Research Impacts

Better—Faster—Cheaper

June 2010

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Introduction

This document is the 2010 collection of High Value Research highlights from across the Nation. These highlights, which were compiled for the American Association of State Highway and Transportation Officials Research Advisory Committee summer meeting, showcase projects that are providing "Transportation Excellence Through Research." The highlights encompass a variety of research with topics ranging from pavements and bridge construction, to motorcycle mortality rates, to animal carcass disposal.

States that submitted projects include: Alabama, Alaska, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Utah, Vermont, Virginia, and Wisconsin. Additionally, the Federal Highway Administration and the National Cooperative Highway Research Program submitted projects.

Alabama Department of Transportation

Project Title, ID, Cost, Duration	***Evaluation of Double Drop Beads Pavement Edge Lines*** ***ID:*** ALDOT Research Project #930-653, ***Cost:*** $131,482 ***Duration:*** 4 years
Submitter	***Agency, organization:*** The University Transportation Center for Alabama, The University of Alabama ***Contact, e-mail:*** Jay Lindly, jlindly@ eng.ua.edu
Research Program	***Sponsoring agency or organization:*** Alabama Department of Transportation (ALDOT) ***Contact, e-mail:*** Jeffery W. Brown, Research and Development Bureau Chief, brownje@dot.state.al.us
Web link, if available	http://utca.eng.ua.edu/projects/final_reports/Project%2005409%20Final%20Report%20REV.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This report presents an evaluation of Double Drop Bead (DDB) edge lines used on ALDOT-maintained highways. It compares DDB to three other pavement marking types in terms of service lives, life-cycle costs, and both dry-night retroreflectivity and wet-night retroreflectivity. The other three marking types are standard flat thermoplastic marking (FTM), rumble strips, and profiled pavement marking (PPM). Wet and dry retroreflectivity for the four pavement marking types was field-measured for marking ages ranging from a few months to approximately 4 years. The project estimated the average dry retroreflectivity of DDB to be significantly higher than the other marking types for the entire 4-year test term, followed in order by rumble strip, FTM, and PPM. In terms of wet retroreflectivity, DDB was again highest, followed by PPM and rumble strip. A valid decay rate for wet FTM could not be established.

	An estimate of the longevity of the markings generally indicates that DDB has the longest useful life on similar ADT (average daily traffic) roads, followed by rumble strip, FTM, and PPM materials. The life-cycle cost analysis showed that over an 8-year life cycle, the cost per mile of marking was lowest for FTM, followed in order by DDB, rumble strip, and PPM. The DDB edge marking exhibits the highest dry retroreflectivity of the four markings throughout the range of marking ages tested and for limited future projections. It provides this increased retroreflectivity for a relatively small increase in cost per mile. For those reasons, the report recommends that ALDOT should strongly consider making DDB edge markings its standard edge marking. However, because ALDOT has so far tested only one type of DDB marking, it should also work to optimize such characteristics as bead sizes, proportions of high refractive index beads, etc. before establishing a standard.

Project Title, ID, Cost, Duration	***Development of a Method to Forecast Freight Demand Arising from the Final Demand Sector & Examination of Federal Data to Analyze Transportation Demand for Local Area Through Trips*** ***ID:*** ALDOT Research Project #930-697, ***Cost:*** $297,423 ***Duration:*** 19 months
Submitter	***Agency, organization:*** The University of Alabama in Huntsville ***Contact, e-mail:*** Michael Anderson, michael.anderson@uah.edu
Research Program	***Sponsoring agency or organization:*** Alabama Department of Transportation (ALDOT) Jeffery W. Brown, Research and Development Bureau Chief, brownje@dot.state.al.us

Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The research was performed to develop a framework and an approach to achieve insight into two important components of freight transportation in Alabama, and the United States. The first objective is to develop the ability to project freight traffic arising from retail sales to households or to the final demand sector of the economy. Normally, this involves shipments from distribution centers and bonded warehouses to retailers located in the State's population centers. The research demonstrates that this final leg of a shipment's journey to the consumer is growing very fast and evolving rapidly. Major retail centers were identified in all of Alabama's cities with populations of over 25,000. A subset of the retailers in these communities was chosen for a detailed analysis of their distribution network. The researchers conducted interviews to gather information about how each network operates. The information collected from the survey included the geographical region served, the physical and operational characteristics of the network, volume of traffic, and anticipated future traffic volumes. The survey revealed that most distribution networks serving Alabama could either be characterized as hub and spoke or route-based. The survey also uncovered many unique characteristics of each network. Finally, researchers determined a method to allocate freight traffic arising from the final demand sector to Alabama counties. Several variables were tested including population, employment, payroll, and personal income. It was found that total personal income of residents in the county appeared to work best with population coming in second. The second research objective focuses on the use of Federal freight flow data to forecast the amount of pass through freight expected in urbanized areas in the State. The report documents procedures developed to utilize the Freight Analysis Framework Version 2 Database to determine the number of vehicles passing through an urban area in Alabama. The procedures developed in this research focus on the National level pass through data, trips from one State to another that pass through other States only because of that State's location; pass through from the port of entries, where the urbanized area is located on a major corridor; and Statewide level through trip data, trips from one part of the State to

	another that pass through the urbanized area because of its geographic location. The need for, and application of, the pass through freight forecasting is evident in the transportation planning models each State is expected to develop and maintain for evaluating transportation projects. The ability to forecast accurately the pass through freight movements will benefit transportation planners in urbanized areas by being able to identify freight volumes that must be accommodated by the infrastructure, but for which the local area has no direct method to survey.

Project Title, ID, Cost, Duration	***Polyvinyl Alcohol Fiber Reinforced Shotcrete for Rehabilitation and Preventative Maintenance of Aging Culverts*** ***ID:*** ALDOT Research Project #930-657 ***Cost:*** $75, 242 ***Duration:*** 2 years
Submitter	***Agency, organization:*** Auburn University ***Contact, e-mail:*** James S. Davidson, jim.davidson@auburn.edu
Research Program	***Sponsoring agency or organization:*** Alabama Department of Transportation (ALDOT) Jeffery W. Brown, Research and Development Bureau Chief, brownje@dot.state.al.us
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The goal of this project was to investigate the potential for using polyvinyl alcohol (PVA) fiber reinforced mortar for the rehabilitation and preventative maintenance of aging metal highway drainage culverts using a spray-on liner application approach. The interest and impetus for the investigation resulted from prior work of the investigators with county engineers that pointed towards the need for new cost-saving technologies

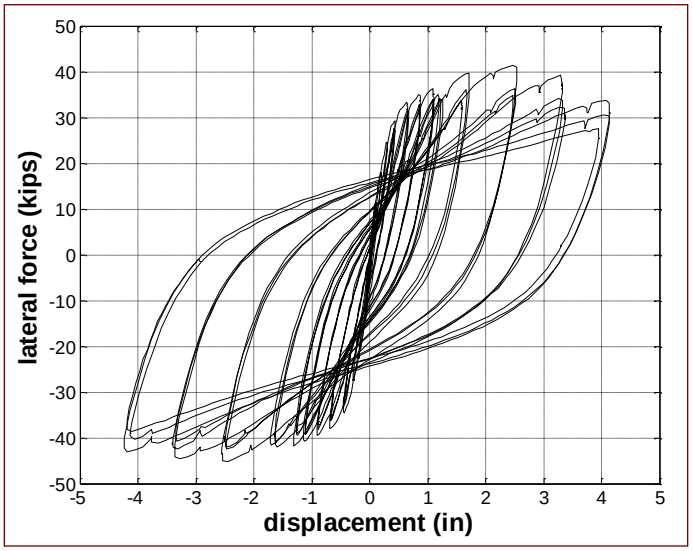
	for rehabilitating deteriorated metal highway drainage culverts that preclude the need to close the roadway and excavate the existing structure. A team comprised of the polymer materials expertise of the University of Alabama at Birmingham Department of Materials Sciences and Engineering; the civil/structural engineering expertise of the Auburn University Department of Civil Engineering; and the concrete application solutions expertise of Blastcrete Equipment Company, Inc. conducted the investigation. The investigation focused on the strength and toughness advantages provided by reinforcing spray-on concrete (shotcrete) with high performance PVA fibers. Tasks included developing and optimizing the material concept, laboratory strength testing, and developing engineering design methodology. Blastcrete Equipment Company, Inc. accomplished full-scale demonstrations of the concept at its facility in Anniston, Alabama. The laboratory-scale component of the investigation verified the significant tensile strength, ductility, and strain-hardening characteristics that have been presented by others for PVA- engineered cementitous composite (ECC). However, achieving the performance demonstrated by others proved challenging, even in a controlled laboratory environment. Ductility and strength performance depends upon using very precise and specific constituents, including fine silica sand with average particle diameter of 110 μm or less, and proprietary admixtures required to prevent clumping of the fibers. Also, since PVA fibers are hydrophilic, achieving proper water content proved challenging. These challenges were amplified when developing a methodology for pumping and spraying the PVA reinforced mortar on the inside of a corrugated steel pipe. Many iterations were required to balance the challenges of pumpability and sprayability with the requirement that the liner material must readily adhere to the obvert of the metal pipe. After successfully lining a 48-inch pipe, a 3-point bending test was conducted to illustrate the strength and stiffness enhancement provided by the liner. Finally, an analytical approach was derived for designing the required liner thickness, and practical field implementation challenges were outlined. Overall, it was concluded that the approach offers great potential as a solution to the metal culvert deterioration problem. PVA-ECC offers

	intriguing and unique characteristics that would minimize the required liner thickness while providing the tension strength, rigidity and ductility required. It was recommended that the next executable task be to demonstrate that a uniform structurally sound liner be applied under field conditions. Additional recommendations included to: (1) develop field construction guidelines, (2) investigate long-term stability issues to ensure stable strength over the service life of the culvert, and (3) refine and validate engineering and design methodology through controlled laboratory testing.

Alaska Department of Transportation

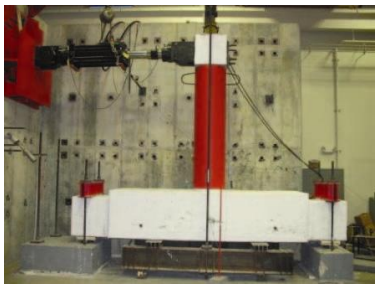
Project Title, ID, Cost, Duration	***Seismic Behavior of Concrete Bridge Columns at Sub-Freezing Temperatures*** ***Report number:*** FHWA-AK-RD-08-01 ***Project Cost:*** $105,000 ***Project Duration:*** 36 months
Submitter	***Agency, organization*:** Alaska Department of Transportation (DOT) & Public Facilities, Research, Development & Technology Transfer ***Contact, e-mail:*** Clint Adler, clint.adler@alaska.gov
Research program	***Sponsoring agency or organization:*** Alaska DOT & Public Facilities, Research, Development & Technology Transfer
Web link, if available	http://www.dot.state.ak.us/stwddes/research/assets/pdf/fhwa_ak_rd_08_01.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The final goal of this research was to develop recommendations for the future seismic design or assessment of reinforced concrete (RC) bridge bent structures in cold seismic regions. Ten large scale circular columns were constructed and tested under cyclic reversal of loads inside an environmental chamber in the North Carolina State University Constructed Facilities Laboratory. The columns were tested at freezing (-40°C, -40°F) and ambient (23°C, 74°F) temperatures. In order to characterize every aspect of the seismic response at low temperatures, the columns' design was governed by a desire behavior: shear dominated, flexural dominated and reinforced concrete filled steel tube columns. Results obtained show that RC member exposed to the combined effect of sub-freezing temperatures and cyclic loads undergo a gradual increase in strength and stiffness coupled with a reduction in displacement capacity. The experimental results were used to calibrate a fiber-based model and a series of static and inelastic analyses were

	performed to typical Alaska DOT bent configurations. Based on the results obtained from the experimental tests, the non-linear simulations and a moment-curvature parametric analyses, a simple methodology was developed to account for the low temperature flexural overstrength and reduction in ductility capacity. This methodology will help bridge engineers improve safety and economy of reinforced concrete bridges in seismically active cold regions.



Project Title, ID, Cost, Duration	***Seismic Retrofit of Cast-in-place Steel Shell Pile Bent Cap Connections*** ***Report number:*** FHWA-AK-RD-06-06 ***Project Cost:*** $30,000 ***Project Duration:*** 48 months

Submitter	***Agency, organization*:** Alaska Department of Transportation (DOT) & Public Facilities, Research, Development & Technology Transfer ***Contact, e-mail:*** Clint Adler, clint.adler@alaska.gov
Research program	***Sponsoring agency or organization:*** Alaska DOT & Public Facilities, Research, Development & Technology Transfer
Web link, if available	http://www.dot.state.ak.us/stwddes/research/assets/pdf/fhwa_ak_rd_06_06.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This research developed seismic retrofit methods for cast-in-place steel shell (CISS) column foundation shaft to cap beam connections. Specific seismic improvements made to the column and the bent cap system were: • The moment capacity of the column was reduced by cutting a portion of the column longitudinal reinforcement at the connection to the bent cap to levels that can ensure a proper ductile seismic response. • A section of the steel shell was cut and removed leaving a gap between the steel shell and the bent cap. • The bent cap dimensions were increased to ensure proper reinforcement spacing and to install the additional flexure and joint shear reinforcement, which was designed according to well-established joint shear force transfer mechanism models. At the conclusion of this research recommendations were made for seismic retrofit of multi-column bridge bents with circular CISS columns. These recommendations are being incorporated into the department's bridge design procedures. This methodology will help bridge engineers improve safety and economy of CISS bridge components in seismically active cold regions.



Connecticut Department of Transportation

Project Title, ID, Cost, Duration	***Historical Overview of Friction Testing in Connecticut*** ***Report number:*** CT-2243-1-10-1 ***Cost:*** $22,000 ***Project Duration:*** 13 months [March 1, 2009–April 30, 2010 (Estimated)]
Submitter	***Agency, organization*:** Connecticut Department of Transportation (ConnDOT) ***Contact, e-mail:*** James M. Sime, james.sime@ct.gov
Research program	***Sponsoring agency or organization:*** ConnDOT
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results  **Figure 1.** 	**Overview:** Pavement friction testing is an essential component of a highway pavement safety program to ensure that adequate pavement friction is provided for safe travel in wet weather conditions. A historical overview of pavement friction testing in Connecticut is presented in this report. Photographs of early pavement friction testers are provided, including vintage photos of a skid trailer from a Federal Highway Administration (FHWA) demonstration in 1968 (Figures 1, 2 and 3) and the first friction tester purchased by ConnDOT (Figure 4). ConnDOT's current friction tester is shown in Figure 5. Early documents that were pivotal in initiating a pavement friction testing program in Connecticut are cited. It provides insight into a State highway agency's perspective as friction testing services evolved. It covers the equipment used and explains the interpretation of data

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6

output. The report documents ConnDOT literature pertaining to pavement friction testing, and lists research studies that have been conducted in Connecticut. ConnDOT policies and procedures are reviewed.

Early pioneers in pavement friction testing services are acknowledged. On January 12, 2010, ConnDOT staff presented Transportation Research Board (TRB) Paper 10-0426 *(20)* titled, "Historical Overview of Pavement Friction Testing in Connecticut" in a Meet the Author Poster Session at the TRB 89th Annual Meeting in Washington, D.C. The poster session was sponsored by the *Surface Properties—Vehicle Interaction Committee* (AFD90). This was Session 580 titled, "Traveled Surface Texture, Friction, Noise, and Profile." A photo of the display presented there is shown in Figure 6.

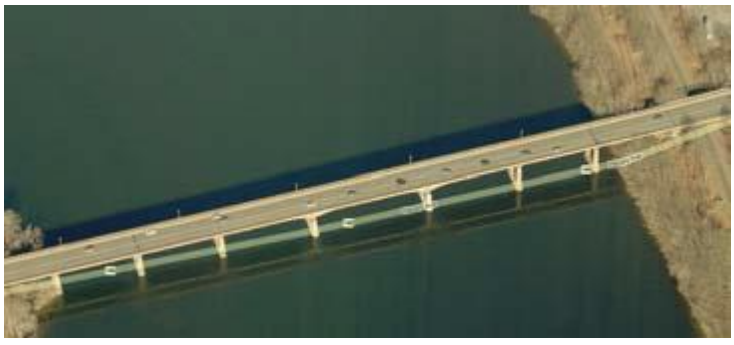
Conclusions:

Over the years, ConnDOT has revised its friction testing program in response to new advances in National/State policies/procedures, information and technology relating to wet pavement friction and safety concerns. This overview will provide future employees with a concise historical reference. This fits into the succession planning that should take place within a State highway agency prior to retirements and changes in employee responsibilities. To put Connecticut's efforts into perspective, results of a National Cooperative Highway Research Program (NCHRP) Synthesis 291 questionnaire showed that "the majority of the responding States use the ASTM locked wheel test method with the standard ribbed tire." Side force and fixed slip methods (such as the GripTester®) with smooth tread tires are more common outside the United States. The synthesis report suggested that macrotexture measurements be taken in addition to friction measurements. ConnDOT engineers have the equipment to measure macrotexture either at highway speeds (High-Speed Selcom Optocator/SLS5000 Sensor) or with the more precise static CTMeter instrument.

In 2005, FHWA issued a technical advisory (T 5040.36) titled, "Surface Texture for Asphalt and Concrete Pavements," which suggests pavement texture targets be established by owner-agencies based upon

	project specific factors, such as roadway geometry. ConnDOT researchers have been measuring texture depths to begin characterizing different pavement designs. Future research should focus on setting texture targets and integrating texture depth and friction measurements, including calculation of International Friction Index (IFI) parameters. **List of Figures:** **FIGURE 1.** Photo (rear view) of FHWA friction tester demonstrated to ConnDOT personnel in May 1968. **FIGURE 2.** Photo (side view) of FHWA friction tester demonstrated to ConnDOT personnel in May 1968. **FIGURE 3.** Photo of FHWA skid trailer demonstrated to ConnDOT personnel in May 1968. **FIGURE 4.** 1969 TestLab Corporation of Chicago Pavement Friction Tester (a one-of-a-kind). **FIGURE 5.** Dynatest Model 1295 Pavement Friction Tester. **FIGURE 6.** ConnDOT Research staff (left to right) Robert Kasica, John Henault, Anne-Marie McDonnell, and Dionysia Oliveira at poster session.

Project Title, ID, Cost, Duration	***Field Strain Monitoring to Evaluate Unexpected Cracking in a Non-Redundant Steel Plate Girder Bridge*** ***Report number:*** CT-2251-2-09-4 ***Cost:*** $100,000 ***Project Duration:*** 48 months [July 1, 2006–June 30, 2010 (Estimated)]

Submitter	***Agency, organization*:** Connecticut Department of Transportation (ConnDOT) ***Contact, e-mail:*** James M. Sime, james.sime@ct.gov
Research program	***Sponsoring agency or organization:*** ConnDOT
Web link, if available	http://www.ct.gov/dot/FSBM
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	**Overview:** Research was carried out to evaluate fatigue cracking in tie plates in a 43-year-old multi-span, non-redundant, steel plate-girder bridge that carries 4 lanes of traffic of a major State route over the Connecticut River. Figure 1 shows an aerial view of the bridge and Figure 2 shows a typical cross section of the structure. Tie plates are needed to provide continuity for the transverse floor beams. Repairs have been ongoing, and the goal was to explain the cause of cracking and provide guidelines for those responsible for designing the repairs to assure that there would be no further cracks. The designers expected that these bolted plates would act in simple tension, which is a reasonable assumption based on the plans and actual bridge. Field monitoring has demonstrated however that the plates are acting as bending members, with bending occurring in the horizontal plane. The field testing, combined with a finite element analysis, has been used to explain the behavior causing bending and to provide guidance on how best to make repairs.  **Figure 1.**

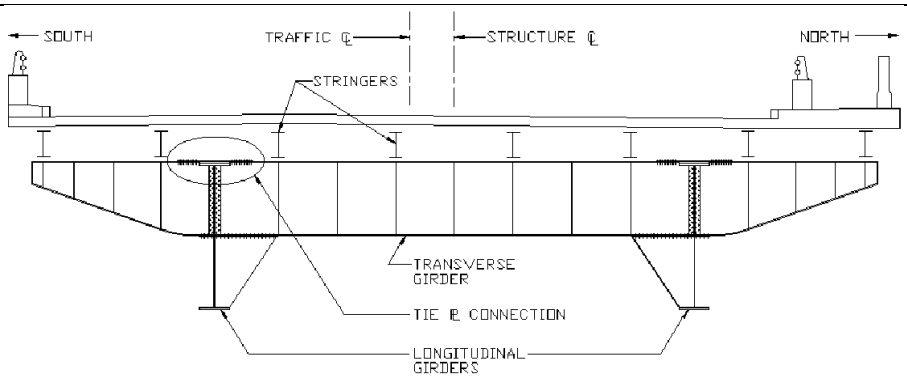


Figure 2.

Conclusions:

The report describes the use of strain monitoring to determine the cause of cracking in key tie plates of a non-redundant steel plate-girder bridge. The tie plates provide continuity for transverse floor beams, which cantilever beyond the main supporting longitudinal girders. Continuing field inspections noted the development of fatigue cracks in the tie plates, and the study began with strain monitoring to develop guidelines for use in repairs. All cracks developed at similar locations on the tie plates, which were clearly designed as simple tension members to provide continuity to the top flange of the transverse floor beam. An initial strain monitoring study demonstrated that: (1) the tie plates are subject to bending in the horizontal plane; (2) the bending is not consistent with potential torsional deformations of the transverse floor beam that would be expected from bending of the longitudinal stringers; (3) the largest tension strains occurred when trucks are in the middle of the span and not directly over the cantilever, when maximum strains of the cantilever would be expected.

Additional field monitoring was used to better understand the cause of the large strains inducing cracks and to explain the behavior. Field data were correlated with a three dimensional finite element model to fully explain how deformations were occurring and to provide insight into potential repairs. The study demonstrated that repairs were only necessary for tie plates at the ends of the spans, greatly reducing the cost of the initial plan to replace all tie plates in the bridge. The field

	strain levels and an explanation of the behavior of the structure were used to provide the designers with guidelines on determining the dimensions of the replacement tie plates. The information provided by this study is being used to maintain the structural integrity of the bridge and provide for an increased service life of this aging part of the State's infrastructure. The information provided by the study also describes a method that can be used by other State transportation agencies to get at the root cause of fatigue cracks so corrective action can be taken to stop them. **List of Figures:** **FIGURE 1.** Aerial View of Bridge. **FIGURE 2.** Typical Cross-Section of Bridge Structure for Simple Spans.

Project Title, ID, Cost, Duration	***A Non-Intrusive Bridge Weigh-in-Motion System for a Single Span Steel Girder Bridge Using Only Strain Measurements*** ***Report number:*** CT-2251-3-09-5 ***Cost:*** $130,000 ***Project Duration:*** 20 months [November 1, 2008–June 30, 2010 (Estimated)]
Submitter	***Agency, organization*:** Connecticut Department of Transportation (ConnDOT) ***Contact, e-mail:*** James M. Sime, james.sime@ct.gov
Research program	***Sponsoring agency or organization:*** ConnDOT
Web link, if available	

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results

FIGURE 1

Aerial view of bridge in relation to weigh station on I-91N.

