

[1.2] Air Content: increase both the target value and tolerance percentages by 0.5

[2] For slip-formed parapet, design and produce a mix with a slump of 1 ± 1/2 inch.

[3] The ME will not test for the chloride permeability requirements for HPC used for Items other than bridge decks.

[4] For chloride permeability testing, the ME will mold 4 additional cylinders, taking 2 cylinders each from 2 randomly selected delivery trucks for testing at 28-day and 56-day intervals.

[5] For compressive strength testing, the initial rate for the HPC is 6 per lot. The retest limit is 4400 pounds per square inch.

The ME will test 2 specimens for chloride permeability and will average the results of the 2 specimens to determine the test result. The ME will perform 2 tests on each lot from samples taken from 2 randomly selected delivery trucks. The lot is eligible for 100 percent payment provided that the test results are equal to or below 2000 coulombs.

Whenever 1 or more individual test results exceed 2,000 coulombs at 28 days, the ME will re-evaluate the lot at the same testing rate at 56 days. If, upon testing at 56 days, 1 or more individual test results exceed 2000 coulombs, the RE may:

1. Require that the Contractor remove and replace the defective lot, or
2. Allow the Contractor to submit a corrective action plan for approval.

903.06 Self-Consolidating Concrete (SCC)

903.06.01 SCC for Drilled Shafts

A. **Composition.** Produce SCC conforming to the composition requirements specified in 903.03.01, except use a Type F admixture and a viscosity modifying admixture (VMA). Use Type F and VMA admixtures, as specified in 903.02.02 and 903.02.04, at a dosage to produce a flowable concrete that does not require vibration for consolidation. Proportion the aggregates so that the fine aggregate is less than 50 percent by weight of the total aggregate.

B. **Mix Design and Verification.** Design the mix as specified in 903.03.02 to conform to the strength requirements, water-cement ratio, and cement content for a Class A concrete and the requirements specified in Table 903.06.01-1.

Table 903.06.01-1 Requirements for SCC for Drilled Shafts

Property	Test Method	Requirement
Air Content		
Coarse Aggregate No. 57	AASHTO T 152	6.5 ± 2.0 percent
Coarse Aggregate No. 67		6.5 ± 2.0 percent
Coarse Aggregate No. 8		7.5 ± 2.0 percent
Slump Flow	NJDOT C-4	21 ± 3 inches
Visual Stability Index		
Plastic Concrete	NJDOT C-4	1 maximum
Hardened Concrete	NJDOT C-5	1 maximum

C. Perform mix design verification as specified in 903.03.02. For the verification batch, ensure that the air content is in the top half of the allowable range and the slump flow is between 21 and 24 inches. Perform air content, slump flow, and visual stability index (plastic concrete) testing on the verification batch. Make concrete cylinders for compression testing as specified in 903.03.02 and make 2 additional 4 × 8-inch cylinders for evaluation of the visual stability index of the hardened concrete. Saw the additional cylinders length-wise according to NJDOT C-5. The ME

will perform the compressive strength testing and the visual evaluation to assign a visual stability index in order to approve the mix.

D. **Verification of Pumpability.** Verify pumpability at least 10 days before pouring the SCC concrete in the drilled shaft. Demonstrate the pumpability of the SCC to the ME by pumping a trial batch through the pump proposed for placing the SCC into the drilled shaft. Use the proposed methods for mixing the concrete including any anticipated time delays. The ME will test the SCC before and after pumping to verify that the SCC meets the requirements of Table 903.06.01-1 after pumping.

E. **Mixing.** Mix SCC as specified in 903.03.03.

F. **Control and Acceptance Testing.** Perform quality control testing as specified in 903.03.05.

The ME will perform acceptance testing as specified in 903.03.05 for a non-pay adjustment Class A concrete, except that the provisions for slump testing are replaced with requirements for slump flow testing and visual stability index on the plastic concrete. The ME will perform the slump flow testing and the visual stability index according to NJDOT C-4, at the sampling rate specified for slump testing of Class A concrete. The ME will perform visual stability index on the hardened concrete according to NJDOT C-5 at a rate of at least 1 per day. If the visual stability index on the hardened concrete does not conform to the criteria in Table 903.06.01-1, the ME will require redesign of the mix.

In the performance of quality control or acceptance testing, fill cylinder molds, slump flow cones, and air buckets in one lift. Do not vibrate, rod, or tap to consolidate the SCC.