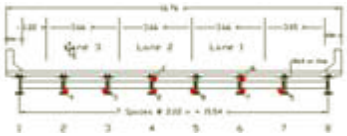


FIGURE 2

Cross section view of the bridge and sensor layout (red dots).

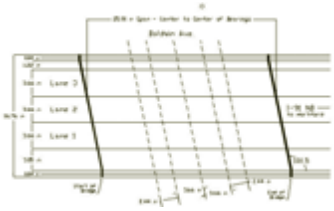


FIGURE 3

Project Potential Impact: Information to adequately quantify the "actual loads" experienced on our transportation network is desperately needed to properly conduct engineering designs and make informed decisions. Information on actual loads, commonly referred to as "weight data," is used for a wide-variety of applications including: designing and maintaining infrastructure (bridges and pavements), applying air quality or freight models, as well as for enforcement of vehicle size and weight limits and economic development. This project represents the preliminary work to leverage bridge health monitoring equipment to non-intrusively collect traffic/load data.

Overview: This study proposed and demonstrated that a non-intrusive bridge weigh-in-motion (WIM) system, using only strain measurements, applied to a single-span steel-girder bridge can be used to produce WIM data, including gross vehicle weights, axle spacing, axle weights, and speed. This was achieved by development of a new bridge WIM methodology that applied existing approaches, together with a novel approach, to calculate vehicle speed and axle displacements and weights. The bridge WIM methodology was automated to identify truck events and calculate estimates from the strain response. A field test was conducted on an in-service highway bridge located on Interstate 91 in Meriden, Connecticut (Figure 1). State-of-the-art bridge monitoring sensors and data acquisition technologies were temporarily mounted and utilized (Figures 2 and 3) on a single-span steel-girder bridge (Figure 4), strategically located one-half mile prior to a weigh station. The field test included calibration of the system using data from multiple passes of a five-axle test truck. The bridge WIM methodology and calibration results were then applied to data collected from a random sample of 117 trucks from the traffic stream. Using this information, bridge WIM estimates were calculated and results were used to verify the methodology in comparison to static measurements obtained for the same vehicles at the weigh station. The performance of the bridge WIM methodology is presented from a statistical perspective whereby the 95 percent confidence intervals are determined for the various errors in truck characteristic measurements. For the test truck, the 95 percent confidence interval for Gross Vehicle Weight (GVW) was +-6.31 percent for Lane 1 and +-15.20 percent for Lane 2. It was observed that

Plan view of the highway bridge.

FIGURE 4

East elevation view of bridge.

the bridge WIM estimates were more precise for Lane 1 than Lane 2. This is likely due to the configuration of the instrumented girders beneath the lanes of travel, as well as the location of Lane 2 on the cross section of the bridge, with adjacent lanes on both sides. The accuracy of the bridge WIM system was also evaluated for 117 trucks from the traffic stream. From the random truck traffic set, it was observed that for 5-axle trucks traveling in Lane 1, which compose 55 percent of the 117 trucks, the 95 percent confidence interval for the GVW difference is (-17.52 percent; 15.26 percent). The accuracy of the system may be dependent on the vehicle type used to calibrate the system. Employing a calibration methodology that accounts for the various vehicle types (multiple trucks with varying number of axles and spacing, suspensions, etc.) for calibration might reduce this difference. Collecting more data for both the test truck(s) and for trucks in Lane 2 may help to provide more confidence in the parameter estimates and ultimately the resulting confidence intervals. Furthermore, as the bridge WIM GVW estimate is directly dependent on speed, there is a need in future studies to more closely examine and consider the accuracy of the speed estimate. The initial field results reported in this study indicate that a non-intrusive bridge WIM methodology shows great promise to achieve the tolerance of 95 percent probability of conformity for Type II ASTM Standard Specifications for Highway WIM Systems.

Implementation of Findings: This study was designed as preliminary research. Based on this work, an SPR project (SPR-2265) titled, "Development and Evaluation of a Dual-Purpose Bridge Health Monitoring and Weigh-In-Motion System," focused on employing these findings and further developing the technology, has been initiated. Field instrumentation is scheduled for May 2010.

District Department of Transportation

Project Title, ID, Cost, Duration	***Mitigating Traffic-Induced Vibrations in Residential Structures in the District of Columbia*** ***Report number:*** ***Cost:*** $296,000 ***Duration:*** 18 Months
Submitter	***Agency, organization:*** District Department of Transportation (DDOT) ***Contact, e-mail:*** William Carr**,** Director, Research & Technology Development**,** william.carr2@dc.gov**;** Peggy Tadej**,** Program Manager, Research & Technology Development**,** peggy.tadej@dc.gov
Research program	DDOT Research Program
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This project is the second phase of a study performed by the DDOT to address traffic-induced vibrations in residential structures throughout the District of Columbia. DDOT has been logging and addressing traffic-induced vibrations from city residents for over 30 years. Historically, these complaints have been addressed in a piece-meal fashion with varying levels of success. To date, a systematic method of determining the cause(s) of these vibrations, quantifying vibration levels that warrant action by DDOT, and the best means to mitigate them have not been established. Phase 1 of the study was performed by Howard University Transportation Research Center and involved research of previous studies and identification of residential blocks for monitoring. Phase 2 of the study involves performing vibration and traffic monitoring of 8 residential blocks (24 residences) throughout the city. Data collected includes traffic volume, speed, vehicle classification and weight, vibration levels (adjacent to street and at structure), pavement composition, subgrade soils, and utilities. The data is being analyzed to

Picture of Device on home to measure vibrations from traffic.	determine acceptable vibration threshold values, evaluate statistical relationships between various parameters and measured vibrations, develop recommendations for mitigating traffic-induced vibrations that can be implemented in the future. 

Federal Highway Administration

Project Title, ID, Cost, Duration	***Statistical Analysis of Performance of Recycled Hot Mix Asphalt Overlays in Flexible Pavement Rehabilitation*** ***ID:*** Report not published yet ***Cost:*** $300,000 ***Duration:*** 18 months
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Aramis Lopez, aramis.lopez@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA ***Contact, e-mail:*** Larry Wiser, larry.wiser@fhwa.dot.gov
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The Long Term Pavement Performance (LTPP) SPS-5 experiment was conceptually designed to provide quality data for developing improved design methodologies and construction alternatives for flexible pavement rehabilitation. Techniques commonly used in the United States and Canada were applied to test sites in various geographical locations. Test sections in each site were subject to similar climatic, subgrade, pavement structure and traffic conditions. The experimental factors considered the surface condition prior to overlay, environment, and traffic loadings, as well as the different treatment alternatives. Mix type was one of the factorial variables in the experiment. Virgin and Reclaimed Asphalt Pavement (RAP) mixes were used in combination with two other design features (surface preparation and overlay thickness) in 9 sections, including a control section, in each one of the 18 sites selected for the experiment. Recent analysis of LTPP data from SPS-5 shows that RAP and virgin hot mix asphalt mixes used in overlays of flexible pavements showed approximately the same performance across a wide range of climates,

	traffic, and existing pavement conditions over a service life ranging up to 17 years. This major finding should give agencies confidence in specifying RAP mixtures for overlays when economic and other conditions warrant.

Project Title, ID, Cost, Duration	***Exploration of NDE Technologies to Detect Corrosion Damage in Post-Tensioned, Cable-Stayed, and Suspension Cable Bridges*** ***Cost:*** $70,000 (so far) ***Duration:*** Ongoing
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Seung-Kyoung Lee, seung-kyoung.lee@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA ***Contact, e-mail:*** Seung-Kyoung Lee, seung-kyoung.lee@dot.gov
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	There are a number of instances where there is insidious corrosion damage on bridges, including some bridges in California, Virginia, and Florida. All prestressed wires and strands in the form of post-tensioned (PT) tendons, stay-cables, and suspension cables can be affected by this problem, which will increase indefinitely in the future. It has been recognized that the current state of non-destructive evaluation (NDE) technologies is inadequate to evaluate the condition of these embedded and ducted strands both for active corrosion and for section loss, breakage, presence of voids and cracks in hardened grout, quality of grout, etc. Similarly, for suspension and stay cables, and ropes and hangers, active corrosion and wire breakage cannot be readily identifiable without labor intensive, intrusive inspection techniques. Researchers at the Turner-Fairbank Highway Research Center in McLean, Virginia, assessed five NDE technologies to detect corrosion of these critical structural elements before they fail. They included Ultrasonic and

	Sonic Echo/Impulse Response, Magnetostrictive Sensor Technology for Guided Long-Range Waves, Microwave Thermoreflectometry, Remnant Magnetic System, and Magnetic Main Flux Method (MMFM). Researchers determined the MMFM to be the most accurate NDE system in terms of locating defect sites and estimation of section loss. (The MMFM technology uses a magnetizer that produces a magnetic flux; a reduced magnetic flux indicates the corrosion damage (i.e., section loss).) However, they could not find any NDE technologies that can be used for internal PT tendons. Because of its great potential as a field deployable NDE system for external PT tendons and stay cables, field demonstration trials were planned at two in-service bridges with known corrosion problems. The first trial was made in April 2010 at the Varina-Enon Bridge in Virginia with successful results and the second one is scheduled at the Luling Bridge in Louisiana in near future.

Project Title, ID, Cost, Duration	***Alternative Intersections/Interchanges: Informational Report*** ***ID:*** Contract No. DTFH61-05-D-00024-T-06-016 ***Cost:*** $567,660 ***Duration:*** August 17, 2006–February 27, 2010
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Joe Bared, joe.bared@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA ***Contact, e-mail:*** Joe Bared, joe.bared@dot.gov
Web link, if available	http://www.fhwa.dot.gov/publications/research/safety/09060/ http://www.fhwa.dot.gov/publications/research/safety/09054/09054.pdf http://www.fhwa.dot.gov/publications/research/safety/09055/09055.pdf http://www.fhwa.dot.gov/publications/research/safety/09056/09056.pdf http://www.fhwa.dot.gov/publications/research/safety/09057/09057.pdf http://www.fhwa.dot.gov/publications/research/safety/09058/09058.pdf http://www.fhwa.dot.gov/publications/research/safety/09059/09059.pdf

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This research produced the *Alternative Intersections/Interchanges: Informational Report*. This report covers four intersection and two interchange designs that are alternatives to conventional at-grade intersections and grade-separated diamond interchanges. It provides information on each alternative, including salient geometric design features, operational and safety issues, access management, costs, construction sequencing, environmental benefits, and applicability. The six treatments are: (1) Displaced Left-Turn Intersection, (2) Median U-Turn Intersection, (3) Restricted Crossing U-Turn Intersection, (4) Quadrant Roadway Intersection, (5) Displaced Left-Turn Diamond Interchange, and (6) Double-Crossover Diamond Interchange (DCD), also called Diverging Diamond Interchange (DDI). The information provided in the report will facilitate consideration of these alternative designs, which may provide operational, safety, and cost benefits over conventional designs.

Project Title, ID, Cost, **Duration**	***Evaluation of Low-Cost Safety Improvements*** ***ID:*** TPF-5(099) ***Cost:*** $2,684,817 ***Duration:*** September 8, 2005–January 30, 2013
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Roya Amjadi, roya.amjadi@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA plus 28 State departments of transportation through the Transportation Pooled-Fund Program (AZ, CA, CT, FL, GA, IA, IL, IN, KS, KY, MA, MD, MN, MO, MS, MT, NC, ND, NY, OK, PA, SC, SD, TN, TX, UT, VA, WI) ***Contact, e-mail:*** Roya Amjadi, roya.amjadi@dot.gov
Web link, if available	http://www.tfhrc.gov/safety/evaluations/index.htm

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This project is developing reliable estimates of the effectiveness of the safety improvements identified in the National Cooperative Highway Research Program (NCHRP) Report 500 series of Guidance for Implementation of the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan. These estimates are developed through scientifically rigorous before-after evaluations at sites in the United States where these treatments are being implemented. Treatments that have been evaluated include: STOP signs with increased retroreflectivity, flashing beacons at STOP-controlled intersections, STOP AHEAD pavement markings, offset left-turn lanes, advance street name signing, curve signing and delineation improvements, two-way, left-turn lanes on two-lane rural roads, and lane width/shoulder width combinations. More reliable estimates of the safety effectiveness of low-cost safety improvements will enable State and local highway agencies to make more cost effective investment decisions.

Project Title, ID, Cost, Duration	***SafetyAnalyst*** ***ID:*** SPR-2(210), TPF-5(060), TPF-5(182) ***Cost:*** $6,462,620 ***Duration:*** April 5, 2001–March 31, 2010
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Ray Krammes, ray.krammes@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA plus 27 State departments of transportation through the Transportation Pooled-Fund Program (AZ, CA, CO, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, MI, MN, MO, MS, MT, NH, NC, NV, NY, OH, VA, VT, WA, WI) ***Contact, e-mail:*** Ray Krammes, ray.krammes@dot.gov

Web link, if available	www.safetyanalyst.org
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This project developed SafetyAnalyst, which incorporates state-of-the-art analytical approaches in a software tool for use in the decision-making process to help highway agencies identify and manage a system-wide program of site-specific improvements to cost effectively enhance highway safety. SafetyAnalyst includes modules for network screening, diagnosis and countermeasure selection, economic appraisal and priority ranking, and evaluation of implemented countermeasures. The analytical approaches in SafetyAnalyst are those identified as the most reliable by the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual. Upon completion, SafetyAnalyst was transferred to AASHTO for long-term distribution, technical support, maintenance, and enhancement as a licensed AASHTOWare product. Use of SafetyAnalyst will lead to more cost-effective safety investment decision making and, ultimately, more fatal and injury crashes avoided per dollar invested.

Project Title, ID, Cost, Duration	***Ultra-High Performance Concrete Program*** ***Cost:*** $500,000 (estimated) ***Duration:*** Ongoing
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Benjamin Graybeal, benjamin.graybeal@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA ***Contact, e-mail:*** Benjamin Graybeal, benjamin.graybeal@dot.gov
Web link, if available	

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Deterioration of highway bridges combined with congestion-related issues has created the need for bridge owners to repair, replace, and construct durable bridges. Given the ever-increasing demands on bridge structures and resources, it is clear that construction techniques of the 20th century are not sufficient to meet 21st century needs. Since its initiation in 2001, FHWA's Ultra-High Performance Concrete (UHPC) Program has been focused on developing practical UHPC applications to provide new solutions to existing problems, whether the solutions emanate from materials, structural configurations, or construction techniques. The advanced properties of UHPC open many new avenues toward these solutions. The range of concepts being considered runs the gamut from conventional ideas such as bridge redecking systems and optimized prestressed girders, to connection details such as field-cast spliced joints between precast modular elements, to novel concepts such as energy dissipating seismic elements and cladding shells for bridge barriers. **Optimized Girder Deployment** The initial research and deployment of UHPC technology in the United States demonstrated the capabilities of the material and the feasibility of component fabrication for infrastructure projects. However, these projects also demonstrated that the development of new, structurally optimized girders shapes is warranted if the mechanical and durability properties of UHPC are to be efficiently engaged in superstructure elements. FHWA initiated a research program aimed at developing a precise, prestressed decked bridge girder component application to typical U.S. highway bridges. The result of this project was the pi-girder, a 33-inch-deep deck-bulb-double-Tee girder that can span up to 87 feet. This component facilitates the accelerated construction of durable infrastructure systems. The Iowa Department of Transportation completed the first deployment of the pi-girder in a bridge near Aurora. The Jakway Park Bridge used three adjacent pi-girders in its main span. It opened to traffic in 2008. **Precast Deck Connections** The advanced mechanical properties of UHPC has also proven capable of advancing the state-of-the-art in bridge component connection technology. In recent decades there has been a push toward accelerating bridge construction using precast components; however, joining these components in the field with durable, robust connections has sometimes proven

	problematic. The bond properties of UHPC have created an opportunity to re-imagine connections, especially at the deck level, in an effort to construct robust, simple, and durable details. The New York State Department of Transportation (NYSDOT) is playing a leading role in using UHPC to create splice connections between deck-level components. During the summer of 2009, NYSDOT constructed two bridges using this type of connection detail. The first bridge, located in Lyons, used UHPC to create the deck-level connection between adjacent deck-bulb-Tee prestressed girders. This 6-inch-wide connection across which the reinforcement is spliced is filled with field-cast UHPC. The second bridge used UHPC to connect conventional precast deck panels. Located near Oneonta, the deck panels were placed on the steel stringers then the extending rebar was spliced via a 6-inch-wide UHPC connection. Concurrently, there is a research effort ongoing at FHWA that focuses on the mechanical and durability properties of these deck-level connection details. The promising nature of this innovation has been borne out in these tests whereincyclic structural loading of full-scale connections has demonstrated very good performance. **Benefits** UHPC opens doors to new structural systems and construction techniques that can assist in the rehabilitation and reconstruction of highway bridges. To date, UHPC has been deployed in five U.S. highway bridges. Additional deployments are in the pipeline. UHPC has been demonstrated as a viable candidate for both precast components and field-cast connections. As familiarity with UHPC increases, additional deployments of existing concepts and development of new concepts are anticipated. UHPC presents great opportunities to construct durable, resilient infrastructure systems.

Project Title, ID, Cost, Duration	***Integrated Corridor Management Demonstration and Evaluation*** ***Cost:*** *$14,000,000* ***Duration:*** 48 months
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA)
Research Program	***Sponsoring agency or organization:*** FHWA , in co-operation with Research and Innovative Technology Administration ***Contact, e-mail:*** Dale Thompson, dale.thompson@dot.gov
Web link, if available	http://www.its.dot.gov/icms/index.htm
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The efforts to date to reduce surface transportation congestion have focused on optimization of individual networks. Corridors offer an opportunity to operate and optimize the entire system as opposed to the individual networks. Through the Integrated Corridor Management (ICM) Systems initiative, the U.S. Department of Transportation will provide guidance to assist agencies in implementing Integrated Corridor Operations, create supporting analysis tools, approaches, and technical standards, and demonstrate the value of ICM. The focus of this project is to demonstrate and evaluate the benefits of ICM implementation in two metropolitan areas: San Diego, California, and Dallas, Texas. Objectives of this research demonstration are: 1. Implement ICM technologies and strategies in two metropolitan areas in the first two years of the project 2. Conduct ICM Demonstration and Evaluation in the final two years of the project 3. Provide lessons learned and recommended practice to be incorporated into an updated ICM Implementation Guide 4. Develop an ICM Demonstration Evaluation Summary Report These ICM demonstrations will showcase ICM operations and management strategies implemented jointly by operating agencies in real-time to improve system performance by reducing delay, improving travel time, and increasing reliability throughout the corridor. Evaluation results

	and lessons learned will be captured and incorporated into an ICM Implementation Guide to enable transferability of successful ICM best practices and implementation techniques in cities across the country. **From ICM Web site:** In an ICM corridor, because of proactive multimodal management of infrastructure assets by institutional partners, travelers could receive information that encompasses the entire transportation network. They could dynamically shift to alternative transportation options—even during a trip—in response to changing traffic conditions. For example, while driving in a future ICM corridor, a traveler could be informed in advance of congestion ahead on that route and be informed of alternative transportation options such as a nearby transit facility's location, timing and parking availability.

Project Title, ID, Cost, Duration	***Step Frequency Ground Penetrating Radar for Location and Evaluation of In-Roadway Sensors*** ***ID:*** 06-FH2 ***Cost:*** *$750,000* ***Duration:*** 36 months
Submitter	***Agency, organization:*** Starodub ***Contact, e-mail:*** Michael Scott, michael.scott@dot.gov
Research Program	***Program:*** Small Business Innovative Research ***Sponsoring agency or organization:*** Federal Highway Administration, in co-operation with Research and Innovative Technology Administration ***Contact, e-mail:*** David R.P. Gibson, david.gibson@dot.gov
Web link, if available	
Brief Summary of the	Traffic sensors embedded as In-Roadway sensors frequently malfunction

Research Project and Impact, or Potential Impact, of Implementing Research Results	due to failure to observe proper installation techniques. Non-destructive evaluation of the installation or maintenance work has the potential to verify correct or incorrect installation procedures. Ground penetrating radar (GPR) is the technique being investigated for this. Objectives of this research study are: 1. Verify whether GPR has the potential to identify defects in installation and/or maintenance. Lab tests were able to detect breaks in loop wires within synthetic pavement in the laboratory. 2. Establish contacts with organizations that have problems with installations and dialog with them. A symposium was held with State department of transportation signal and loop maintenance engineers and technicians. 3. Identify critical gaps with regard to the collection and processing of GPR data and what hardware changes or algorithms might be used to enhance the NDE GPR techniques. A new algorithm was developed to allow real time calibration of the GPR system to the pavement. Additional algorithms were developed to allow ultra high resolution definition of the signal returns from the GPR to allow imaging of features previously below the detection level. 4. Conduct laboratory and field tests of improved hardware and algorithms and conduct field demonstrations (in progress). Preliminary work at the Turner Fairbank Highway Research Center in McLean, Virginia, has shown that they are able to detect whether a loop is functioning in its electromagnetic capacity. It has also shown that they can image a loop wire in the pavement. The next stage will be to go to Acadia National Park where a variety of functioning and non-functioning loops are installed in the pavement. Data will be taken and analyzed on nine loops of various types. This will allow determination of whether high resolution GPR in conjunction with electromagnetic loop sensing can diagnose loop operation or lack thereof.

Project Title, ID, Cost, Duration	***Reconnaissance Effort for Chile Earthquake*** ***Cost:*** $25,000 (trip for 6 people) ***Duration:*** 12 days
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Phil Yen, wen-huei.yen@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA ***Contact, e-mail:*** Phil Yen, wen-huei.yen@dot.gov
Web link, if available	http://www.fhwa.dot.gov/research/topics/infrastructure/structures/tirtreport.cfm
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	On February 27, 2010, a devastating earthquake, measuring 8.8 on the Richter scale, struck off the coast of the Maule region of Chile affecting a large area including the cities of Concepcion and Santiago, the Chilean capital. Characterized by its very strong type of long duration ground motion, which created tsunamis across the region, it lasted more than 140 seconds. Usually earthquakes average 35 seconds. Several aftershocks, with a magnitude exceeding 6.0, occurred in the days following. It is estimated that this earthquake was approximately 500 times the energy of the 7.0-magnitude quake that struck Haiti in January 2010. Many bridges and tunnels in Chile were constructed with the newest seismic design codes similar to the current United States and European codes. More than 20 highway bridges either collapsed or sustained severe damage. Currently most highway infrastructure are designed for the magnitude of earthquakes, not the duration of earthquakes. Therefore, a comparative study of the affected infrastructure could lead to improvements in design codes and standards to prevent similar damages, increase resilience, and maintain sustainable infrastructure. To conduct this investigation, the FHWA Office of Research, Development, and Technology deployed a Transportation Infrastructure Reconnaissance Team (TIRT) to study a select number of bridges and tunnels in Chile. The TIRT visited 32 sites containing more than 40

	structures. What researchers observed was that many bridges designed similar to the U.S. seismic code performed relatively well. However, there were some bridges that had short seat widths or constructed with weak or no diaphragms, which did not perform well. More studying is needed to determine if bridges need to be designed for the duration of an earthquake in addition to magnitude. A report of the preliminary findings will be published soon in late summer.

Project Title, ID, Cost, Duration	***Accelerated Loading Facility*** ***ID:*** TPF 5-(019) Full Scale and Accelerated Pavement Testing for Superpave and Structural Validation & SPR 2-(124) Accelerated Pavement Testing of Crumb Rubber Modified Asphalt Pavements ***Cost:*** $1.48 million ***Duration:*** 6 years
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA) ***Contact, e-mail:*** Jack Youtcheff, jack.youtcheff@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA ***Contact, e-mail:*** Jack Youtcheff, jack.youtcheff@dot.gov
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The Accelerated Pavement Testing (APT) Facility at the Turner-Fairbank Highway Research Center (TFHRC) in McLean, Virginia, consists of 12 pavement test lanes and 2 Accelerated Loading Facility (ALF) machines. ALFs provide full-scale pavement testing to evaluate pavement specifications, structural designs, laboratory test procedures, and durability of both new and existing pavement materials. The most recently completed experiment fulfilled two primary objectives: (1) evaluate the performance of modified (conventional polymer modification, crumb rubber, hybrids,

	etc.) asphalt binders for Superpave validation and (2) provide input to Mechanistic Empirical Pavement Design (MEPD) methodologies for pavement structural and performance validation. Existing Superpave asphalt binder performance specifications were developed for unmodified asphalts. In the past decade there has been an increase in the use of polymer modification to prevent the primary damage mechanisms of rutting, fatigue and thermal cracking. Many State Highway Agencies have implemented Superpave "plus" specifications in order to evaluate the probable performance of modified asphalt binders. The goal of this first objective is to not only evaluate the field performance of common modified asphalt binders, but also to recommend a specification test that may be used with polymer modified binders. Candidate replacement specification tests were evaluated via their ability to discern fatigue cracking resistance of ALF pavements having a variety of polymer modification. Two specification tests were identified as being more capable than others; binder yield energy and critical tip opening displacement. Based on the field performance and laboratory tests, crumb rubber (recycled tires) modified asphalt (Arizona wet process) was shown to significantly slow or stop the growth of fatigue cracks in a composite asphalt pavement structure. A hybrid technique to modify asphalt with a combination of crumb rubber and conventional polymers (terminal blend) exhibited good fatigue cracking resistance without any special handling procedures typically associated with crumb rubber modified asphalts. Also, a simple addition of polypropylene fibers (recycled carpet) to asphalt mix was shown to have extreme resistance to fatigue cracking without the use of more expensive polymer modified asphalt binders. The second objective of the latest ALF experiment quantified the capabilities of National Cooperative Highway Research Program 1-37A and 1-40 MEPD methodologies for pavement structural design and to predict rutting and fatigue cracking of modified asphalts. The Long Term Pavement Performance sections originally used to calibrate the MEPD methodologies did not include modified asphalt materials. Thus, TFHRC's APT provided a unique opportunity to evaluate sections of different thicknesses (4 versus 6 inches) and with various polymer modifications for MEPD validation. A Falling Weight Deflectometer (FWD) and strain gauge instrumentation were used to measure pavement response. The results illustrated that the globally-calibrated MEPD performance models

	could differentiate between structural asphalt thickness but had difficulty differentiating the modified from the unmodified asphalt binder components. Nonetheless, the MEPD performance ranking and predictions were enhanced and improved using mixture-specific performance tests (in contrast to global calibration) such as Dynamic Modulus and Flow Number and emerging research (i.e., fatigue performance evaluation using continuum damage principles). The mixture-specific performance tests are currently being implemented using the Asphalt Mix Performance Tester. **Added On-going Activities** • Embrittlement/preservation study: One caveat of APT experiments is that loading takes place in the early stages of the pavement life. This is considered favorable for rutting evaluation, but less so for fatigue cracking experiments. The same family of modified and unmodified asphalts characterized in the most recent APT study were aged by accelerated means (thermal heating) to capture the effects of long-term aging and embrittlement on full-scale fatigue cracking. In contrast to the main experiment where the pavements experienced general fatigue cracking (i.e., bottom-up cracking), aged pavements exhibited top-down cracking thereby reproducing another form of cracking that occurs in highways. A different ranking of the performance was found and asphalt binders extracted from the ALF pavements are undergoing the same suite of candidate binder fatigue cracking specification tests in order to strengthen the statistics of identifying the best-discriminating asphalt binder fatigue cracking specification. In order to extend the service life of an asphalt pavement, the application of thin maintenance treatments are being considered. A thin 1 inch application of fine 4.75mm (nominal max aggregate size) hot mix asphalt maintenance treatment has been placed side-by-side with sections without the treatment. The intent will be to scientifically quantify the ability of the treatment to interrupt top down cracking and aging as well protection provided to the underlying pavement structure. • Seasonal monitoring of the behavior of unbound base and subgrade layers using FWD and back calculation methodologies. • Investigation of next generation, increased resolution Ground

	Penetrating Radar capabilities to measure changes in asphalt pavement and subsurface cracking zones. • Portable Seismic Pavement Analyzer characterization of fatigue damage degradation using non-destructive, seismic techniques to measure asphalt pavement modulus. **Previous ALF Accomplishments** • Design and performance of ultra-thin white topping concrete overlays • Evaluation of impact of vehicle tire configuration and load level on pavement performance • Validation of Superpave asphalt binder performance specifications for unmodified asphalts

Project Title, ID, Cost, Duration	***Geosynthetic Reinforced Soil Bridge Abutments*** ***Report Number:*** FHWA-RD-01-118
Submitter	***Agency, organization:*** Federal Highway Administration (FHWA), Office of Corporate Research, Technology, & Innovation Management ***Contact, e-mail:*** Mike Adams, mike.adams@dot.gov
Research Program	***Sponsoring agency or organization:*** FHWA ***Contact, e-mail:*** Mike Adams, mike.adams@dot.gov
Web link, if available	http://www.tfhrc.gov/about/geotech.htm
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	**Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS)** is a fast, cost-effective method of bridge support that blends the roadway into the superstructure to create a joint-less interface between the bridge and the approach way. It uses alternating layers of compacted fill and sheets of geotextile reinforcement to provide support for the bridge superstructure, which is placed directly on the GRS abutment mass without a joint and without cast-in-place concrete. GRS is also used to construct approach

	ways and transitions onto the roadway. This innovative bridge system alleviates the "bump at the bridge" caused by differential settlement between the bridge abutment and approaching roadway. The riding surface of the IBS can be maintained in the future just like it was part of the roadway pavement. No special attention to joints or the bridge deck is required. Unlike a traditional "integral abutment," the IBS is unique in its use of GRS to support the superstructure. This method of ABC is truly as easy as 1-2-3 to build: (1) a sheet of geotextile, (2) a row of facing blocks, and (3) a layer of well compacted quality gravel. The GRS IBS demonstrates many other distinct and innovative qualities. This technology is extremely durable and can perform well in earthquakes if constructed properly with closely spaced reinforcement. The GRS abutments can be built with readily available material using common construction equipment without the need for highly skilled labor. Construction of the abutment is contained within its footprint for a reduced work zone. An additional benefit is convenience and design flexibility as GRS IBS can be built in variable weather conditions and can be adapted very easily in the case of unforeseen site conditions. In summary, the unique advantages that this technology offers in the construction of small bridges are: • Reduced construction time • 25 percent to 30 percent less cost than standard pile capped abutments with 2:1 slopes • 50 percent less than a Standard DOT • Less dependence on weather conditions during construction • Flexible design—easily field modified for unforeseen site conditions • Easy to maintain because of fewer parts • Can be built with common equipment and materials

Florida Department of Transportation

Project Title, ID, Cost, Duration	***Wave Loading on Bridge Decks*** ***ID:*** BD545-58 ***Cost:*** $302,142 ***Duration:*** 2 years, 7 months
Submitter	***Agency, organization:*** Florida Department of Transportation (FDOT) ***Contact, e-mail:*** Darryll Dockstader, Manager, Research Center, Darryll.dockstader@dot.state.fl.us Vicki Morrison, Technology Transfer Coordinator, Vicki.morrison@dot.state.fl.us
Research program	***Sponsoring agency or organization:*** FDOT
Web link, if available	http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_RD/FDOT_BD545_58_rpt.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Several Gulf Coast bridges sustained critical damage during recent hurricanes. The cause of these failures was attributed to the effects of storm surge and water wave loading on bridge decks, a forcing mechanism previously unaccounted for in coastal bridge design. In cooperation with FDOT, researchers re-created Hurricane Ivan's impacts to the Interstate 10 (I-10)/Escambia Bay Bridge in a laboratory by developing a model to test wave forces with drag and inertia coefficients. The model accurately predicted failure for the I-10 bridge decks that had failed and survival of those bridge decks that had survived. Researchers tested the model on other bridges subjected to hurricane storm surge and waves. They found that the predicted forces did not exceed the resistive forces (dead weight plus tie-downs). The model was shown to accurately predict pressure, velocity and acceleration within the water as a wave passes under or over bridge decks. The model has been applied to numerical experiments on various types of spans and meteorological and

	oceanographic conditions to develop parametric equations adopted in the American Association of State Highway and Transportation Officials' publication, "Guide Specifications for Bridges Vulnerable to Coastal Storms."

Project Title, ID, Cost, Duration	***Prestressed Concrete Pile Installation—Utilizing Jetting and Pressure Grouting*** ***ID:*** BD545-31 ***Cost:*** $351,050 ***Duration:*** 3 years, 4 months
Submitter	***Agency, organization:*** Florida Department of Transportation (FDOT) ***Contact, e-mail:*** Darryll Dockstader, Manager, Research Center, darryll.dockstader@dot.state.fl.us; Vicki Morrison, Technology Transfer Coordinator, vicki.morrison@dot.state.fl.us
Research program	***Sponsoring agency or organization:*** FDOT
Web link, if available	http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_GT/FDOT_BD545_31_rpt.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Many FDOT structures are supported by prestresssed concrete piles driven into the ground. However, the process of driving piles creates noise and vibrations that adversely affect people and buildings. Constructing drilled shaft foundations with rebar and poured concrete produces less noise and vibration. However, such foundations support less weight, so more shafts are required, increasing cost and footprint. FDOT recently studied a foundation installation method that uses a technique called jet-grouting. Jetting involves using a high-pressure nozzle that forces compressed air and water into the ground to create a shaft into which a prestressed concrete pile is placed. Grouting involves the high pressure injection of grout around the pile tip that bonds with the surrounding substructure and pile. This method not only has the

	advantage of using reinforced prestressed concrete piles, which are stronger than drilled shafts, but grouting the pile tip increases load capacity of the pile by 1.5 to 2 times. Thus, shorter piles can be used. Application of the pressurized grout simultaneously produces a load test, which shortens the inspection process. Noise and vibration reductions, a smaller footprint, and shorter piles and inspection times suggest the value of this method in urban settings.

Project Title, ID, Cost, Duration	***Attenuating Mass Concrete Effects in Drilled Shafts*** ***ID:*** BD544-39 ***Cost:*** $199,994 ***Duration:*** 2 years
Submitter	***Agency, organization:*** Florida Department of Transportation (FDOT) ***Contact, e-mail:*** Darryll Dockstader, Manager, Research Center, darryll.dockstader@dot.state.fl.us; Vicki Morrison, Technology Transfer Coordinator, vicki.morrison@dot.state.fl.us
Research program	***Sponsoring agency or organization:*** FDOT
Web link, if available	http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_SMO/FDOT_BD544_39_rpt.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	As cement, sand, and water mix to form concrete, chemical reactions produce heat. Upon cooling, mass concrete structures such as large diameter drilled shafts may crack. Engineers currently regulate temperature with internal cooling tubes or by adjusting the concrete mix. FDOT research has developed an alternative to controlling shaft temperature: omitting the core. Researchers constructed a 9-foot diameter drilled shaft 25 feet deep with a 4-foot diameter central void. The study showed that casting voided shafts provides several benefits, which include reducing (1) concrete volume by 40 percent, (2) onsite concreting time, and (3) need for

	internal cooling systems. FDOT is working with industry experts to identify cost-effective implementation strategies. Researchers also developed a probe to test mass concrete thermal integrity. They tested curing temperatures of 27 drilled shafts and other structures and recorded data into a thermal three-dimensional (3-D) model, corroborating their findings with field measurements. They found the model could predict precise temperature traces for any location within a mass concrete structure. Thermal integrity testing combined with the 3-D model provides an accurate method to predict concrete conditions, allowing engineers to assess types of concrete mixes, environmental conditions, and shaft designs that can help mitigate mass concrete effects.

Project Title, ID, Cost, Duration	***Environmental Digital Data Repositories Project*** ***ID:*** BD545-63 ***Cost:*** $184,964.29 ***Duration:*** 2 years
Submitter	***Agency, organization:*** Florida Department of Transportation (FDOT) ***Contact, e-mail:*** Darryll Dockstader, Manager, Research Center, darryll.dockstader@dot.state.fl.us; Vicki Morrison, Technology Transfer Coordinator, vicki.morrison@dot.state.fl.us
Research program	***Sponsoring agency or organization:*** FDOT
Web link, if available	http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_EMO/FDOT_BD545_63_rpt.pdf

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Requests to change Strategic Intermodal System (SIS) facilities often include several alternatives and facility types. Decision makers analyze each alternative and facility type against features in the SIS database and assess environmental impacts using a Geographic Information System (GIS) application called the Strategic Intermodal System Environmental Screening Tool (SIS-EST). Researchers developed a new schema called BRIDGE that allows for the bi-directional flow of data between the SIS and SIS-EST databases. The schema is also compatible with another GIS application used by FDOT to evaluate all major transportation improvement projects, the Efficient Transportation Decision Making (ETDM) tool. BRIDGE contains the bare bones database infrastructure necessary to perform GIS analysis and provides for specific SIS-EST needs. BRIDGE has the ability to integrate and combine any combination of disparate geographic feature types (points, lines, polygons) into a collection of related features. It gives decision makers the ability to evaluate individual components of a project, rather than being constrained to evaluating the project as a whole, in order to pinpoint problem areas and remedy the problems through alternative routes and facilities. BRIDGE has been incorporated into the SIS review process and is estimated to have reduced review time by two thirds.

Project Title, ID, Cost, Duration	***Safe-Up Remedial Action for Failed Pole/Base Plate Weld on High Mast Lighting Pole*** ***ID:*** BD015-23 ***Cost:*** $30,000 ***Duration:*** 1 year

Submitter	***Agency, organization:*** Florida Department of Transportation (FDOT) ***Contact, e-mail:*** Darryll Dockstader, Manager, Research Center, darryll.dockstader@dot.state.fl.us; Vicki Morrison, Technology Transfer Coordinator, vicki.morrison@dot.state.fl.us
Research program	***Sponsoring agency or organization:*** FDOT
Web link, if available	http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_STR/FDOT_BD015-23_rpt.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The FDOT District 4 recently issued a Declaration of Emergency to replace 61 high mast lighting poles (HMLPs) with fatigue cracks in the weld of the pole to base plate. The cracks propagated as much as 25 percent of the total weld's length and were determined to compromise the structural integrity of the HMLPs. Immediate removal and replacement was deemed necessary, costing $3 million. FDOT initiated research to determine whether repairing fatigue cracks would be feasible in the future. Four repair methods were studied: (1) rewelding the cracks, (2) installing welded plate stiffeners, (3) installing bolted stiffeners, and (4) installing steel jacket encasements. Six HMLPs were tested: four were repaired using each of the proposed methods, one was a control cracked specimen, and one was a virgin specimen. The six poles were evaluated using a full-scale structural load test. Of the four proposed repair methods, the welded plate stiffeners and bolted stiffeners performed best in laboratory tests. The proposed repair methods provide a quick response and implementation strategy using FDOT in-house resources (manpower and equipment). They also provide a method allowing sufficient time to plan for replacement without jeopardizing public safety or impacting the work program.

Georgia Department of Transportation

Project Title, ID, Cost, Duration	***Evaluation of a Highway Bridge Constructed Using High Strength Lightweight Concrete Prestressed Bridge Girders*** ***ID:*** 2041 ***Cost:*** $282,260 ***Duration:*** 81 months
Submitter	***Agency, organization:*** Georgia Department of Transportation (GDOT) ***Contact, e-mail:*** Supriya Kamatkar, skamatkar@dot.ga.gov
Research program	***Sponsoring agency or organization:*** GDOT
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This research has shown that high strength lightweight concrete (HSLC) can be used effectively to construct long-span precast prestressed bridge girders. GDOT evaluated the behavior of a highway bridge constructed with precast, prestressed HSLC girders in 2009. Use of the material permits girders to be about 20 percent longer than girders of normal weight concrete for the same weight and reduces the need for superload permits, hence lowering transport costs. Normal weight concrete girders begin to require superload permits for spans greater than 135 ft. Lightweight girders do not require superload permits until spans are greater than 157 ft. The added transport cost per girder requiring a superload permit is about $500. For just one bridge with four spans and 6 girders per span, the cost for permits and transport would be $12,000. For 20 long-span bridges, the added transport cost would be $240,000.

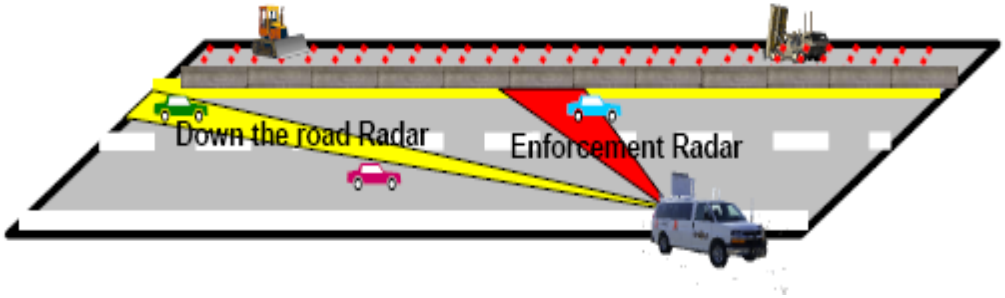
Project Title, ID, Cost, Duration	***Stability of Precast Prestressed Concrete Bridge Girders Considering Sweep and Thermal Effects*** ***ID:*** 05-15 ***Cost:*** $656,035 ***Duration:*** 45 months
Submitter	***Agency, organization:*** Georgia Department of Transportation (GDOT) ***Contact, e-mail:*** Supriya Kamatkar, skamatkar@dot.ga.gov
Research program	***Sponsoring agency or organization:*** GDOT
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This research determined the stability of precast prestressed bridge girders during their erection, with consideration of the effects of girder sweep, an initial lateral deformation. The construction safety of long-span precast concrete girders depends on the stability of the girders during their erection and during placement of the girder diaphragms and of the concrete bridge deck. Stability failure of long-span girders could result in construction personnel injuries, closure of highways over which the bridge was being constructed, and increased long-span girder costs. The project developed design guidelines and improved specifications to ensure that such failures would not occur in Georgia.

Project Title, ID, Cost, Duration	***Corrosion of Steel Bridge Girder Anchor Bolts*** ***ID:*** 07-16 ***Cost:*** $112,548 ***Duration:*** 18 months

Submitter	***Agency, organization:*** Georgia Department of Transportation ***Contact, e-mail:*** Supriya Kamatkar, skamatkar@dot.ga.gov
Research program	***Sponsoring agency or organization:*** Georgia Department of Transportation
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	GDOT investigated the condition of stainless steel bolts used to anchor steel bridge girders to concrete pier caps, to: (1) determine the causes of corrosion and deterioration of the bolts, and (2) recommend improvements in the bolts' design and construction, where necessary, to ensure safety and economy. Anchor bolt corrosion poses two principal problems for bridge structures: safety and stress induction. Corrosion reduces bolt strength, and various types of lateral loading could cause bolt failure, lateral motion of the bridge, and possible bridge collapse. Corrosion could also inhibit bridge bearing movement and induce significant stresses in the girders and in the supporting concrete pier cap. These stresses could cause girder failure or concrete cracking, both of which require expensive repair. Researchers recommended continued use of stainless steel anchor bolts and provided design details. To date, GDOT retrofits about 24 bridges annually for anchor bolt repairs. A typical bridge has 4 spans and averages 10 girders per span. The cost of an anchor bolt replacement was $400 per each end of the girder, bringing the total annual costs for anchor bolt replacements to $768,000. Use of the new design details is expected to save GDOT this entire amount each year.

Illinois Department of Transportation

Project Title, ID, Cost, Duration	***Speed Photo Enforcement*** ***ID:*** R56 ***Cost:*** $309,000 ***Duration:*** 3 years
Submitter	***Agency, organization:*** Illinois Department of Transportation (IDOT), Bureau of Materials and Physical Research ***Contact, e-mail:*** Amy M. Schutzbach, P.E., Engineer of Physical Research, amy.schutzbach@illinois.gov
Research program	***Sponsoring agency or organization:*** IDOT, Bureau of Materials and Physical Research, Illinois Center for Transportation
Web link, if available	http://ict.illinois.edu/Publications/report%20files/FHWA-ICT-10-064.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The intent of this research project was to determine the effectiveness of photo speed enforcement in work zones compared to traditional enforcement methods. The study looked at base condition speeds, speeds with utilizing speed indicator board only, a squad car without lights on, and photo speed enforcement and found that photo speed enforcement was most effective at reducing speeds for both cars and trucks. This allowed both IDOT and Illinois State Police to further implement and expand the program. It was recommended to continue photo speed enforcement and to consider placing drone vans to maximize these efforts. Illinois has implemented photo speed enforcement Statewide in work zones using specially trained State Police Officers to deploy vans equipped with photo speed enforcement equipment, review and approve violations for citation issuance, and appear in court for adjudication of all approved work zone citations. Illinois has expanded photo speed enforcement and added another van to have one in each of the IDOT districts.



Project Title, ID, Cost, Duration	***Evaluation/Modification of Illinois Department of Transportation Foundation Piling Design & Construction Policy*** ***ID:*** R27-24 ***Cost:*** $125,000 ***Duration:*** 2 years
Submitter	***Agency, organization:*** Illinois Department of Transportation (IDOT), Bureau of Materials and Physical Research ***Contact, e-mail:*** Amy M. Schutzbach, P.E., Engineer of Physical Research, amy.schutzbach@illinois.gov
Research program	***Sponsoring agency or organization:*** IDOT, Bureau of Materials and Physical Research, Illinois Center for Transportation

Web link, if available	http://ict.illinois.edu/Publications/report%20files/FHWA-ICT-09-037.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The most dramatic benefit is that the study identified a more accurate pile capacity verification formula that allows designers to require approximately 10 percent less piling. With IDOT's $10 million annual piling expense, it is expected that the new policy will save the department about $1 million per year. The other benefit is that the research re-calibrated our pile length estimation method to better correspond to the new verification formula that is expected to result in fewer splices, less pile cutoff waste, and reduced down time waiting for additional pile length to be delivered, which will all also add to the expected savings.

Project Title, ID, Cost, Duration	***Improving the Safety of Moving Lane Closures*** ***ID:*** R27-32 ***Cost:*** $100,000 ***Duration:*** 1 year
Submitter	***Agency, organization:*** Illinois Department of Transportation (IDOT), Bureau of Materials and Physical Research ***Contact, e-mail:*** Amy M. Schutzbach, P.E., Engineer of Physical Research, amy.schutzbach@illinois.gov
Research program	***Sponsoring agency or organization:*** IDOT, Bureau of Materials and Physical Research, Illinois Center for Transportation
Web link, if available	http://ict.illinois.edu/Publications/report%20files/FHWA-ICT-09-049.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Moving lane closures are an increasingly utilized and inherently hazardous traffic control procedure for highway maintenance and operations activities. To improve the safety of moving lane closures for workers and motorists, this research studied driver behavior around moving lane closures and the effect of different components of current traffic control scenarios, including the number, configuration, and spacing of shadow vehicles, and the effect of various traffic control devices and sign messages. A future Phase II project will expand on these findings and produce specific recommendations for revisions to current traffic control standards to improve the safety of moving lane closures for highway workers and the travelling public.

Project Title, ID, Cost, Duration	***Snowplow Simulator Training Study*** ***ID:*** R27-SP15 ***Cost:*** $27,000 ***Duration:*** 9 months
Submitter	***Agency, organization:*** Illinois Department of Transportation (IDOT), Bureau of Materials and Physical Research ***Contact, e-mail:*** Amy M. Schutzbach, P.E., Engineer of Physical Research, amy.schutzbach@illinois.gov
Research program	***Sponsoring agency or organization:*** IDOT, Bureau of Materials and Physical Research, Illinois Center for Transportation
Web link, if available	http://ict.illinois.edu/project_spotlights_home_page-snowplow.html

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The research focuses on evaluating the effectiveness and cost efficiency of simulation training. The goal is to help IDOT determine if simulation training is worth the expenditure to train snowplow operators. If deemed to be practical and cost effective, the simulator training could enhance safety, reduce traffic accidents and property damage, and increase driver efficiency though decreased maintenance costs and a reduction in fuel consumption. In these ways, the evaluation has the potential to provide significant cost savings to IDOT and the State of Illinois. The final report is expected in late summer 2010.

Indiana Department of Transportation

Project Title, ID, Cost, Duration	***Improving the Design of U-Beams for Indiana*** ***Report number:*** Study currently underway ***Cost:*** $309,000 ***Duration:*** 40 months
Submitter	***Agency, organization:*** Indiana Department of Transportation (INDOT), Division of Research and Development ***Contact, e-mail:*** Tommy E. Nantung, tnantung@indot.in.gov
Research program	***Sponsoring agency or organization:*** INDOT and Joint Transportation Research Program—Purdue University
Web link, if available	www.purdue.edu/JTRP
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The objective of this research program is to develop design strategies to improve the efficiency and optimize the design of the Indiana modified U-beam. The research is focusing on issues raised by design engineers during the design of U-beams for the Interstate 465 corridor in Indianapolis. In particular, this research program is evaluating the live load distribution appropriate for the design of U-beams, assessing the behavior and design of the bridge deck when supported by U-beams, and evaluating both the shear strength and shear design of the composite U-beam system. Of particular interest is the influence of debonding on shear strength. The program also is documenting construction practices such that improvements can be made in this area. It is anticipated that this research program will enable designers to more economically utilize the capabilities of the U-beam that is being introduced into the State of Indiana. Through better understanding of the nature of this new girder, not only can more economic design be achieved, but improved safety of the traveling public can be provided. Furthermore, it is anticipated that the research results regarding shear strength and debonding will not be limited to U-beams, but have

	broader impact influencing the design of all prestressed girders and influence the next generation of the American Association of State Highway and Transportation Officials design specifications. By better understanding girder distribution, INDOT bridge designers have the potential to decrease strength required from the girders for a given span. By eliminating some of the debonding limitations, there are significant benefits. Designers can design longer spans with girders that could eliminate some substructure costs. It also opens up corridors with fewer piers. There are also costs associated with girder construction that includes decrease web width, decrease stirrups, less rebar congestion and easier beam fabrication.

Project Title, ID, Cost, Duration	***Expert System to Support Site Investigation for Safety Improvement*** ***Report number:*** FHWA/IN/JTRP- 2008/4 ***Cost:*** $75,000 (Phase I) + $80,000 (Phase II) ***Duration:*** 48 months
Submitter	***Agency, organization:*** Indiana Department of Transportation (INDOT), Division of Research and Development ***Contact, e-mail:*** Tommy E. Nantung, tnantung@indot.in.gov
Research program	***Sponsoring agency or organization:*** INDOT and Joint Transportation Research Program—Purdue University
Web link, if available	www.purdue.edu/JTRP
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This project has produced a novel, state-of-the-art yet practical method Road Safety Investigation Tool (RSIT) that facilitates the most difficult task in the hazard elimination program—identifying the road features and driver behaviors that unduly increase the risk of crash at high-crash locations. The RSIT method utilizes a, so-called, intelligent checklist that helps plan site investigations and their execution. The unique concept of an intelligent checklist includes elimination of unneeded

	checks during the planning phase based on the known local conditions and during the investigation based on the checks already processed. The identified local conditions are then used by the tool to identify relevant safety countermeasures and their expected effectiveness. The operations of elimination and identification are performed seamlessly in the background by RSIT installed on a portable computer. The results are documented in a report and saved for later use. The core of the method is a knowledge base that includes hundreds of rules—intuitive and easy to update by a user. To facilitate the updating and customization of knowledge base, a dedicated editor has been developed and integrated with the method. Transportation agencies at the State, city, and county level can customize the provided initial knowledge base to make it fit better the agency's needs. Evaluation of an older version of the RSIT method indicated savings in time spent on site investigation, higher consistency in the investigation results among participating individuals, and identification of safety deficiencies overlooked when a traditional paper-based checklist was used. The RSIT method efficiently transfers the knowledge of specialists experienced in site investigations and confirmed through research to less experienced site investigators. The RSIT benefits agencies and their investigative teams by reducing the cost needed to perform the task and road users who experience improved road safety.

Project Title, ID, Cost, Duration	***Saw-Cutting Guidelines for Concrete Pavements: Examining the Requirements for Time and Depth of Saw-Cutting*** ***Report number:*** FHWA/IN/JTRP- 2007/5 ***Cost:*** $100,000 ***Duration:*** 42 months

Submitter	***Agency, organization:*** Indiana Department of Transportation (INDOT), Division of Research and Development ***Contact, e-mail:*** Tommy E. Nantung, tnantung@indot.in.gov
Research program	***Sponsoring agency or organization:*** INDOT and Joint Transportation Research Program—Purdue University
Web link, if available	www.purdue.edu/JTRP
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Joints are placed in Portland cement concrete pavements (PCCP) to control random cracking. The goal of this project was to reduce the risk for joint raveling and random cracking. Specifically, this project has focused on: developing a procedure for determining the appropriate saw-cutting time window for typical pavements constructed in the State of Indiana, determining the depth of the saw-cut that minimizes the risk of micro-cracking and random crack development, and developing tools and training materials for paving contractors and State inspectors that aid in implementing the findings of this study in concrete pavements. Recommendations are made to assist contractors in determining when saw-cuts are placed that can greatly improve field operations. Joint breakdown is currently the Achilles heel of concrete pavements. The cost of a partial depth joint repair is approximately \$13 per ft^2. This can be quite substantial. A potential increase in service life may be realized if INDOT can "slow joint deterioration." The costs of joint repair can be eliminated and the cost of replacing a cracked pavement with cracked panels can be eliminated.

Project Title, ID, Cost, Duration	***Treatment Guidelines for Pavement Preservation*** ***Report number:*** SPR-3114 ***Cost:*** $6,000 ***Duration:*** 2 years
Submitter	***Agency, organization:*** Indiana Department of Transportation (INDOT), Division of Research and Development ***Contact, e-mail:*** Tommy E. Nantung, tnantung@indot.in.gov
Research program	***Sponsoring agency or organization:*** INDOT and Joint Transportation Research Program—Purdue University
Web link, if available	www.purdue.edu/JTRP
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This project presents pavement treatment practice guidelines and a distress identification manual for the purpose of improving INDOT pavement preservation practices. The treatment guidelines consist of 10 treatment types for asphalt pavements and composite pavements and 8 treatment types for Portland cement concrete pavement (PCCP). The treatment guidelines include treatment descriptions, benefits, applicable pavement conditions, treatment materials, and treatment procedures. The guidelines are based on information obtained mainly from the INDOT Standard Specification, the INDOT Design Manual, and the INDOT Field Operations Handbook for Crew Leaders. The distress identification manual presents different types of distresses found on the surfaces of asphalt pavement, composite pavement, and PCCP. Each distress type in this manual is presented along with descriptions, causes, measurements, and pictures of each type of distress. The manual is mainly based on the Distress Identification Manual for the Long Term Pavement Performance Program (LTPP, with INDOT specific modifications) and the INDOT Design Manual. The treatment guidelines for pavement preservation can help to enhance the overall construction quality of treatments by illustrating the appropriate use of such treatments in applications, thereby contributing to their improved performance. This improvement will help to ensure

	that the treatments are used to their maximum benefit and efficiency. These guidelines and manual were introduced to the INDOT Pavement Preservation Subcommittee Section for assisting the district level preservation treatment practices. District level training on the manual will be conducted later this year. The main result of the implementation of this project is significant saving in maintenance costs for INDOT. In addition, this project meets one of the objectives of the INDOT Strategic Plan.

Project Title, ID, Cost, Duration	***Analysis and Determination of Axle Load Spectra and Traffic Input for the Mechanistic-Empirical Pavement Design Guide*** ***Report number:*** FHWA/IN/JTRP-2008/7 ***Cost:*** $100,000 ***Duration:*** 3 years
Submitter	***Agency, organization:*** Indiana Department of Transportation (INDOT), Division of Research and Development ***Contact, e-mail:*** Tommy E. Nantung, tnantung@indot.in.gov
Research program	***Sponsoring agency or organization:*** Purdue University and INDOT Research Program
Web link, if available	www.purdue.edu/JTRP
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	To improve the pavement design procedures, a new method, called the Mechanistic-Empirical Pavement Design Guide (MEPDG), has been developed through a National Cooperative Highway Research Program study to use the axle load spectra to represent the vehicle loads in pavement design. The MEPDG method allows full integration of vehicular traffic loadings, climatic features, soil characteristics, and paving materials properties into the detailed analysis of pavement structural behaviors

	and the resulting pavement performance. This study has produced the traffic input for INDOT to implement the new pavement design method. The traffic input is an essential component for using the MEPDG to design pavement structures. The truck traffic inputs were obtained using the INDOT weigh-in-motion (WIM) traffic data. The truck traffic data include average annual daily truck traffic, average monthly and hourly truck traffic, adjustment factors, axle load spectra, and axle weight and spacing values. In addition to the axle load spectra and truck traffic input, this study also analyzed the annual average daily traffic (AADT) distributions in Indiana through geo-statistical analysis utilizing ArcGIS tools. The geo-statistical analysis generated a series of results for spatial AADT predictions and future WIM station location determinations. It is believed that the results of this study will significantly facilitate INDOT's transition process from the current pavement design method to the MEPDG method. The ready-to-use truck traffic data will assure high quality input and result in a more efficient pavement design. The truck traffic input data will increase the efficiency of pavement design and save man power and money as the engineers and designers do not need to spend large amount of time and money to prepare input data for pavement design. The truck traffic spectra can also be used to estimate user costs at highway work zones. The estimated savings for moving the design process to MEPDG for 2009 construction was $10 million.

Project Title, ID, Cost, Duration	***Railroad Interconnect at Signalized Intersections*** ***Cost:*** $100,000 ***Duration:*** 29 months

Submitter	***Agency, organization:*** Indiana Department of Transportation (INDOT), Division of Research and Development ***Contact, e-mail:*** Tommy E. Nantung, tnantung@indot.in.gov
Research program	***Sponsoring agency or organization:*** INDOT and Joint Transportation Research Program—Purdue University
Web link, if available	Brennan, T.M., C.M. Day, J.R. Sturdevant, E. Raamot, and D.M. Bullock, "Railroad Preempted Intersection Track Clearance Performance Measures," Transportation Research Board Paper ID:10-0118, in press (Received AHB25 Committee 2010 Best Paper Award), 2010. ftp://ftp.ecn.purdue.edu/darcy/trb2010/10-0118_Revised_Manuscript_2009_11_15.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Track clearance green phases are used at railroad preempted intersections to provide time to clear the railroad tracks of highway vehicles before a train arrives. This research defined performance measures using high resolution, real-time traffic signal event data to assess the maximum right-of-way transfer time to track clear green phases as well as the synchronization of the track clearance phase with the railroad gate warning system located at the crossing. These performance measures were applied to a railroad preempted intersection over a 13-month period. Right-of-way transfer time from over 5,000 preemption events demonstrate the importance of using automated methods for validating right-of-way-transfer time design assumptions made by traffic engineers. The technical report concludes with recommendations for incorporating these performance measures in traffic controller firmware to address recommendations proposed in 1996 by the National Transportation Safety Board after the Fox River, Illinois railroad-grade crossing crash in 1995.

Project Title, ID, Cost, Duration	***High Performance Concrete Bridge Decks: A Fast Track Implementation Study—Volume 1: Structural Behavior*** ***Report number:*** FHWA/IN/JTRP-2005/11 ***Cost:*** $202,697 ***Duration:*** 4 years
Submitter	***Agency, organization:*** Indiana Department of Transportation INDOT, Division of Research and Development ***Contact, e-mail:*** Tommy E. Nantung, tnantung@indot.in.gov
Research program	***Sponsoring agency or organization:*** INDOT and Joint Transportation Research Program—Purdue University
Web link, if available	www.purdue.edu/JTRP
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The objective of this research was to determine the performance, particularly in terms of transverse cracking and shrinkage, of a bridge incorporating design details that will likely reduce cracking as well as the use of a low shrinkage, high-performance concrete. A bridge deck containing a reduced bar spacing (#5 size at 6 inches in both directions and both mats) and a high-performance concrete was instrumented to evaluate the behavior of a system designed to control transverse deck cracking. Based on the results of this study, it is found that the combination of low-shrinkage concrete along with improved reinforcing details can significantly improve the cracking behavior of a bridge deck. This research study supports the recommendations previously outlined in a previous study "Investigation of Bridge Deck Cracking in Various Bridge Superstructure Systems" (FHWA/IN/JTRP-2002/25). Significant benefits can be realized through the continued implementation of these recommendations. Minimizing deck cracking can reduce maintenance and deck replacement costs while increasing the lifespan of the bridge. It is estimated that the results are elimination of a deck overlay and extend the time for re-decking from 30 years to 45 years with cost savings of $75 per square feet.

Iowa Department of Transportation

Project Title, ID, Cost, Duration	***Iowa's Bridge Diagnostic Load Testing Program***
Submitter	***Agency, organization:*** Iowa Department of Transportation (DOT) ***Contact, e-mail:*** Sandra Q. Larson, P.E., Director, Research and Technology Bureau, sandra.larson@dot.iowa.gov
Research program	***Sponsoring agency or organization:*** Iowa DOT and the Iowa Highway Research Board
Web link, if available	http://www.iowadot.gov/research/pdf/newsmarch2010.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Most bridge engineers rely exclusively on traditional theoretical analysis when determining bridge capacity. Typically, this provides reliable means for assessing the condition of common bridge types. However, based on traditional methods, some bridges with a history of good performance that have marginal load capacity (older bridges designed using outdated specifications or those with unknown design history) require additional assessment to more accurately determine true load capacity. In these cases, diagnostic load testing has proven an effective evaluation tool. Load testing bridges can be a cost-effective way to avoid rehabilitation, replacement, and additional costs (incurred by the traveling public). Calculating additional costs for a restricted bridge is not easy, yet, when trucks must use longer alternate routes due to load restrictions, additional costs are incurred. In the late 1990s, the Iowa DOT Office of Bridges and Structures (OBS) identified the need to develop a diagnostic load testing program and began seeking innovative solutions to supplement traditional analysis techniques. To determine if a bridge's calculated load capacity accurately reflects its true load capacity, the Iowa DOT has begun load testing restricted bridges. A primary goal of the OBS bridge capacity evaluation program

	is to implement improved methods for load testing that help save time and precious resources, while increasing the dependability and longevity of Iowa's bridges.

Kansas Department of Transportation

Project Title, ID, Cost, Duration	***Treatment of Contaminated Roadway Runoff Using Vegetated Filter Strips*** ***ID:*** K-TRAN: KU-03-5 ***Cost:*** $54,000 (Projected Benefit to Cost Ratio: 52:1) ***Duration:*** September 2002–November 2004
Submitter	***Agency, organization:*** Kansas Department of Transportation (KDOT) ***Contact, e-mail:*** Rodney Montney, Engineer of Research, rodney.montney@ksdot.org
Research program	***Sponsoring agency or organization:*** KDOT, Bureau of Materials and Research
Web link, if available	http://dmsweb01/idmws/DocContent.dll?Library=PublicDocs^dt00mx38&ID=003778816&Page=1
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The overall goal of this field study was to evaluate the potential effectiveness of vegetated highway embankments as a stormwater runoff best management practice (BMP) for retention of metals, polycyclic aromatic hydrocarbons (PAHs), and particulates. The study characterized roadway sediment particulate matter, annual pollutant mass loading, and long-term pollutant retention for three field sites in eastern Kansas. The field study indicated that pollutant retention was primarily a surficial phenomenon, limited to the top 0 to 2 inches of highway embankment soils. Effectiveness of vegetated embankments for net particle retention was found to be greater than 70 percent for particles of 0.020 mm or greater. The 18 ft long vegetated highway embankments evaluated in this study were effective stormwater runoff BMPs for zinc with 42 to 100 percent long-term pollutant mass retention. Moderate performance was observed for pyrene and chrysene with 20 to 100 percent mass retention. Vegetative embankments were less effective for copper and benzo(a)pyrene with 9 to 42 percent mass retention. The key benefits of utilizing highway embankments for runoff control include cost-effectiveness relative to other engineered systems and compatibility with roadway design and maintenance requirements.

	While specific pollutant mass retention was observed to be variable and dependent on metal or PAH properties in runoff, the overall result is a significant reduction in pollutant mass to the local watershed, particularly when embankments are greater than 30 to 45 feet in length.

Project Title, ID, Cost, Duration	***Determining Major Causes of Highway Work Zone Accidents in Kansas*** ***ID:*** K-TRAN: KU-05-1 ***Cost:*** $48,000 (Projected Benefit to Cost Ratio: 12.1:1) ***Duration:*** July 2004–January 2006
Submitter	***Agency, organization:*** Kansas Department of Transportation (KDOT) ***Contact, e-mail:*** Rodney Montney, Engineer of Research, Rodney.Montney@ksdot.org
Research program	***Sponsoring agency or organization:*** KDOT, Bureau of Materials and Research
Web link, if available	http://dmsweb01/idmws/DocContent.dll?Library=PublicDocs^dt00mx38&ID=003714927
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Highway work zones constitute a major safety concern for government agencies, the legislature, the highway industry, and the traveling public. Despite the efforts made by government agencies and the highway industry, there is little indication that work zone crashes are on the decline Nationwide. The main reason behind this is that current safety countermeasures are not working effectively in the work zones. Lack of effective countermeasures may be due to the fact that the characteristics of work zone crashes are not well understood. The primary objective of this research was to investigate the characteristics of fatal crashes and risk factors to these crashes in the work zones so that effective countermeasures could be developed and implemented in the near future.

The objective was accomplished using a four-step approach. First, a literature review on previous work zone crash studies was conducted to establish a solid understanding on this issue. Second, the research team collected the crash data from the KDOT accident database and the original accident reports. A total of 157 fatal crash cases between 1992 and 2004 were examined. Third, based on the collected data, the researchers systematically examined the work zone fatal crashes using statistical analysis methods such as descriptive analyses and regression analyses. At the end of analyses, the unique crash characteristics and risk factors in the work zones were determined. Finally, improvements on work zone safety were recommended.

Risk Category	Risk Description	Safety Improvement Recommendation
High-risk drivers	Male Drivers	Safety education
	Drivers between 35–44	Safety education
	Drivers ≥65	Safety education
High-risk time periods	Daytime non-peak hours (10:00 a.m.–4:00 p.m.)	Safety education and control enforcement
	Nighttime (8:00 p.m.–6:00 a.m.)	Illumination or retro-reflective devices
	Slow-construction season (November–March)	Routine traffic control inspection and public information
High-risk locations	Rural two-lane highways with speed limits from 51 mph to 70 mph	Effective speed control devices and speed limit enforcement
	Complex geometric alignments	Developing special traffic controls for complex geometric alignment
Most common crash types	Multi-vehicle collisions (head-on, angle-side impact, and rear-end)	Effective speed control devices and speed limit enforcement
	Heavy truck involved crashes	Safety education, speed control and work zone geometric design with enough space for heavy

			truck maneuver
	Driver errors	Inattentive Driving	Devices such as flashing lights or temporary raised pavement markers in the advance warning area
		Misjudgment/disregarded traffic controls	Traffic control enforcement and avoiding confusing traffic control signs/signals

Project Title, ID, Cost, Duration	***Providing Engineering Services to Counties*** ***ID:*** K-TRAN: KU/KSU-04-6 ***Cost:*** :$50,000/year to hire a Local Road Engineer (Projected Benefit to Cost Ratio: 12.09:1) ***Duration:*** March 2004–May 2006
Submitter	***Agency, organization:*** Kansas Department of Transportation (KDOT) ***Contact, e-mail:*** Rodney Montney, Engineer of Research, Rodney.Montney@ksdot.org
Research program	***Sponsoring agency or organization:*** KDOT, Bureau of Materials and Research
Web link, if available	http://dmsweb01/idmws/DocContent.dll?Library=PublicDocs^dt00mx38&ID=003776084&Page=1
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	An engineer is required by law to safeguard the health, safety, and welfare of the public. The current Kansas statute states, "The Board of County Commissioners of each county shall appoint a licensed professional engineer, whose title shall be county engineer." (K.S.A. 68-501). The statute needs to be changed because it is not economically or socially feasible for each county in the State of Kansas to hire a county engineer. However, it is necessary for each county to have access to

	engineering services because engineering activities are conducted in every county at some point throughout the year. The objective of this study was to discuss the implications of State Statute KSA 68-501 and discuss ways to provide Engineering Services to Kansas counties with as little negative financial and social effects as possible to counties that don't need a full time engineer on staff. To accomplish this, a transportation break-through team of the Kansas Collaborative was developed. This Kansas Collaborative had three initiatives: (1) to establish a local road engineer to provide counties without a county engineer access to engineering advice, (2) to establish purchasing procedures using State contract pricing for local units of government, and (3) to establish a Kansas DOT contract project notification system to help local units of government benefit from utilizing Kansas DOT contractors when they are mobilized in their area during Kansas DOT construction projects across the State. These initiatives have been implemented.

Kentucky Transportation Cabinet

Project Title, ID, Cost, Duration	***Bridge Strengthening with Post Installed Shear Studs*** ***ID:*** Report not yet available, but paper published to the Web site cited below. ***Cost:*** Bridge retrofit $26,000 and associated research $260,000. ***Duration:*** 2008–2010
Submitter	***Agency, organization:*** Kentucky Transportation Cabinet (KYTC), Department of Highways ***Contact, e-mail:*** Jamie Bewley-Bird, PE (Research Coordinator, jamie.bewley@ky.gov
Research program	***Sponsoring agency or organization:*** KYTC and Federal Highway Administration (Research conducted by the Kentucky Transportation Center in the College of Engineering at the University of Kentucky)
Web link, if available	www.ktc.uky.edu (select High Value Research button) or contact iharik@engr.uky.edu
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The KY 32 Bridge over Lytles Creek, located in Scott County, Kentucky, is a single span steel girder bridge with a non-composite reinforced concrete bridge deck. A field investigation was carried out to evaluate the viability of using post installed shear studs to increase the load capacity of a non-composite single span bridge. Adhesive anchor shear studs that can be installed with minimum traffic disruption were selected for this project. A finite element analysis was performed to investigate the number of studs required to achieve a minimum HS25 load rating. An American Association of State Highway and Transportation Officials load rating analysis showed that the maximum inventory level load rating of the bridge before the installation of the shear studs was an HS12.2 truck load. Following the placement of the shear studs, the inventory level load rating increased to an HS33.0 truck

	load—an increase of 170 percent in load rating capacity. The final field test provided information to positively verify that post installation of shear studs to achieve partial composite action could be successfully performed to increase the flexural capacity of non-composite bridge girders.

Project Title, ID, Cost, Duration	***Identify and Evaluate Potentially Defective Steel on the Combs-Hehl Interstate 275 Bridges*** ***ID:*** Report not yet available, but paper published to the Web site cited below. ***Cost:*** Bridge $1,800,000 ***Duration:*** 2008–2010
Submitter	***Agency, organization:*** Kentucky Transportation Cabinet (KYTC), Department of Highways ***Contact, e-mail:*** Jamie Bewley-Bird, PE (Research Coordinator, Jamie.Bewley@ky.gov
Research program	***Sponsoring agency or organization:*** KYTC and Federal Highway Administration (Research conducted by the Kentucky Transportation Center in the College of Engineering at the University of Kentucky)
Web link, if available	www.ktc.uky.edu (select High Value Research button) or contact thopwood@engr.uky.edu
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	In 2006, three cracked secondary splice plates were encountered on the westbound Interstate 275 bridge. By May 2008 the cracks had grown, leading the Cabinet to replace them. Follow-on metallurgical investigation of the plates revealed that, while they met the chemistry of ASTM A 514 steel, their mechanical properties were out-of-specification. The risk posed by any brittle SCC-steel remaining on the two bridges generated significant concern and the Cabinet sought to

	identify it. Hardness testing was a viable means of separating the acceptable steel from any steel that was out-the-specification. The field testing was performed using ultrasonic hardness testing per ASTM E 1038, and GE/Krautkramer MIC 20 ultrasonic hardness testers in conjunction with 10 kgf probes. Final hardness evaluation was performed using the TeleWeld Telebrineller, a mechanical impact tester, per ASTM E 10. All ASTM A 514 steel on the two bridges were identified. There were 1356 separate plates/locations on the two bridges representing some 4,500,000 lb. of steel. Two locations on each plate were subjected to ultrasonic hardness testing and any plates having values > HRC 27 were further evaluated using the impact hardness test. Fourteen out-of-specification ASTM A 514 plates were identified, ranging in 4 thicknesses from 3/8 inch to 3/4 inch. None of them were fracture-critical. In the future, metallurgical evaluations should be considered/performed on any cracked ASTM A 514 steel found on bridges.

Project Title, ID, Cost, Duration	***Factors Affecting Asphalt Pavement Density and the Effect on Long Term Pavement Performance*** ***ID:*** Report KTC-10-05/RSF14-05-1F soon to be published to the Web site cited below. ***Cost:*** $330,000 ***Duration:*** 2008–2010
Submitter	***Agency, organization:*** Kentucky Transportation Cabinet (KYTC), Department of Highways ***Contact, e-mail:*** Jamie Bewley-Bird, PE (Research Coordinator, jamie.bewley@ky.gov

Research program	***Sponsoring agency or organization:*** KYTC and Federal Highway Administration (Research conducted by the Kentucky Transportation Center in the College of Engineering at the University of Kentucky with the Asphalt Institute)
Web link, if available	www.ktc.uky.edu (soon to be published report will be available at this site) or contact cgraves@engr.uky.edu
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The joint research evaluated construction projects were provided by the Kentucky and Ohio transportation agencies. Research indicated that construction procedures have significant impact on in-place asphalt density. Preliminary laboratory work was completed to quantify the benefits of higher asphalt construction density on fatigue, rutting, and structural performance. A 1 percent increase in density could achieve a 5 percent increase in pavement life relating to fatigue and increases approaching 25 percent could potentially be realized in certain situations. Density could potentially be increased by monitoring the rolling temperature during paving operations. By determining which variables (i.e. roller pattern, temperature when rolled, etc.) are most influential to pavement performance and then monitoring those variables, Kentucky would be able to increase the service life of asphalt roadways by up to 25 percent, saving as much as $30 million annually on a resurfacing budget of $129.2 million (2007), while still maintaining the current roadway level of service. Ensuring that the pavement roller is able to roll the surface at the appropriate temperature can result in increases of in situ density of up to 4 percent. In laboratory testing, this increase in density translated to a significant increase in durability performance. An asphalt mix having 7 percent air voids endured 50 percent more cycles to failure than the same mix at 11 percent air voids. By decreasing the air voids, we achieved a 50 percent increase in performance.

Project Title, ID, Cost, Duration	***Pavement Settlement Issues and Hydro-Geochemical Water Testing Results for the Cumberland Gap Tunnel*** ***Report number:*** KTC –10-03/KH58-07-1F *(soon to be published)* ***Cost:*** $121,390 ***Duration:*** 2008–2010
Submitter	***Agency, organization:*** Kentucky Transportation Cabinet (KYTC), Department of Highways ***Contact, e-mail:*** Jamie Bewley-Bird, PE (Research Coordinator, jamie.bewley@ky.gov
Research program	***Sponsoring agency or organization:*** KYTC and Federal Highway Administration (Research conducted by the Kentucky Transportation Center in the College of Engineering at the University of Kentucky with others)
Web link, if available	www.ktc.uky.edu (soon to be published report will be available at this site) or contact cgraves@engr.uky.edu
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Ground Penetrating Radar (GPR) surveys and Hydro-Geochemical Water Testing (HGWT) have been performed at the Cumberland Gap Tunnel to determine why the reinforced concrete pavement has settled in various areas throughout both tunnels. Approximately 7,300 total square feet of pavement surface has voids beneath it ranging from 0.05 to 40 inches in depth. Up to 1 million gallons of calcium deficient water flows through the tunnel's ground water collection system on a daily basis, dissolving the lime stone sub-base. If the pavement was to fail, its impact would impose an approximate 1.1 million dollars of daily users cost to the traveling public due to long and potentially dangerous diversion routes around the Cumberland Gap Mountain. There are several strategies outlined in this report to address both short-term and long-term remediation. It is proposed that grout material should be placed beneath the pavement structure (at an estimated cost of $50,000 to $100,000 per year). For the long term it is proposed that approximately 2,800 lineal feet of pavement and backfill material be removed in both tunnels and replaced with an inert granite backfill and

	a new 10 inch reinforced concrete pavement be installed for a long-term remediation (estimated cost—$10 million).

Louisiana Department of Transportation

Project Title, ID, Cost, Duration	***Development of A Design Methodology for Asphalt Treated Mixtures*** ***Report number:*** FHWA/LA/453 ***Cost*:** $ 397,688 ***Duration:*** 2 years
Submitter	**Agency, organization:** Louisiana Transportation Research Center (LTRC)/Louisiana Department of Transportation and Development (LADOTD) ***Contact, e-mail:*** Harold "Skip" Paul, harold.paul@la.gov
Research program	***Sponsoring agency or organization:*** LTRC/LADOTD
Web link, if available	www.ltrc.lsu.edu
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This report summarizes the results of a study that was conducted to develop a simplified design methodology for asphalt treated mixtures that are durable, stable, constructible, and cost effective. The quantification of this lean and simple asphalt mixture, 3 percent asphalt combined with an aggregate blend of 75 percent stone and 25 percent sand proves that good performance can be obtained simply when densities meet 98 percent of a "standard" 30 gyrations in a gyratory compactor. This simple mixture with a modified asphalt, provides equal performance to Louisiana's standard base mix, which requires Percent Within Limits, 3.5 percent voids and 92 percent relative density. It can be placed using the same equipment required to place stone bases. (Up to 20 percent less cost than standard asphalt mixture can be realized in lieu of stone.) The results of Part I showed that the asphalt treated mixtures containing commonly available limestone had the best performance among all

	other mixtures designed in this study. Their performance was similar to conventional base course. All mixtures exhibited superior performance compared to unbound granular base materials in permanent deformation resistance. The Mechanistic–Empirical Pavement Design Guide showed asphalt treated mixtures can extend the service life or reduce the design thickness of a pavement. Part II of this study demonstrated that the in-situ tests results of asphalt treated mixtures exhibited similar moduli to those of conventional hot mix asphalt base course mixtures.

Project Title, ID, Cost, Duration	***Utilizing the Dynamic Cone Penetrometer in the Subgrade Analysis and Pavement Design Process*** ***Report number:*** LTRC report number 417 ***Cost:*** $443,732 ***Duration:*** 30 months
Submitter	***Agency, organization:*** Louisiana Transportation Research Center(LTRC)/Louisiana Department of Transportation and Development (LADOTD) ***Contact, e-mail:*** Harold "Skip" Paul**,** harold.paul@la.gov
Research program	***Sponsoring agency or organization:*** LTRC/Planning Division/LADOTD
Web link, if available	http://www.ltrc.lsu.edu/pubs_final_reports_5.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Field and laboratory testing programs were conducted to develop models that predict the resilient modulus of subgrade soils from the test results of various test devices, namely, Falling Weight Deflectometer (FWD), Dynamic Deflection Determination (Dynaflect), Continuous Intrusion Miniature Cone Penetrometer (CIMCPT), and Dynamic Cone Penetrometer (DCP). The field testing program included FWD, Dynaflect, CIMCPT, and DCP testing; whereas the laboratory program included repeated load triaxial resilient modulus tests, physical property tests and compaction tests. Results of the laboratory and field testing

	programs were analyzed and evaluated. Statistical models for predicting the resilient modulus were developed. LADOTD chief engineer has approved the implementation of the DCP in the subgrade soil analysis process as well as the Pavement Design Process. This was accomplished by revising existing LADOTD standard practices, developing specifications for using the DCP, computer software to analyze DCP data, as well as a comprehensive training program including videos. Full implementation is expected by June 2010. The project level analysis resulting from the utilization of the above method as compared to the previous network level approach allows for more accurate pavement designs. Over-designing pavements leads to misallocation of resources and under-designing pavements leads to premature failures which in turn ultimately increases the cost in terms of service life.

Project Title, ID, Cost, Duration	***Evaluation of Superpave Mixtures Containing Hydrated Lime*** ***Report number:*** FHWA/LA/432 ***Cost:*** $173,000 ***Duration****:* 2 years
Submitter	***Agency, organization:*** Louisiana Transportation Research Center (LTRC)/Louisiana Department of Transportation and Development (LADOTD) ***Contact, e-mail:*** Harold "Skip" Paul, harold.paul@la.gov
Research program	***Sponsoring agency or organization:*** LTRC/LADOTD
Web link, if available	www.ltrc.lsu.edu

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This research found that the inclusion of hydrated lime to a mixture with PG70-22m performs similar to a mixture with PG76-22m. This laboratory study examined the mixture performance of PG 64(7)-22, PG70-22m and PG76-22m with and without hydrated lime that was added both dry to the mixture and wet slurry on the aggregate. The addition of hydrated lime to mixtures containing SB polymer modified asphalt PG 70-22M and 76-22M binder improved the rut resistance and maintained minimum adequate levels of fatigue resistance. The hydrated lime treatment has shown excellent promises to improve the permanent deformation characteristics in hot mix asphalt pavements. Therefore, hydrated lime treated mixtures can be used to construct the middle layer of the perpetual pavement, which is expected to be made of high modulus rut resistant asphalt mixture to provide sufficient stability of the pavement. The use of hydrated lime in Louisiana's Superpave mixes should provide for a longer life expectancy of the completed roadway structure with a decreased initial cost. Specifically, it is recommended that "when adding hydrated lime per standard specifications 503.05 (added to aggregate first) to mixtures containing PG 70-22 m, binder shall be considered equal to mixtures containing PG 76-22 m."

Project Title, ID, Cost, Duration	***Development of Uniform Sections for PMS Inventory and Applications*** ***Report number:*** 430: "Development of Uniform Sections for PMS Inventory and Applications"; 460: "Development of Index Based Pavement Performance Models for Pavement Management system (PMS) of LADOTD" ***Cost:*** $173,183 ***Duration:*** 30 months

Submitter	***Agency, organization:*** Louisiana Transportation Research Center (LTRC)/Louisiana Department of Transportation and Development (LADOTD) ***Contact, e-mail:*** Harold "Skip" Paul, harold.paul@la.gov
Research program	***Sponsoring agency or organization:*** LTRC/Planning Division/LADOTD
Web link, if available	www.ltrc.lsu.edu
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The main objective of the research study project is to find the most cost effective way to incorporate pavement management systems (PMS) into LADOTD's regular operation and make the information in PMS usable for engineers within the department (especially for district level personnel who schedule construction and maintenance activities). The objective of this study is accomplished as follows: (1) Identify the needs of PMS users at LADOTD, (2) establish a unified roadway identification system acceptable to all PMS users, and (3) evaluate and update the existing pavement performance, and treatment selection models. More than 25 recommendations have been made based on actual data analysis and the needs of PMS users. Most of them are implemented or in the process of being implemented, which has enhanced the PMS capabilities in managing the pavements and facilitated better communication amongst various PMS data users and decision makers. This study has provided LADOTD the tools that will help to maintain and improve the existing highway network in a cost-effective manner by utilizing the following: (1) Upgraded processes and techniques in decision making with improved communication between various sections of LADOTD, (2) updated models for pavement performance prediction for timely maintenance and rehabilitation, and (3) the remaining service life for asset management activities in the future.

Maine Department of Transportation

Project Title, ID, Cost, Duration	***Statewide Focus Area Identification*** ***Cost:*** $40,000 ***Duration:*** 2 years
Submitter	***Agency, organization:*** Maine Department of Transportation (MaineDOT) ***Contact, e-mail:*** Dale Peabody, dale.peabody@maine.gov
Research program	***Sponsoring agency or organization:*** MaineDOT SPR, Maine Department of Inland, Fisheries & Wildlife, Maine Department of Conservation
Web link, if available	http://www.maine.gov/doc/nrimc/mnap/focusarea/index.htm http://beginningwithhabitat.org/about_bwh/focusareas.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Focus Areas are priority areas for conservation planning, restoration and preservation. Conservation activities will help ensure that the rare natural features present within these areas will persist in that part of Maine. The regulatory and resource agencies refer to this information when reviewing mitigation proposals submitted by MaineDOT. As a result of the Focus Area project 16 new focus areas were designated in organized towns in northern and western Maine in 2008. In addition, 6 new focus areas were designated along the coast, and the boundaries of 14 focus areas along the coast were revised. A few examples are given of how MaineDOT has benefited from this information. The completion of the Focus Area study was critical to establishment of an in-lieu fee mitigation program that allows permit applicants to pay a fee for impacts to certain natural resources, such as wetlands and streams, instead of doing project-specific mitigation. MaineDOT used the in-lieu fee option to its advantage in order to permit several high priority and The American Recovery & Reinvestment Act-funded projects under an accelerated timeframe. The availability of this option allowed the MaineDOT Environmental Office to meet the aggressive permit and advertise schedules required on these projects. Second, MaineDOT has used the northern Maine Focus Area information to support mitigation

	plan development for the Caribou Bypass project. Given the preference of some of the Federal agencies for mitigation near existing conserved areas or priority conservation areas, the information was used to provide landscape context to potential mitigation options and to limit the extent of the site search. The selected site is a parcel located within a Focus Area. MaineDOT will contribute funding and technical assistance towards its conservation. Resources of Statewide priority will be protected quicker than by securing funding from other sources, and MaineDOT will meet its mitigation requirement at a savings of nearly $200,000 over other mitigation strategies. Finally, MaineDOT is actively pursuing a Federal wetland mitigation bank to streamline project permitting. This focus area study will help prioritize potential bank locations and expedite Federal/State resource agency buy-in on site selection.

Project Title, ID, Cost, Duration	***Maine Road Salt Risk Assessment Project*** ***Cost:*** $80,000 ***Duration:*** September 2008April 2010
Submitter	***Agency, organization:*** Maine Department of Transportation (MaineDOT) ***Contact, e-mail:*** Bill Thompson, Office of Safety, Training, and Research, william.thompson@maine.gov
Research program	***Sponsoring agency or organization:*** MaineDOT
Web link	http://mcspolicycenter.umaine.edu/?q=RoadSalt
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The overall goal of this project was to investigate and evaluate the risks posed by ice and snow melting chemicals used by MaineDOT & Maine municipalities, in regard to the environmental impacts, sustainability, safety concerns, and public policy implications.

Key Findings

- Some environmental effects are short term; that is, they are seasonal and largely reversible.
- Although long-term effects of salt contamination in the environment are cumulative, they may be reversible. Recovery will take many years to decades after salt inputs stop.
- New policies are needed to encourage the use of chemicals and technologies that have fewer environmental effects than those of sand and salt.
- Estimated Statewide expenditures for winter road maintenance in 2008–2009 (State and municipal) was $98 million, or $76 per capita. An estimated 490,000 tons of rock salt were purchased in 2008–2009 in Maine or roughly 750 pounds for every Maine resident, or 21 tons per road mile.
- The combination of young drivers and snow-covered roads is hazardous. Drivers ages 16–17 are involved in 9 percent more winter-condition crashes than their share of crashes for all road conditions. Drivers ages 18–19, 20–24, and 25–34 also have higher numbers of winter-condition crashes than expected, but not as many as 16–17 year olds.
- Drivers are exposed to fewer road conditions of snow and ice than a decade ago, and this has led to improved mobility and safety.
- No risk ranking of salts is possible. Climatic conditions, methods of use, and application rates may have more influence on corrosion than their chemical composition.
- Corrosion affects different metals and alloys differently and is also influenced by environmental factors such as moisture and temperature.

Project Benefits

Conducted an independent stakeholder-driven analysis of risks related to the use of road salt.

Disseminated information to stakeholder groups and the Maine Legislature Transportation Committee on the policy choices between mobility, costs, and environmental impacts of ice melting chemicals.

Project Title, ID, Cost, Duration	***Composite Invert Liner for Highway Pipe Culverts*** ***Report number:*** ME 10-02 ***Cost:*** $40,000 for R&D Phase
Submitter	***Agency, organization:*** Maine Department of Transportation (MaineDOT) ***Contact, e-mail:*** Dale Peabody, dale.peabody@maine.gov
Research program	***Sponsoring agency or organization:*** MaineDOT—State TransCap Bridge
Web link, if available	See the video at: http://media.maine.gov/cgi-bin/vid?id=Ny6RlLuY3w7S4O4 Report at: http://www.state.me.us/mdot/transportation-research/transportation-research-div.php
	The composite liner concept was developed and tested by MaineDOT, Kenway Corporation and the University of Maine AEWC Advanced Structures and Composites Center. The liner, fish weirs, and fish ladder were manufactured and installed by Kenway. The overall cost of the composite liner including fabrication and installation was about 8 percent more than the estimate for the traditional concrete liner. However, the actual in-stream work was reduced. Important to fish passage the composite liner raised the invert approximately one inch while the traditional concrete liner is around 6 inches. Use of the thinner composite liner may eliminate the need for costly downstream fish ladders on some future projects. **Potential Benefits** • Reduction in overall costs • More durable, light weight and ease of installation • 75 to 100 year estimated service life • More environmentally friendly

Maryland Department of Transportation

Project Title, ID, Cost, Duration	***An Integrated Work-Zone Computer System for Capacity Estimation, Cost/Benefit Analysis, and Design of Control*** ***Report number:*** MD-09- SP708B4B ***Cost:*** $176,859 ***Project Duration:*** 4/30/2007–12/29/2009
Submitter	***Agency, organization*:** Maryland State Highway Administration (SHA) ***Contact, e-mail:*** Allison Hardt, Chief, Research Division, ahardt@sha.state.md.us
Research program	***Sponsoring agency or organization:*** Maryland State Highway Administration
Web link, if available	http://attap.umd.edu/lcap/
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Work zones have been widely recognized as one of the main contributors to increased delays and deteriorating traffic safety on highway networks. The effectiveness of work-zone operational and control strategies is contingent on an accurate estimate of the available work-zone capacity. The primary objective was to develop a computer system to guide SHA engineers and consultants in estimating work-zone capacity and analyzing workzone traffic impacts. A complete set of procedures for constructing an analytical model for work-zone capacity estimation was developed, which consist of field surveys, data analysis, and model development. It also includes an approach that can use the field survey results to calibrate a microscopic simulation to capture local driving behaviors. The final research product, a computer program called LCAP, has a Basic version that integrates the estimation model developed in this research and some previous studies, and a Pro version that takes advantage of an advanced microscopic simulation model for analyzing more complex geometric features, such as ramps in work-zone areas. Both versions are being extensively used by SHA engineers and consultants. Improved operational safety and reduced traffic impact

	were achieved with the implementation of the effective operational/control designs selected with the help of LCAP.

Project Title, ID, Cost, Duration	***Determining Sinkhole Susceptibility in the Frederick and Hagerstown Valleys*** ***Report number:*** MD-09-SP508B4K ***Cost:*** $222,500 ***Duration:*** 9/20/01–9/30/09
Submitter	***Agency, organization*:** Maryland State Highway Administration (SHA) ***Contact, e-mail:*** Allison Hardt, Chief, Research Division, ahardt@sha.state.md.us
Research program	***Sponsoring agency or organization:*** Maryland State Highway Administration
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Areas underlain by limestone, marble, and dolomite, (carbonate rocks), are prone to dissolution by ground water that produces topographic features and characterizes what is known as *karst terranes*. The application of geologic mapping, karst location, and data analysis permits the definition and characterization of variations within karst areas as was documented in a study conducted by the Maryland Geological Survey (MGS), in cooperation with Maryland SHA. The goal was to determine what limestone layers were more susceptible to dissolution and catastrophic cover-collapse sinkhole formation. From this data set, a karst susceptibility index (KSI) was developed that gives a relative scale of sinkhole potential and that can be used as a first approximation for determining which areas in the region are most likely to develop cover collapse sinkholes. The Geographic Information Systems maps developed provide a detailed assessment of geologic units and geohazard presence. The findings are being in planning studies to provide information on the geology of the site and to help understand

	the sinkhole development potential in the study area. SHA's Engineering Geology Division uses the information to better understand, map, and establish the relative risk of the various geohazards with sinkhole development of high priority. The information is also used to provide guidance to the engineering districts for identification and repair of identified or suspected sinkholes.

Michigan Department of Transportation

Project Title, ID, Cost, Duration	***A Sensor Network System for the Health Monitoring of the Parkview Bridge Deck*** ***Report number:*** RC-1536 ***Cost:*** : $224,522 (Cost Sharing 20% MDOT, 80% Federal Highway Administration through the SPR, Part II, Program) ***Duration:*** December 2005–January 2010
Submitter	***Agency, organization*:** Michigan Department of Transportation (MDOT), Office of Research & Best Practices ***Contact, e-mail:*** Calvin Roberts, P.E., robertsc@michigan.gov
Research program	***Sponsoring agency or organization:*** MDOT
Web link, if available	This final report will be available online soon at www.michigan.gov/mdot/0,1607,7-151-9622_11045_24249---,00.html. Contact Calvin Roberts for the draft report.
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Until recently, accelerated bridge construction and its potential cost and timesavings were unproven in Michigan. In addition, MDOT needed a method to monitor and verify the performance of bridges constructed with such techniques. In 2008 MDOT built a four-span, three-lane bridge using rapid construction techniques. Piers, abutments, I-beam girders, and full-depth deck panels were all prefabricated off-site. Researchers compared the costs, construction time and work flow with traditional construction techniques. Researchers also instrumented the prefabricated deck panels with a structural health monitoring system. This system recorded strain and temperature data for the one-year period following completion of the bridge.

	Value and Implementation Side-by-side analysis of rapid and traditional construction techniques showed overall user timesavings of 45 days with rapid construction, or a reduction of 42 percent in project duration, compared with traditional techniques. The sensor system also performed as intended, demonstrating that each joint between panels behaved according to design specification and that the structure acted as a unit. MDOT and its contractors also learned valuable lessons in fabrication of complex bridge deck components. Due to several factors, the bridge deck panels did not fit together properly in the field; all 48 were rejected and needed to be reconstructed and reinstrumented. This demonstrated the need for improved quality assurance procedures. Using these research results, Michigan DOT has a clear path forward for new rapid bridge construction projects now under consideration.

Project Title, ID, Cost, Duration	***Characterization of Truck Traffic in Michigan for the New Mechanistic-Empirical Pavement Design Guide*** ***Report number:*** RC-1537 ***Cost:*** : $118,214 (Cost Sharing 20% MDOT, 80% Federal Highway Administration through the SPR, Part II, Program) ***Duration:*** October 2007–December 2009
Submitter	***Agency, organization*:** Michigan Department of Transportation (MDOT), Office of Research & Best Practices ***Contact, e-mail:*** Calvin Roberts, P.E., robertsc@michigan.gov
Research program	***Sponsoring agency or organization:*** MDOT

Web link, if available	http://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC-1537_316196_7.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	MDOT analyzed truck traffic as a critical input to the Mechanistic-Empirical Pavement Design Guide (MEPDG). MDOT needed to look at a range of traffic parameters and determine their influence on asphalt and concrete pavement design using MEPDG. Parameters with significant impact on MEPDG design would require level 2 (regional) inputs, whereas those that have little effect on MEPDG design would only require only level 3 (Statewide average) inputs, which are less costly and time-intensive to collect. Researchers also performed a distribution analysis of the State's weigh-in-motion stations to determine if Michigan's network of stations will sufficiently capture required traffic data. **Value and Implementation** The study showed that the impact of traffic input parameters to MEPDG varies both by parameter and by pavement type. Knowing the degree of detail required for inputs to MEPDG will make a big difference for MDOT as it continues its assessments of this design methodology. In the analysis of weigh-in-motion stations, researchers found that the distribution in the State is nearly sufficient, with recommendations made to add just a few sites. As MEPDG evaluation continues, MDOT used the results of this research to expand its staff members' knowledge of the mechanistic-empirical design methodology. MDOT developed and conducted a class for pavement engineers to introduce the concept of mechanistic-empirical design and provided hands-on experience in using the MEPDG software.

Project Title, ID, Cost, Duration	***Height Modernization, Phases III and IV*** ***Cost:*** : $1.2 million (Cost Sharing 20% MDOT, 80% Federal Highway Administration through the SPR, Part II, Program) ***Duration:*** Started May 2008, field work completed September 2009, data verification and integration forthcoming
Submitter	***Agency, organization*:** Michigan Department of Transportation (MDOT), Office of Research & Best Practices ***Contact, e-mail:*** Calvin Roberts, P.E., robertsc@michigan.gov
Research program	***Sponsoring agency or organization:*** MDOT
Web link, if available	http://www.ngs.noaa.gov/heightmod/Michigan.shtml
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Accurate positioning information is necessary for highway project surveying and is a key input for many intelligent transportation systems applications. Michigan DOT addressed the challenge of height modernization—adding elevation data to the State's existing network of horizontal reference monuments. After a pilot study in a four-county area, MDOT deemed dense coverage of vertical reference markers Statewide to be cost-prohibitive. In this follow-up research project, the agency focused on the State's corridors of significance, setting vertical markers every 3 km and establishing vertical reference points along 1,200 miles of highway. In total, 18 to 20 percent of the corridors of significance have been upgraded with vertical data. **Value and Implementation** With height modernization in place, a MDOT construction project using the new vertical data can realize a 30 to 50 percent cost savings for leveling, control, mapping, and photogrammetry. A case study of a 5-mile photogrammetric control project showed completion of leveling in 4 days compared with an estimated 5 weeks using conventional techniques. A number of users beyond MDOT are benefiting from height

	modernization in the State as well. This includes city and county road commissioners and drain commissioners who use the markers to create accurate three-dimensional as-built drawings and farmers who use Global Positioning System-assisted agricultural vehicles. Michigan's data also feeds into a National database that provides critical information to Federal agencies on environmental planning and management.

Minnesota Department of Transportation

Project Title, ID, Cost, Duration	***Crack and Concrete Bridge Deck Sealant Performance*** ***Report number:*** 2009-13 ***Cost:*** : $75,000 ***Duration:*** 33 months *Note: Implementation, project #2009-159, is underway through 2012*
Submitter	***Agency, organization*:** Minnesota Department of Transportation (Mn/DOT) Research Services ***Contact, e-mail:*** Linda Taylor, Director of Research Services, linda.taylor@state.mn.usl
Research program	***Sponsoring agency or organization:*** Mn/DOT's Research Program & Local Road Research Board Split Funding
Web link, if available	Technical Summary - http://www.lrrb.org/pdf/200913TS.pdf Project Final Report - http://www.lrrb.org/pdf/200913.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Researchers synthesized best practices and product recommendations for concrete bridge deck crack sealants from published research, the performance of various solutions and a survey of State DOTs regarding their current practices. The objective of this project is to define the current state-of-the-art regarding the use of bridge deck sealants and crack sealers to extend the life of reinforced concrete bridge decks. The report includes the information generated from a literature review and survey that focused on current and significant studies in the field of deck and crack sealing. The intent of the survey was to determine common practices for the use and application of these sealers in different States throughout the United States. Based on the information collected from the literature review and the survey, the best sealant materials and application practices are recommended for use in Minnesota and throughout the Midwest. The

	report consists of four sections including: (1) a synthesis of the literature review on the background, application, and performance of concrete deck sealants and crack sealers, (2) a summary of the survey conducted by Mn/DOT to determine the current selection criteria, materials, application practices, and findings from different States in United States, (3) an assessment of selection criteria, materials, application practices, and performance, and (4) conclusions, recommendations, and areas in need of further research.

Project Title, ID, Cost, Duration	***Bridge Health Monitoring and Inspection: A Survey of Methods*** ***Report number:*** 2009-29 ***Cost:*** : $143,160 ***Duration:*** 20 months
Submitter	***Agency, organization*:** Minnesota Department of Transportation (Mn/DOT) Research Services ***Contact, e-mail:*** Linda Taylor, Director of Research Services, linda.taylor@state.mn.usl
Research program	***Sponsoring agency or organization:*** Mn/DOT's Research Program
Web link, if available	Technical Summary http://www.lrrb.org/pdf/200929TS.pdf Project Final Report http://www.lrrb.org/PDF/200929.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The evaluation of bridges for both safety and performance can be significantly enhanced by using remote monitoring systems to complement costly and time-consuming hands-on inspections. Researchers surveyed the many technologies and methods available for remotely monitoring bridges and developed a database tool to aid bridge engineers in deciding which commercially available products best fit a particular application. Since the collapse of the Interstate 35W bridge in August 2007, bridge health monitoring has become an area of intense interest. This report defines terminology related to bridge health

	monitoring and provides a general glossary of available monitoring systems. The glossary is meant to help readers make an informed decision by understanding how different systems function and their strengths and weakness. The authors developed a questionnaire to send to commercial companies offering monitoring systems. Of the 72 questionnaires that were sent to commercial companies, 38 companies responded and are included in this report. From information provided with these questionnaires, available commercial systems are briefly summarized. Criteria for system evaluation were developed to help the bridge owner narrow down company choices for bridge application. After the owner answers a set of questions pertaining to a particular bridge, a program developed in Microsoft Excel helps the bridge owner decide the best system for a particular situation. An example is provided for program clarity. Once company choice is narrowed down, additional criteria were developed to aid in final product choice.

Project Title, ID, Cost, Duration	***Best Practices for Dust Control on Gravel Roads*** ***Report number:*** 2009-04 ***Cost:*** : $75,000 ***Duration:*** 32 months
Submitter	***Agency, organization*:** Minnesota Department of Transportation (Mn/DOT) Research Services ***Contact, e-mail:*** Linda Taylor, Director of Research Services, linda.taylor@state.mn.usl
Research program	***Sponsoring agency or organization:*** Local Road Research Board
Web link, if available	Technical Summary http://www.lrrb.org/pdf/200904TS.pdf Project Final Report http://www.lrrb.org/pdf/200904.pdf

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Road dust from increased traffic on aggregate-surfaced roads results in complaints from roadside residents, impaired driver vision, and potential hazards for drivers on narrow roads and at intersections. In this study, researchers evaluated three dust control products and determined a maximally effective application schedule for dust control treatments. This study evaluated the performance and cost of commonly used dust palliatives using a mobile air sampling technique. Treatments of calcium chloride, magnesium chloride, and organic polymer-plus-binder were evaluated at standard application rates during the first year and at variable rates during the second year. The treatments were applied to a variety of subject roads that were located throughout Minnesota. Average daily traffic levels varied from 25 to 700 vehicles per day. The overall data trend showed that treatments reduced dust levels and measurements showed that aggregate surface moisture content was the best predictor of dust control efficiency. Positive relationships were measured between dust control efficiency and other variables in the study, generally reinforcing the concept that higher application rates may be more successful on gravels containing greater amounts of material passing the #200 sieve. A negative relationship was measured between dust control efficiency and sand equivalency, showing that treatments on gravels containing more sand material were less effective. In addition to dust control, study participants observed a secondary benefit of surface stabilization, which lasted for a period of time. Treated sections that developed surface stabilization were able to reduce maintenance activities to intersection areas only.

Project Title, ID, Cost, Duration	***Stormwater Maintenance Best Management Practices Resource Guide*** ***Report number:*** 2009RIC12 ***Cost:*** : $31,997 ***Duration:*** 29 months

Submitter	***Agency, organization*:** Minnesota Department of Transportation (Mn/DOT) Research Services ***Contact, e-mail:*** Linda Taylor, Director of Research Services, linda.taylor@state.mn.usl
Research program	***Sponsoring agency or organization:*** Local Road Research Board
Web link, if available	Technical Summary: http://www.lrrb.org/pdf/2009RIC12TS.pdf Project Final Report: http://www.lrrb.org/pdf/2009RIC12.pdf Guide : http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html University of Minnesota Best Management Practices (BMP): http://stormwater.safl.umn.edu/sites/stormwater.safl.umn.edu/files/asbmpfull.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Investigators assembled a guide that provides definitions and descriptions of the five stormwater management systems most commonly used in Minnesota. The guide offers inspection and maintenance templates for adaptation by local engineers to specific facilities and procedures. The use of stormwater treatment strategies, often referred to as BMPs, has increased significantly due to new stormwater regulations. These regulations also require governmental units to develop a systematic approach for the documentation of BMP inspection and maintenance as BMPs require ongoing inspection and maintenance to ensure that they are achieving their desired treatment goals. The resource guide was created to supplement the Minnesota Stormwater Manual in regards to local government inspection and maintenance activities associated with various BMP categories. It can be used as a tool by city staff and policy makers for evaluating various BMPs to install based on anticipated long-term maintenance requirements. This reference guide focuses primarily on BMPs that have been heavily used in Minnesota (Stormwater Ponds, Bioretention Basins, Underground Treatment Devices, Underground Detention, Infiltration)

	and concludes with a brief section covering BMPs that are newer to Minnesota and have been less commonly used to date (Sand/Media Filtration, Pervious Pavements, Tree Pits and Stormwater Planters). This section provides a description of the BMPs, a list of some Minnesota applications of the BMPs and resource documents for further exploration.

Mississippi Department of Transportation

Project Title, ID, Cost, Duration	***Evaluation of Hot Mix Asphalt Lift Thickness*** ***ID:*** FHWA/MS-DOT-RD-09-193 ***Cost:*** $80,000 ***Duration:*** 26 months
Submitter	***Agency, organization:*** Mississippi Department of Transportation (MDOT), Research Division ***Contact, e-mail:*** James Watkins, P.E., State Research Engineer, jwatkins@mdot.state.ms.us
Research program	***Sponsoring agency or organization:*** MDOT
Web link, if available	http://www.gomdot.com/Divisions/Highways/Resources/Research/pdf/Reports/InterimFinal/SS193.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Proper compaction of hot mix asphalt (HMA) mixture is vital to ensuring that a stable and durable pavement is constructed. There are many factors that can affect the compaction of HMA such as gradation, environmental factors, placement in the field, etc. This project evaluated the influence of lift thickness on the ability to achieve desirable in-place density levels. The study was conducted on different projects in the field. An experimental design was developed to evaluate how lift thickness will affect temperature, density, and permeability. A thick lift of HMA provides several benefits with respect to compactability. Thicker lifts will maintain more desirable compaction temperatures than thinner lifts. At the same time, a thicker lift will provide more room for aggregates to slide past each other, which makes it easier to achieve density with a reasonable compactive effort. It was recommended that MDOT adopt new requirements for allowable lift thicknesses for constructed HMA layers. This recommendation is based upon the increased density achieved with thicker layers, the increased time that thicker layers will maintain a desirable compaction

	temperature, the lack of influence on thickness-to-nomimal maximum aggregated size (NMAS) ratio on density gradients and the lack of influence of thickness-to NMAS ratio on permeability. The department increased lift thickness on its 12.5 mm and 19 mm mixes, which provided better densities and longer life.

Missouri Department of Transportation

Project Title, ID, Cost, Duration	***Median Guard Cable Performance in Relation with Median Slope on Interstate 70*** ***Report number:*** RI08-039 ***Cost:*** In-House Effort ***Duration:*** 21 months
Submitter	***Agency, organization*:** Missouri Department of Transportation (MoDOT) ***Contact, e-mail:*** Mara Campbell, mara.campbell@modot.mo
Research program	***Sponsoring agency or organization:*** MoDOT
Web link, if available	http://library.modot.mo.gov/RDT/reports/Ri08039/or10016.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	A preliminary study conducted in 2006 on Interstate 44 showed there was no statistically significant difference of success rate between guard cables installed on medians with flatter (≥6H:1V) and steeper slopes (<6H:1V). The main purpose of this study was to find out how median slopes influence guard cable effectiveness based on analysis of a larger data set on Interstate 70. A total of 521 survey forms representing the 521 identified crash sites were distributed to regional staff to collect median and crash data. Overall, median guard cable is an effective safety measure with an average of 95.6% success rate in preventing vehicles encroaching into opposing lanes along I-70. The success rates for guard cables installed on both steeper and flatter slopes are high, with 98.1% for steeper slopes and 93.9% for flatter ones. The fact that guard cable success rate for steeper slopes (<6H:1V) is not any lower than the rate for flatter slopes (≥6H:1V) showed that median slope does not solely affect guard cable effectiveness. Other factors

	(e.g., crash speed, collision angle, etc.) also contribute to the success or failure of median guard cable in keeping vehicles from encroaching into the opposite lane.

Project Title, ID, Cost, Duration	***The New Interstate 64 Economic and Regional Mobility Study*** ***Report number:*** RI07-047 ***Cost:*** : $897,421 ***Duration:*** 48 months
Submitter	***Agency, organization*:** Missouri Department of Transportation (MoDOT) ***Contact, e-mail:*** Mara Campbell, mara.campbell@modot.mo
Research program	***Sponsoring agency or organization:*** MoDOT
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	MoDOT embarked on a design-build project in the St. Louis area to reconstruct 10 miles of urban interstate highway, interchanges, and bridges. The objective of this research study is to provide a before, during, and after analysis of the economic dimensions, community issues, and regional mobility issues with the construction of the New Interstate 64 (I-64) Project in St Louis city and county. This research is interested in evaluating the following questions throughout the evaluation study: • How well did the full closure work? • How did the public and communities affected by the closure manage during the construction project? The following are the 5 key components to the research study, which is scheduled to be completed in fall of 2011: • Operational Efforts of New I-64

	• Economic Impact Assessment • Motorist Assist Assessment along Arterials • Communication Assessment of I-64 • Communication and Outreach Expectations to share findings after reopening

Project Title, ID, Cost, Duration	***Evaluation of Motorist Assist Return on Investment*** ***Report number:*** RD09-004 ***Cost:*** : $59,969.69 ***Duration:*** 6 months
Submitter	***Agency, organization*:** Missouri Department of Transportation (MoDOT) ***Contact, e-mail:*** Mara Campbell, mara.campbell@modot.mo
Research program	***Sponsoring agency or organization:*** MoDOT
Web link, if available	http://library.modot.mo.gov/RDT/reports//Rd09004/or10013.pdf http://library.modot.mo.gov/RDT/reports/RD09004/or10018.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	MoDOT embarked on a design-build project in the St. Louis area to reconstruct 10 miles of urban interstate highway, interchanges, and bridges. The objective of this research study is to provide a before, during, and after analysis of the economic dimensions, community issues, and regional mobility issues with the construction of the New Interstate 64 (I-64) Project in St Louis city and county. This research is interested in evaluating the following questions throughout the evaluation study: • How well did the full closure work? • How did the public and communities affected by the closure manage during the construction project?

	The following are the five key components to the research study which is scheduled to be completed in fall of 2011: • Operational Efforts of New I-64 • Economic Impact Assessment • Motorist Assist Assessment along Arterials • Communication Assessment of I-64 • Communication and Outreach Expectations to share findings after reopening

Montana Department of Transportation

Project Title, ID, Cost, Duration	***Local Transportation and Land Use Coordination: Tools and Gaps*** ***Report number:*** FHWA/MT-10-002/8195 (in press) ***Cost:*** $299,873 ***Duration:*** 21 months
Submitter	***Agency, organization:*** Montana Department of Transportation (MDT) ***Contact, e-mail:*** Sue Sillick, ssillick@mt.gov
Research program	***Sponsoring agency or organization:*** MDT
Web link, if available	http://www.mdt.mt.gov/research/projects/planning/smart_trans.shtml
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This research involved the development a toolkit of off-the-shelf policies, practices, analytic tools, and other ideas that can assist MDT and its local partners in expanding cities to better coordinate transportation and land use planning and decision-making. A successful research product will promote advance planning for future land use development with a process that encourages early engagement of MDT by local jurisdictions so that transportation impacts and needs can be avoided, minimized, and/or otherwise addressed. The toolkit and underlying research will produce benefits for MDT, local jurisdictions in Montana, and similar high-growth communities in other States. The research has the potential to deliver four key benefits: (1) provide tangible and proven guidance that MDT and local planning professionals can use to help frame discussions with local decision-makers, (2) increase opportunities for interagency communication and trust, (3) improve credibility with the general public, and (4) save money by reducing the need for retroactive (and very expensive) capacity increases on State highways in expanding urban areas.

National Cooperative Highway Research Program

Project Title, ID, Cost, Duration	***National Cooperative Highway Research Program (NCHRP) Project 09-12 resulting in NCHRP Report 452: Recommended Use of Reclaimed Asphalt Pavement in the Superpave Mix Design Method: Technician's Manual.*** ***Cost:*** $463,514 ***Duration:*** 2.5 years
Submitter	***Agency, organization:*** NCHRP, Transportation Research Board (TRB) ***Contact, e-mail:*** Crawford Jencks, cjencks@nas.edu
Research program	***Sponsoring agency or organization***. The NCHRP is administered by the TRB and sponsored by the member departments (i.e., individual State departments of transportation) of the American Association of State Highway and Transportation Officials (AASHTO) in cooperation with the Federal Highway Administration (FHWA).
Web link, if available	http://onlinepubs.trb.org/onlinepubs/nchrp/impacts/NCHRPImpacts_452.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This research led to modifications to three widely adopted AASHTO specifications on mix design and binder extraction. The research demonstrated that States could maintain quality while putting even more recycled material on the roads. To this day, States continue to rely on the report's methodology for blending old asphalt with new binder in their Superpave mix designs. NCHRP Report 452 has proved to be a valuable tool for long-time recyclers as well as those new to the practice.

Project Title, ID, Cost, Duration	***National Cooperative Highway Research Program (NCHRP) Project 14-13 resulting in NCHRP Report 511: Customer-Driven Benchmarking for Highway Maintenance Activities*** ***Cost:*** $300,000 ***Duration:*** 4 years
Submitter	***Agency, organization:*** NCHRP, Transportation Research Board (TRB) ***Contact, e-mail:*** Crawford Jencks, cjencks@nas.edu
Research program	***Sponsoring agency or organization.*** The NCHRP is administered by the TRB and sponsored by the member departments (i.e., individual State departments of transportation) of the American Association of State Highway and Transportation Officials (AASHTO) in cooperation with the Federal Highway Administration (FHWA).
Web link, if available	http://onlinepubs.trb.org/onlinepubs/nchrp/impacts/NCHRPImpacts_511.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Report 511 was among the first publications to document the concept of performance frontiers—graphical representations of the best practices that could be achieved using different levels of resources. The guide outlines the key concepts of benchmarking, including the use of performance measures and selection of benchmarking partners, and provides a step-by-step guide to implementation. According to practitioners, Report 511 was a springboard for defining common highway maintenance performance measures that can be used by multiple agencies. As more States adopt the measures, the usefulness of Report 511 for comparing performance and unearthing best practices will steadily increase.

Project Title, ID, Cost, Duration	***National Cooperative Highway Research Program (NCHRP) Project 17-10 and 17-10(02) resulting in NCHRP Report 494, Structural Supports for Highway Signs, Luminaires, and Traffic Signals*** ***Cost:*** $670,000 ***Duration:*** 5.5 years—total for original project (17-10) and follow-up 17-10(02)
Submitter	***Agency, organization:*** NCHRP, Transportation Research Board (TRB) ***Contact, e-mail:*** Crawford Jencks, cjencks@nas.edu
Research program	***Sponsoring agency or organization***. The NCHRP is administered by the TRB and sponsored by the member departments (i.e., individual State departments of transportation) of the American Association of State Highway and Transportation Officials (AASHTO) in cooperation with the Federal Highway Administration (FHWA).
Web link, if available	http://onlinepubs.trb.org/onlinepubs/nchrp/impacts/NCHRPImpacts_494.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	NCHRP work project 17-10 resulted in an extensive revision of AASHTO's support structure specifications in 2001, but several technical issues still needed to be resolved. NCHRP initiated a follow-up study, 17-10(02), to address these topics, including further research on wind loading, fatigue and vibration, and foundations and anchor bolts. Published as NCHRP Report 494, the study addresses 10 different design issues, and provides enhancements and improvements to the current structural supports specifications. Several of the results have been incorporated into the AASHTO specifications, while others will be part of future code revisions. As design specifications evolve, Report 494 promises to be influential for years to come.

New Hampshire Department of Transportation

Project Title, ID, Cost, Duration	***Estimating Flood Discharges at Selected Recurrence Intervals for New Hampshire Streams*** ***ID:*** U.S.G.S. Scientific Investigations Report 2008–5206 ***Cost:*** $130,000 ***Duration:*** 24 months
Submitter	***Agency, organization:*** New Hampshire Department of Transportation (NHDOT) ***Contact, e-mail:*** Glenn Roberts, Chief of Research, groberts@dot.state.nh.us
Research program	***Sponsoring agency or organization:*** NHDOT
Web link, if available	http://water.usgs.gov/osw/streamstats/new_hampshire.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Recently completed research provides a new tool for NHDOT to estimate flood discharges for New Hampshire streams. Using flow data and drainage basin characteristics from 117 streamgaged sites in and around the State, the project updated estimates of flood discharges at selected recurrence intervals for those sites and developed equations for estimating peak flows at ungaged, unregulated rural streams in New Hampshire. To make the information easily usable, a software program called StreamStats was developed. The StreamStats program allows the user to select a point on a waterway and see an estimate of the peak flows and other data for that location. The program uses U.S. Geological Survey (USGS) maps in conjunction with Geographic Information Systems data and terrain modeling to graphically delineate drainage areas and calculate flow estimates based on the equations developed through the project. StreamStats is flexible enough to allow the user to modify the drainage area if necessary. A report detailing the methods used to develop the flow estimation equations can be found on the USGS Web

	site at the URL provided above. The StreamStats application is Web-based and can be found at the same location.

Project Title, ID, Cost, Duration	***Hampton Airfield Preservation Study*** ***ID:*** FHWA-NH-RD-14282L ***Cost:*** $100,000 ***Duration:*** 18 months
Submitter	***Agency, organization:*** New Hampshire Department of Transportation (NHDOT) ***Contact, e-mail:*** Glenn Roberts, Chief of Research, groberts@dot.state.nh.us
Research program	***Sponsoring agency or organization:*** NHDOT
Web link, if available	http://www.nh.gov/dot/org/projectdevelopment/materials/research/projects/14282l.htm
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The number of general aviation airports in the United States is on the decline. In 2001, the Aircraft Owners and Pilots Association documented the annual closure rate for public-use airports at one every 2 weeks. In time, the loss of these airports affects facilities supporting commercial passenger service by leaving fewer airports to accommodate growing demand. Impacts to the transportation infrastructure are far reaching; while negative effects to commerce and local and National economies are certain, airport closures also threaten to undermine the community access provided by the industry. Hampton Airfield is a small but active facility located on the New Hampshire seacoast. With very limited outside financial support, the owners have heretofore endured many of the challenges facing similar airports. The NHDOT conducted a case study analyzing the various aspects of the airfield's operation including efforts to promote, preserve,

	and protect the facility amid growing pressures from non-aviation development. An *Airport Preservation Tool Box* was developed concurrently with the study as a resource for airport stakeholders and proponents. The success at Hampton Airfield has been due to the owner's ability to nurture a combination of diverse resources to generate the revenue required to maintain the airport's unique environment where aviation interests can be fostered, grown, and shared with others. While ongoing preservation will require a continuation of past efforts, changes in the industry and surrounding environment will also necessitate reliance on assistance and programs not controlled by the owner. The study includes recommended actions and champions to accomplish this goal.

New Jersey Department of Transportation

Project Title, ID, Cost, Duration	***New Jersey Motorcycle Fatality Rates*** ***Report Number:*** NJ-2010-003 ***Cost:*** $199,561 ***Duration:*** 18 months
Submitter	***Agency, organization:*** New Jersey Department of Transportation (NJDOT) ***Contact, e-mail:*** Edward Kondrath: ed.kondrath@dot.state.nj.us
Research program	***Research Program:*** NJDOT Bureau of Research ***Principal Investigator:*** Yusef Mehta, PhD. Rowan University
Web link, if available	http://www.state.nj.us/transportation/refdata/research/reports/NJ-20010-003.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	There are approximately 2,700 motorcycle crashes in New Jersey each year. The goal of this research was to investigate causes of motorcycle crashes and develop recommendations for reducing the number and severity of motorcycle crashes in New Jersey. Recommendations include a revision of the testing and training processes, increased motorcycle awareness amongst drivers, increased safety awareness amongst motorcyclists, and investigation of roadways identified as hazardous. Motorcyclists are vulnerable users of the road since motorcycles do not provide the same protection as cars or other vehicles. Moreover, motorcyclists are less conspicuous on the road, making them harder to see for other road users. Motorcycle crashes are caused by a combination of different factors, including motorcyclist behavior and experience, other driver behavior, and the road environment. Additionally, there are more fatal motorcycle collisions with guardrail than fatal car-guardrail collisions on the National level. Roadways are not typically designed with the special needs of motorcyclists in mind, as design factors that provide more safety to

	users of other vehicles may be more hazardous to motorcyclists. The objective of this project was to investigate and develop recommendations to reduce the number and severity of motorcycle crashes in New Jersey. To accomplish this objective, the research team: (1) assembled previous research regarding motorcycle training and motorcycle-guardrail collisions, (2) developed and implemented a survey to motorcyclists, rider coaches, and motorcycle dealerships in New Jersey, (3) analyzed National and Statewide trends in fatal motorcycle collisions, (4) conducted in-depth investigations of sites where motorcycle collisions with roadside objects occurred, and (5) located and analyzed high-risk crash sites across the State.

Project Title, ID, Cost, Duration	***Development of Falling Weight Deflectometer Procedures Manual*** ***Report Number:*** FHWA-NJ-2008-13 ***Project Cost:*** $90,423 ***Project Duration:*** 12 Months
Submitter	***Agency, organization:*** New Jersey Department of Transportation (NJDOT) ***Contact, e-mail:*** Vincent Nichnadowicz, vincent.nichnadowicz@dot.state.nj.us
Research program	***Research Program:*** NJDOT Bureau of Research ***Principal Investigator:*** Nenad Gucunski, PhD, Rutgers University, Center for Advanced Infrastructure and Transportation
Web link, if available	http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2008-013.pdf

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	State-of-practice in Falling Weight Deflectometer, (FWD) testing and analysis procedures were examined by looking at the standard protocols of a number of highway agencies. The specific needs of NJDOT also were examined and a protocol was developed that encompassed current standard practice in a way most suited to NJDOT operations. The final product was a customized FWD procedure manual. Using FWD analysis will result in more cost-effective rehabilitation decisions by providing information that can be used to match the treatment to the cause. FWD testing not only provides more accurate structural capacity assessment than traditional methods but also does so without having to further damage existing pavement structures.

Project Title, ID, Cost, Duration	***Manual of Guidelines for Inspection of Intelligent Transportation Systems Equipment & Facilities*** ***Report Number****:* NJ-2008-006 ***Project Cost****:* $358,483 ***Project Duration****:* 14 months
Submitter	***Agency, organization:*** New Jersey Department of Transportation (NJDOT) ***Contact, e-mail***: Nazhat Aboobaker, nazhat.aboobaker@dot.state.nj.us
Research program	***Research Program:*** NJDOT Bureau of Research ***Principal Investigator****:* Kaan Ozbay, PhD, Rutgers University
Web link, if available	

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Intelligent Transportation Systems (ITS) offers a valuable tool in ensuring the mobility and to improve the operations and management of our existing transportation facilities in New Jersey. ITS plays a pivotal role in ensuring increased efficiency and connectivity of the State's highway transportation system, which continues to evolve in order to respond to the challenges of an economically vibrant State such as New Jersey. Thus, given the high-density growth of the region, it is important to ensure that deployed ITS equipment works properly and efficiently. Central to this objective is the need for new tools that will provide the State with complete, practical, and efficient acceptance and/or inspection procedures for the proper installation and preventive and/or routine maintenance of its ITS equipment. The principal motivation of this study is to provide the New NJDOT with a state-of-the-art and practical software tool based on the ITS inspection (acceptance) and maintenance manual (ITSIMM) also developed in close collaboration with NJDOT. ITSIMM and its computer application, Rutgers ITS Inspection and Maintenance Software (RITSIMS), are needed by the department's inspectors and maintenance, and ITS design and traffic operations personnel, to assist them in effective inspection and maintenance of ITS equipment. These unique and valuable tools are expected to improve the productivity of NJDOT personnel in the field and thus save NJDOT time and money in the long run. Moreover, the state-of-the-art knowledge compiled in the form of a practical yet unique manual will be an important contribution to research and development for ITS. This study developed a state-of-the-art ITSSIMM and RITSIMS based on ITSIMM that are expected to serve as valuable resources to assist the NJDOT personnel in their daily activities of inspection and maintenance of ITS equipment.

Project Title, ID, Cost, Duration	***Water Level Determination for Transportation Projects: Mean High Water Manual*** ***Report Number:*** NJ-2007-014 ***Project Cost:*** $70,639 ***Project Duration:*** 3 years
Submitter	***Agency, organization:*** New Jersey Department of Transportation (NJDOT) ***Contact, e-mail:*** Robert Sasor, Robert.Sasor@dot.state.nj.us
Research program	***Research Program:*** NJDOT Bureau of Research ***Principal Investigator:*** Joshua Greenfeld, PhD, New Jersey Institute of Technology
Web link, if available	http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2007-014.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Determination of bridge clearance and the proper design of cofferdams, caissons, and bridge fenders over navigable rivers and other waterways are important public safety issues. An error in calculating or determining the correct bridge clearance and in determining the proper elevations of cofferdams, caissons, etc. could result in safety hazard conditions, property damage, or damage to the integrity of the transportation network. A minimum bridge clearance is calculated from tide observations, tide predictions, the expected life span of the structure and from an assessment of the size of vessels expected to travel beneath them. Using inappropriate procedures and old data that has not been properly documented and field verified could result in mistakes during construction leading to problems in the operation of waterways such as more restrictive usage. It could also create problems with regulatory agencies and it may impact on the rights of the public and adjacent owners. Not using the waterway to its fullest intent may, in turn, have a negative impact on the local

	economy. After an investigation of the many issues related to determining water level needs for transportation projects, the Mean High Water (MHW) Manual was developed to establish an accurate and uniform NJDOT procedure for determining water level as applied to safety, construction projects, and bridge clearance determination in tidal areas. NJDOT consultants and in-house staff use the MHW Manual as a general reference for work in areas subject to tidal waters. Use of the manual will reduce design and construction errors allowing rivers and other waterways to be used safely and fully, thereby avoiding property damage and negative impacts on the local economy. The MHW Manual is a supplement to the NJDOT Survey Manual.

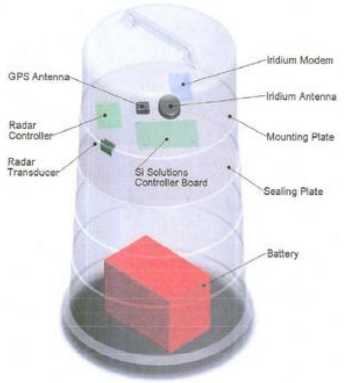
Project Title, ID, Cost, Duration	***Location of Highway Ramps and Schools*** ***Report Number:*** NJ-2009-002 ***Project Cost****:* $64,498 ***Project Duration:*** 14 months
Submitter	***Agency, organization:*** New Jersey Department of Transportation (NJDOT) ***Contact, e-mail****:* Stefanie Potapa, Stefanie.Potapa@dot.state.nj.us
Research program	***Research program:*** NJDOT Bureau of Research ***Principal Investigator****:* Christopher Lamm, Cambridge Systematics
Web link, if available	

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The objective of this project was to assist NJDOT in addressing the State legislation, A 856, which requires a Statewide study to identify public safety hazards posed by highway entry or exit ramps located within 1,000 feet of a school, and makes recommendations on how to avoid or minimize such hazards and ways to abate student pedestrian safety hazards. The research involved a literature review and examination of case studies to determine best practices to address safety hazards associated with ramps located near schools. A Geographic Information Systems (GIS) analysis identified schools located near highway ramps, and identified accidents involving pedestrians age 18 and under near ramps Statewide, which occurred during school commuting hours, defined as the periods between 6 a.m. to 9 a.m. and 2 p.m. to 5 p.m. The data analysis led to the development of a list of the top 25 high-risk schools throughout the State. The study team selected three schools from the top 25 high-risk schools list, which represented a variety of ramp types, accident types and severity, and geographic diversity. The three schools served as case studies for the Implementation Task of this study, through which detailed research into the causes of the accidents, supplied by detailed police reports and interviews with school officials, and analysis of the physical environment, traffic control, school-sponsored education, or pedestrian and bicycle policies were assessed. The product of this task was a toolbox of mitigation strategies that could be applied in various environments and situations. The toolbox will allow NJDOT and other stakeholders to select infrastructure, education and encouragement, and enforcement strategies to protect bicyclists and pedestrians who travel across or near ramps on their way to school.

Project Title, ID, Cost, Duration	***Flexible Overlays for Rigid Pavements*** ***Project Number:*** FHWA-NJ-2009-014 ***Project Cost:*** $668,682 ***Project Duration:*** 2 years
Submitter	***Agency, organization:*** New Jersey Department of Transportation (NJDOT) ***Contact, e-mail:*** W. Lad Szalaj, lad.szalaj@dot.state.nj.us
Research program	***Research Program:*** NJDOT Bureau of Research ***Principal Investigator:*** Thomas Bennert, PhD, Rutgers University
Web link, if available	http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2009-014.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Approximately 45 percent of the NJDOT's roadways are composite—hot mix asphalt (HMA) overlying Portland cement concrete (PCC). HMA is used as the overlying material because of its inexpensive nature when compared to most PCC rehabilitation/reconstruction alternatives. In addition to being economical, HMA also allows faster repairs resulting in shorter construction duration and lower "user" delay costs. However, due to the majority of the PCC pavements being in average to poor condition, many HMA overlays are exposed to extreme movements (both vertical and horizontal). The combination of associated load and environmentally induced movements creates complex stresses and strains in the vicinity of expansion joints and cracks in the PCC, thus dramatically reducing the life of the HMA overlay, typically in the form of reflective cracking. It should be noted that there currently does not exist an American Association of State Highway and Transportation Officials accepted pavement design method for the pavement design of composite pavements. This research project was undertaken to evaluate how the NJDOT can optimize the use of HMA overlays when rehabilitating PCC/composite pavements. Field test sections were evaluated and instrumented to measure the PCC joint movements and pavement specific traffic conditions. Asphalt mixtures placed on the test sections were sampled and evaluated under

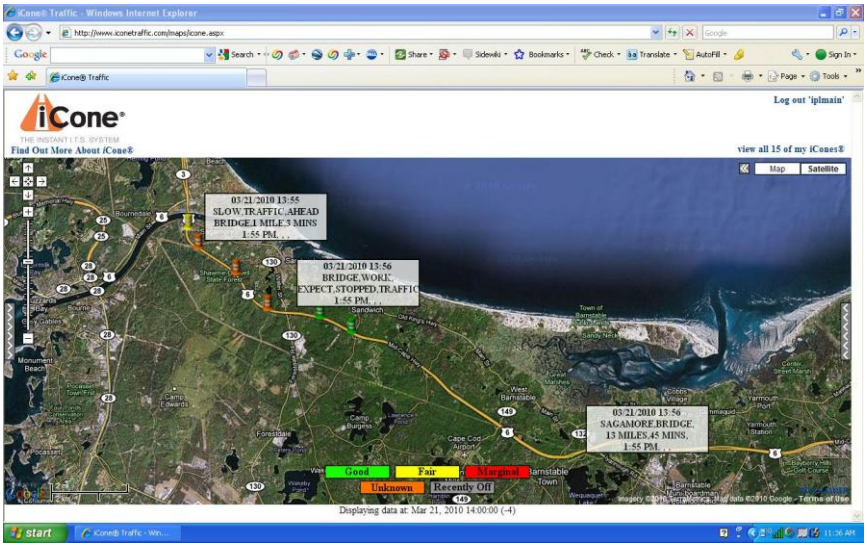
	laboratory tests that model field movements and conditions. The collected field and laboratory data, as well as collected Literature Review information and National Survey information, provided valuable information used to develop an asphalt mixture design and selection procedure for the NJDOT. A final asphalt overlay/mixture selection process was developed to allow State agencies to select more appropriate asphalt mixtures than can withstand the vertical and horizontal modes of deflection at the PCC joint/crack that result in reflective cracking.

New York State Department of Transportation

Project Title, ID, Cost, Duration	***Universal Real Time Highway Information System Development*** ***Project Cost:*** $650,000 (combined Department of Transportation, New York State Energy Research and Development Authority and Grant funding) ***Project Duration:*** February 2006–October 2008
Submitter	***Agency, organization:*** New York State Department of Transportation (NYSDOT) ***Contact, e-mail:*** Rick McDonough, rmcdonough@dot.state.ny.us NYSDOT, Office of Modal Safety and Security
Research program	***Sponsoring agency or organization:*** NYSDOT Contract Research
Web link, if available	http://www.iconeproducts.com/
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results 	The iCone was developed as a separate project within the original project. The iCone is a device that beams real-time traffic information over the Internet to a central Web site for use by government officials, emergency response personnel, trucking fleets, the public and information resellers, including media outlets and Global Positioning System (GPS) services like Garmin. The iCone is a fully autonomous system that simplifies work-zone Intelligent Transportation Systems down to the literal flip of a switch providing all stakeholders in the highway and traffic community with visibility into the conditions at the work site. The product is comprised of a highway construction barrel with a computer chip, circuit board, GPS device, radar sensor and networking capability inside. The device is the only one of its kind, has been crash test approved by the Federal Highway Administration, and currently is under evaluation by seven State Departments of Transportation. The iCone completed its field testing with the New York State DOT in the fall of 2008. The iCone traffic beacon features: simple operation; autonomy (operates for weeks without recharging); universal coverage (every road in North

America); high accuracy positioning (GPS identifies the exact lane that is closed); traffic speed detection (congestion measured by transmitted average speeds); durable construction; full support lease arrangement; and data processing (traffic reporting and monitoring).

The iCone allows the project engineers to monitor and analyze traffic conditions in the work-zone in real-time. With clear knowledge of the congestion, queuing and delay in work-zones the work-zone traffic engineers are able to adapt traffic control plans to balance the traffic impact with the safety and productivity of the project. Because the iCone system is Web enabled the Traffic Management Centers and the 511 system can tap this traffic data resource and the law enforcement community can deploy assets strategically, saving thousands of dollars.



Project Title, ID, Cost, Duration	***Pathogen Analysis of New York State Department of Transportation Road-Killed Deer Carcass Compost Facilities*** ***Project cost:*** $269,055 ***Duration:*** September 2005–December 2008
Submitter	***Agency, organization:*** New York State Department of Transportation (NYSDOT) ***Contact, e-mail:*** Elisabeth Kolb, ekolb@dot.state.ny.us NYSDOT Office of Operations
Research program	***Sponsoring agency or organization:*** NYSDOT Contract Research
Web link, if available	Link to final report: http://cwmi.css.cornell.edu/TIRC/temperaturepathogen.pdf Link to other project information and training materials: http://cwmi.css.cornell.edu/tirc.htm
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Over 25,000 dead deer are managed annually by NYSDOT. This does not include deer killed on county and local roads managed by local highway departments or other wildlife like raccoon, coyote, etc. This research project showed that static pile composting of deer carcasses is an effective road-kill deer disposal method, effectively reducing pathogen levels and produces a useable end product. The static pile composting process envelopes road-killed deer in woodchips and allows piles with natural air circulation to sit undisturbed. Worker health and safety concerns were addressed and composting was determined to be safe; a health and safety bulletin was updated based on findings and circulated to the labor force. Composting was found to be an environmentally beneficial carcass disposal method for other road-kill animals as well, such as bear, raccoon, and fox. To date, at least 23 NYSDOT maintenance facilities have started compost facilities where setback and space guidelines can be met. Savings are achieved by eliminating deer pit construction (savings in labor and equipment), reducing trips to the landfills and tipping fees and eliminating the need for deer pick-ups by contractors, which can cost $30–$100 per deer. Although exact tracking of savings in labor and

equipment hours have not been made, conservative estimates by regional representatives report a combined savings of $120,000 per year in reduced tipping fees and contractor cost. Expanded across the State and including the county local highway departments the annual savings will be significant.

Properly managed compost piles do not pose a threat to groundwater and surface water, which is an inherent risk in deer pitting or surface disposal. The end product is achieved after 12 months of active composting and serves as an excellent soil amendment along the highway right-of-way in low public contact settings. Grass and plant establishments with this compost material have been highly successful including stabilization of steep slopes and erodible areas. To date, the practice has been in employed by municipal highway departments in New York State and elsewhere. Many do not have feasible disposal options as many landfills are no longer accepting carcasses and composting offers the only alternative.

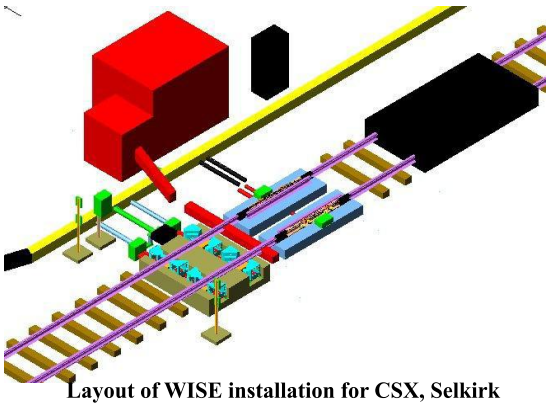
Photo: NYSDOT Highway Maintenance Supervisor Mike Augustine and Assistant Resident Engineer Tom Story monitor the temperature of a compost pile in Highland, NY. The pile contains 700 deer carcasses.

Project Title, ID, Cost, Duration	***Development of a Commercial Vehicle Electronic Screening System with High Speed Weigh-In-Motion along Westbound Interstate 90, Schodack, NY*** ***Cost:*** $1,141,300 (NYSDOT in partnership with Office of Modal Safety and Security, Federal Highway Administration, Federal Motor Carrier Safety Administration, New York State Energy Research and Development Authority, Interstate 95 Corridor Coalition) ***Duration:*** April 2003–April 2010
Submitter	***Agency, organization:*** New York State Department of Transportation (NYSDOT) ***Contact, e-mail:*** Rick McDonough, rmcdonough@dot.state.ny.us NYSDOT, Office of Modal Safety and Security
Research program	***Sponsoring agency or organization:*** NYSDOT Contract Research
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	To develop and assess a cost effective mainline commercial vehicle screening system that will automatically identify the vehicle through transponder or license plate readers, weigh the truck at high speed using Weigh In Motion (WIM) technology, and provide a credential review for compliance and enforcement operations by NYSDOT and the New York State Police. Plans are being advanced to install similar devices with Statewide partners including the New York State Thruway Authority and New York State Bridge Authority. The Department wants to determine which type of the three WIM technologies (piezo, quartz, and load cell) is most effective, including considerations of cost, installation, maintenance, operation, performance, and pavement, weather and other variables impact on accuracies and performance over time. Mainline commercial vehicle screening is an effective tool that improves the effectiveness of roadside enforcement. Commercial vehicles pose a significant threat in terms of safety, security, and life cycle costs of bridges and pavement. Increased use of these technologies will result in a safer and more compliant fleet operating in New York State while reducing damage to pavement and bridges. The fully automated and functional e-screening

system should be handed over to the New York State Police to be used for roadside enforcement April 2010.

While this project is still underway, initial results have helped the department select the WIM technology that it is deploying at other locations.

There are four more sites identified for installation including one at the Newburgh Beacon Bridge. Another two dozen sites are expected to be added to the program over the next 3–5 years using the New York State Transportation Investment Generating Economic Recovery grant application as the backbone of the near term business plan. E-Screening systems help remove overweight and unsafe vehicles from the highway, saving millions of dollars annually in accident avoidance, accident related congestion and increased bridge and pavement life cycle costs while reducing the industries cost of operations as well as heavy vehicle emissions and fuel use.

Project Title, ID, Cost, Duration	***Wheel Inspection System Environment Qualification and Validation*** ***Cost:*** $329,994 [New York State Department of Transportation (NYSDOT) and New York State Energy Research and Development Authority (NYSERDA) joint funding] ***Duration:*** June 2006–December 2008
Submitter	***Agency, organization:*** NYSDOT ***Contact:*** Zack Mian, International Electronic Machines Corp., 518-268-1636
Research program	***Sponsoring agency or organization:*** NYSDOT Contract Research
Web link, if available	https://www.nysdot.gov/divisions/engineering/technical-services/trans-r-and-d-repository/WISE%20Final%20Report%20for%20NYSDOT.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	International Electronic Machines Corporation (IEM) has developed and is now marketing a state-of-the-art Wheel Inspection System Environment (WISE). WISE provides wheel profile and dimensional measurements, i.e. rim thickness, flange height, flange thickness, flange angle, diameter, reference groove; brake pad thickness measurements; and flags out-of-round wheels and flat spots. WISE provides modules for wheel profile, crack detection, flat spot detection, and brake pad management system. It easily integrates with existing way-side equipment and works seamlessly with existing railroad rolling stock management systems.  **Layout of WISE installation for CSX, Selkirk**

During the course of this project, IEM has installed, tested, and achieved a successfully functioning WISEt at the CSX hump yard in Selkirk, New York. The system has been proven a reliable means of profiling wheel measurements and brake pad thickness through an abundance of data. At the Selkirk Yard, WISE inspects on average 12,000 wheels each day. Without the WISE system one employee could inspect about 100 wheels each day. The Crack Detection module has shown the ability to collect data that indicates a flawed wheel, but has yet to go on line at the Selkirk yard. IEM is working to improve the module's durability and noise filtering so that it can survive in a freight train environment. The Crack system is expected to perform successfully in the cleaner transit environment.

The Profile module measuring the wheels of a passing freight train

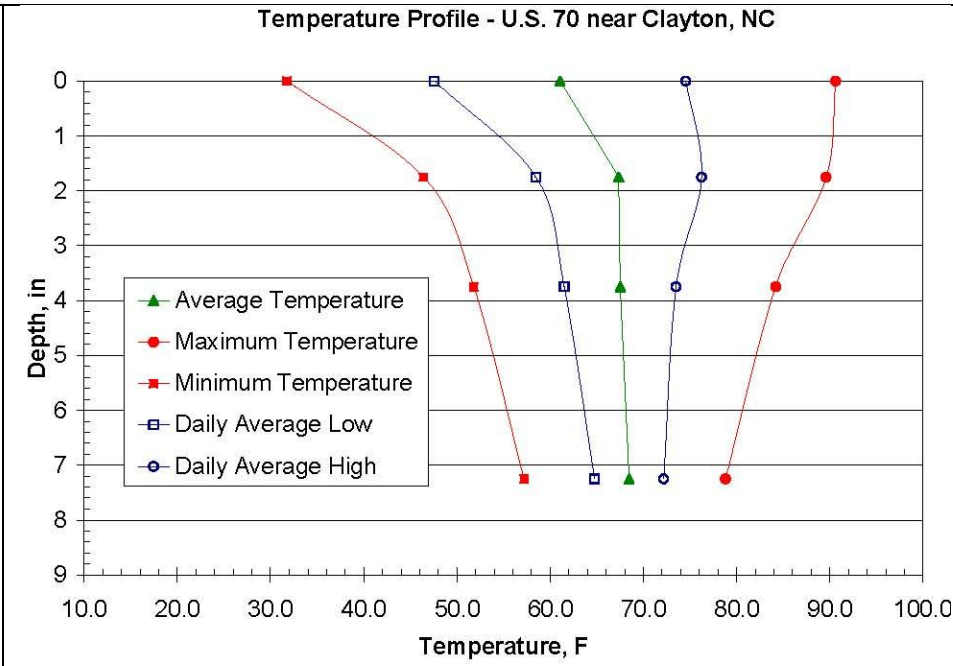
The final report (link below) details the thorough testing and validation of these modules through the project that was funded jointly by NYSERDA and NYSDOT. WISE has subsequently been installed at two additional CSX hump yards in Georgia and Ohio and at a new transit maintenance facility in Sydney, Australia. They are installing, with CSX, the first "Super Site" for high-speed railroad wheel/brake/bearing inspection at Voorheesville later this spring. This system incorporates several of the technologies developed for the earlier work at Selkirk but has been upgraded for use at the higher speeds typical of the main line rail. Additional sales are pending.

North Carolina Department of Transportation

Project Title, ID, Cost, Duration	***Subgrade Stabilization Alternatives to Lime and Cement*** ***ID***: FHWA/NC/2007-11 ***Cost:*** $310,723 ***Duration:*** 40 months
Submitter:	***Agency, organization:*** North Carolina Department of Transportation (NCDOT) Research Unit ***Contact, e-mail:*** Ernest Morrison, P.E., eemorrison@ncdot.gov
Research program:	***Sponsoring agency or organization:*** NCDOT
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This project involved four distinct research activities: (1) the influence of temperature on lime-stabilized soils, (2) the influence of temperature on cement-stabilized soils, (3) temperature modeling of stabilized subgrade, and (4) use of calcium chloride to accelerate strength gain of cement-stabilized soils. Significant conclusions from the lime-focused research include that the minimum lime content of a soil increases as temperature decreases. Overall, these results suggest that current specifications may be modified to allow lime stabilization to proceed in cooler temperatures, provided a corresponding increase in curing time and/or thermal protection is provided prior to loading. The soil cement data indicate that curing soil-cement at lower temperatures will result in lower strengths. Results indicate that the mean strength at 3 days is 84 percent to 93 percent of that for 7 days, in support of a potential change in current subgrade evaluation practice predicated on the longer duration. Specifications for stabilization work have often been based on air temperature measurements, however the performance of lime or cement

	treated soil is expected to be more closely related to the in situ temperature. A computer application was developed to use the model to make predictions of subgrade temperatures and cured strength. This research has the potential to allow for more efficient and expanded time frame cold weather road construction operations. This research could result in quicker completion of road construction projects and reduced construction costs.

Picture:



Project Title, ID, Cost, Duration	***Placement of Detection Loops on High Speed Approaches to Traffic Signals*** ***ID:*** FHWA/NC/2007-13 ***Cost:*** $130,000 ***Duration:*** July 2006–August 2009 (37 months)

Submitter	***Agency, organization:*** North Carolina Department of Transportation (NCDOT) Office of Research ***Contact, e-mail:*** Neal Galehouse, P.E., nlgalehouse@ncdot.gov
Research Program	***Sponsoring agency or organization:*** NCDOT
Web link	https://apps.dot.state.nc.us/Projects/Research/ProjectInfo.aspx?ID=2181
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This study focused on improving the way NCDOT provides for safe and efficient operation of signalized intersections in rural areas. The safety concern relates to high-speed right-angle, rear-end, and other collisions that occur because motorists are not expecting to see a signal, let alone one that is displaying yellow or red. The challenge is for the signal control strategy to prevent vehicles from being in dilemma zones, where the motorist is not sure whether to continue or stop, when the transition to yellow occurs, while not compromising efficient operation. Currently, NCDOT treats such situations by adding advance vehicle detection using the NQ4 system, flashers and warning signals, and other site-specific improvements as a supplement to volume-density control. Thus, the question was this: Is there a better way to provide protection that is less costly, more effective, and simpler? A survey of best practice suggested that the Detector-Control System (D-CS) developed by Bonneson *et al*. (2002) would be worth testing. It seemed to produce good results, be robust in its impacts, and be simple to implement. It also seemed likely to be cost effective since it did not involve more sensors than NCDOT presently uses for the NQ4 installations. Both the hardware-in-the-loop simulation tests and the field studies showed that the D-CS system did work well. It reduced the likelihood that vehicles are caught in dilemma zones at the onset of yellow, and it did so without compromising efficiency. Moreover, cycle lengths did not increase after D-CS was introduced. In contrast to the NQ4 system, which was also tested, and did quite well, both in simulation and in the field, D-CS tended to produce shorter cycle lengths (more efficient and responsive operation) and it did a slightly better job of ensuring that no vehicles were in dilemma zones at the onset of yellow. The project included a benefit-cost assessment, which was predicated on the hardware-in-the-loop simulation results, found that the D-CS system had a high payoff. It produced BC ratios significantly greater than 1.0

	and the ratios were higher for the D-CS system than for the NQ4 system. Using site specific data, the researcher estimated when accounting for cost of controller installation, crash reduction, and user delay, (assuming a 5 percent crash reduction) the average site would see a net benefit of between a few thousand dollars per year, up to $400,000 by installing the D-CS system.

Project Title, ID, Cost, Duration	***Stilling Basin Design and Operation for Water Quality: Field Testing*** ***ID:*** FHWA/NC/2007-02 ***Cost:*** $70,000 ***Duration:*** July 2007 to June 2008 (12 months)
Submitter	***Agency, organization:*** North Carolina Department of Transportation (NCDOT) Office of Research ***Contact, e-mail:*** Mustansir Kadibhai, P.E., mkadibhai@ncdot.gov
Research Program	***Sponsoring agency or organization:*** NCDOT
Web link	https://apps.dot.state.nc.us/Projects/Research/ProjectInfo.aspx?ID=1921
Brief Summary	Many construction projects involve the need to pump turbid water from borrow pits or other excavations into stilling basins or sediment bags prior to discharge. The design and operation of these basins needs to be optimized to provide the best water treatment prior to discharge. This project was designed to provide an evaluation of stilling basin designs and polyacrylamide (PAM) injection to minimize turbidity in discharged water. A Piedmont subsoil was mixed with water in a large holding pond that served as a source of the turbid water that was pumped into the stilling basin. Initial turbidities were in the range of 250–400 nephelometric turbidity units (NTU) in the source basin. Physical changes to the open basin, both with porous baffles and

	distribution along the bottom, significantly reduced turbidity or total suspended solids in the stilling basin, but the highest reduction was only 25 percent. Chemical treatment with PAM reduced turbidity and TSS by up to 88 percent and 84 percent, respectively, with little effect from the baffles or bottom spreader. Both types of PAM dosing systems worked well. There was some evidence that flocs formed after PAM treatment were intercepted by the dam slope. The porous baffle with 10 percent open pore space was significantly more effective than the baffle with 45 percent open pore space, but only when no PAM was added. The PAM treatments were highly effective and should be relatively simple and economical to use to reduce turbidity in pumped water. This research demonstrated that chemical treatment could be relatively simple and effective in reducing turbidity in pumped water. This can be implemented in most pumped water operations. Direct cost savings are difficult to calculate since much of the savings are in reduced fines and stop work orders fewer complaints that require a response. Common filtration systems typically cost $5,000 to $10,000 per month to rent and operate, easily 10 times more than the proposed systems tested. In addition, reduced impacts on aquatic environments would also be a financial benefit to the State.

Ohio Department of Transportation

Project Title, ID, Cost, Duration	***Relationship Between Skid Resistance Numbers Measured With Ribbed and Smooth Tire and Wet Accident Locations*** ***ID:*** FHWA/OH-2008/11 ***Cost:*** $109,999 ***Duration:*** 23 months
Submitter	***Agency, organization:*** Ohio Department of Transportation (ODOT), Office of Innovation Partnerships and Energy, Innovation Research and Implementation Section ***Contact***: Jennifer Gallagher, 614-644-5928
Research program	***Sponsoring agency or organization:*** ODOT, Office of Innovation Partnerships and Energy, Innovation Research and Implementation Section
Web link, if available	http://www.dot.state.oh.us/Divisions/TransSysDev/Research/reportsandplans/Pages/PavementReportsDetail.aspx#134323
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	ODOT initiated this research to determine if surface friction testing results can be correlated to wet weather crash data in Ohio. Testing with both the ribbed and smooth tire was conducted to determine if one is more suitable in developing reliable correlations. The establishment of such correlations would aid in the development of a proactive wet-pavement accident reduction program that would effectively predict locations where wet-pavement crashes may likely occur. The products of this research effort are intended to help refine ODOT's surface characteristics testing program so that the most effective testing methods and procedures are employed. These results should improve safety and help ODOT achieve the long-term goal of reducing total crashes by 10 percent and rear-end crashes by 25 percent by the year 2015. This research contributes to the overall goal of achieving an

	integrated transportation system and taking a holistic view to pavement management.

Project Title, ID, Cost, Duration	***Performance Assessment of Warm Mix Asphalt Pavements*** ***ID:*** FHWA/OH-2009/08 ***Cost:*** $250,223.39 ***Duration:*** 38 months
Submitter	***Agency, organization:*** Ohio Department of Transportation (ODOT), Office of Innovation Partnerships and Energy, Innovation Research and Implementation Section ***Contact:*** Jennifer Gallagher, 614-644-5928
Research program	***Sponsoring agency or organization:*** ODOT, Office of Innovation Partnerships and Energy, Innovation Research and Implementation Section
Web link, if available	http://www.dot.state.oh.us/Divisions/TransSysDev/Research/reportsandplans/Pages/PavementReportsDetail.aspx#134312
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	ODOT initiated this research to evaluate the engineering and physical properties of warm mix asphalt (WMA) mixtures, both in the laboratory and in the field, and compare these properties to conventionally used hot mix asphalt (HMA) pavements. Based on the observed response and performance measurements, WMA performed at least as well as the HMA control mix. In addition, all three of the tested WMA mixes could be placed at significantly lower temperatures and produced reduced emissions at the paving site, leading to reduced costs. The application at a lower temperature also provides a safer environment for road crews working with the product. WMA demonstrated its ability for reducing energy consumption and emissions with no loss of pavement quality and no significant negative issues have turned up in performance to date. As a result, ODOT has

	revised its construction specification #401.05 to allow for the use of specific WMA technologies. The specification includes equipment requirements for asphalt plants and instructions for how WMA can be utilized in mix designs.

Project Title, ID, Cost, Duration	***Effectiveness of Noise Barriers Installed Adjacent to Transverse Grooved Concrete Pavement*** ***ID:*** FHWA/OH-2009/12 ***Cost:*** $192,307.96 ***Duration:*** 21 months
Submitter	***Agency, organization:*** Ohio Department of Transportation (ODOT), Office of Innovation Partnerships and Energy, Innovation Research and Implementation Section ***Contact:*** Jennifer Gallagher, 614-644-5928
Research program	***Sponsoring agency or organization:*** ODOT, Office of Innovation Partnerships and Energy, Innovation Research and Implementation Section
Web link, if available	http://www.dot.state.oh.us/Divisions/TransSysDev/Research/reportsandplans/Pages/EnvironmentalReportsDetail.aspx#134365
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	ODOT initiated this research to support the Federal Highway Administration in its effort to provide accurate noise predictions from the Traffic Noise Model when modeling highways constructed with random transverse grooved concrete pavement types. During the contract period, ODOT elected to re-texture the surface of a portion of Interstate 275 through diamond grinding. The project was initiated in an effort to mitigate tire pavement noise and thus address the complaints of the residents living adjacent to the highway. In order to quantify the effectiveness of the diamond grinding the project scope for this research was expanded to compare the noise results before and after

	the diamond grinding. The research findings indicated that diamond grinding should be considered as a mitigation measure for locations where ODOT is concerned about traffic noise levels at sites with random transverse grooved concrete pavement. These results were used to support a proposed modification to specification #451.09. The modification voids the use of transverse grooved concrete pavements on noise sensitive projects and encourages the use of diamond grinding on existing sections, even in the presence of noise barriers, to reduce noise.

Oklahoma Department of Transportation

Project Title, ID, Cost, Duration	***Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Preservation Tool*** *~Research in Progress~* ***Cost:*** FFY2009: $92,854, FFY2010: $17,950 (managed in-house, part time, with most industry materials and labor provided at no cost) ***Project Duration:*** 3 years
Submitter	***Agency, organization:*** Oklahoma Department of Transportation (ODOT) ***Contact, e-mail:*** Caleb Riemer, P.E., criemer@odot.org
Research program	***Sponsoring agency or organization:*** ODOT State Planning & Research Program Part 2 FFY2010
Web link, if available	http://www.okladot.state.ok.us/hqdiv/p-r-div/spr-rip/spr-pdf/spr.pdf Publication page 62 (pdf file page 70)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	With the decline in the condition of the Nation's transportation infrastructure, pavement preservation has become an essential component to every State department of transportation's program. Small States, like Oklahoma, have annual construction budgets that are much smaller than larger States and as a result, preserving the State's infrastructure is doubly important. Unfortunately, true pavement maintenance/preservation research has been limited to investigatory material science across the United States, which while valuable, does not usually provide the technical and more importantly, financial information that pavement managers need to make informed decisions. This project builds on research done in Australia and New Zealand by conducting a long-term study of 23 methods to restore pavement skid resistance by retexturing the existing surface with either a surface treatment, chemical treatment, or a mechanical process. It will furnish

	ODOT with the technical engineering data for each treatment coupled with an economic analysis of the costs and benefits associated with each treatment. The project is designed to provide ODOT pavement managers the required information to make rational engineering decisions based on both physical and financial data for the use of potential pavement preservation tools, evaluated in the field under identical traffic and environmental conditions, over the same period by an impartial investigator.

Pennsylvania Department of Transportation

Project Title, ID, Cost, Duration	***Research Implementation Activities*** ***ID:*** 5R-10 ***Cost:*** $1,271,461.78 ***Project Duration:*** 2/15/07–2/14/10
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final Report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	PennDOT Research & Innovation Implementation Program. The goals of the program include: • Identify innovations for implementation • Communicate research results & innovations Statewide • Facilitate practical use of innovations Through this project, PennDOT has been able to implement several successful, high impact projects, including the deployment of the following: • Bridge Maintenance Academy • Pavement Maintenance Academy • Pavement Marking Handbook & Training Course • Defensive Driving Training Course

	• Engineering & Traffic Studies Training Course • PennDOT Challenge Exam Study Guides • Local Transportation Project Process Manual • Winter Leadership Presentations Finally, the Research & Innovation Implementation Program has been responsible for the development of PennDOT's Winter Services Strategic Plan. This plan addresses key issues such as situational awareness, contingency planning, equipment and staffing, communication, performance measurement, best practices, and advanced technology opportunities.

Project Title, ID, Cost, Duration	***School Bus Drivers' Safety Training*** ***ID:*** 071201 ***Cost:*** $149,729.27 ***Project Duration:*** 9/2/08–11/1/09
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be access via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Pennsylvania continues to be a leader in the area of pupil transportation safety. The Commonwealth is one of only a few States that mandate school bus drivers to complete an initial and refresher school bus driver training course. As part of an ongoing effort to improve school bus safety, PennDOT was interested in improving the school bus driver training curriculum to ensure that school bus drivers have all the

	necessary information to drive safely. Through this project, the updated curriculum created addresses student management and discipline, student loading and unloading procedures, transportation of exceptional children, preventative maintenance, driving fundamentals, crash and emergency procedures, as well as handling student emergencies. To facilitate this, the effectiveness of the curriculum was evaluated and improvements were identified that were subsequently incorporated into the School Bus Driver's Manual.

Project Title, ID, Cost, Duration	***Research of Current Practices in Pavement Performance Modeling*** ***ID:*** 080307 ***Cost:*** $100,702 ***Project Duration:*** 6/1/09–2/28/10
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Within pavement management systems (PMSs), pavement performance models are used for the following activities: • Estimating future pavement conditions • Identifying the appropriate timing for pavement maintenance and rehabilitation actions • Identifying the most cost-effective treatment strategy for pavements in the network • Estimating Statewide pavement needs required to address agency-specified goals, objectives, and constraints

	• Demonstrating the consequences of different pavement investment strategies In anticipation of developing pavement performance models, PennDOT initiated a study to investigate performance modeling activities and condition information used by other State highway agencies and to obtain recommendations on how to proceed with their own modeling efforts. The findings and recommendations of the study are detailed in the final report of the project.

Project Title, ID, Cost, Duration	***Study of Bead Gun Angle When Applying Glass Beads on Waterborne Paint*** ***ID:*** 510401 WO 16 ***Cost:*** $200,887 ***Project Duration:*** 4/9/08–10/8/09
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Retroreflectivity of pavement markings is an important measure of their nighttime effectiveness. In Pennsylvania, retroreflectivity is achieved by placement of spherical glass beads in the pavement markings paint using a bead gun attached to a paint truck. The purpose of this project was to investigate the application angle of glass beads on waterborne paint to determine which angle(s) result in optimal bead embedment and maximize pavement marking retroreflectivity and visibility from a paint truck moving at various

	speeds. Through analysis, the results indicate that the 12 mph truck application speed and -20 degree bead gun angle provides the optimal nighttime visibility based on laboratory and field evaluations performed.

Project Title, ID, Cost, Duration	***Repair Methods for Prestressed Girder Bridges*** ***ID:*** 510601 WO6 ***Cost:*** $91,628 ***Project Duration:*** 11/1/07–6/30/09
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Prestressed concrete bridges throughout Pennsylvania and the Nation are exhibiting signs of deterioration and distress. Recent catastrophic collapses have led to a re-evaluation of the condition of many prestressed structures resulting in new postings and in some cases emergency decommissioning of structures. Although there are many research and case studies addressing repair of prestressed bridge girders, there is little comprehensive guidance available. The purpose of this project was to provide an extensive state of the art and state of the practice review of both assessment and repair techniques suitable for damaged prestressed concrete bridge systems in order to prepare a "best practices" guide for the same. The emphasis was placed on structural load bearing repair techniques rather than simply aesthetic repairs. Recommendations from the report have been organized into three general topics: bridge inspection, bridge rating and assessment, and repair design selection criteria.

Project Title, ID, Cost, Duration	***Market Analysis of Construction Materials*** ***ID:*** 510601 WO16 ***Cost:*** $170,924 ***Project Duration:*** 7/15/08–1/14/10
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Due to the volatility of current highway construction commodity prices, owners, contractors, and designers are facing serious challenges in both short term and long term planning. Among these challenges is significant uncertainty about the prices and availability of critical highway construction materials. At the same time, nearly all facets of infrastructure in the United States require redesign, expansion, or repair. Planners need to make decisions that maximize the value of investment dollars while at the same time considering the environmental and human factors associated with that investment. One way to reduce the uncertainty and make better investment decisions is by studying the past, present and future commodity prices and availability. The purpose of this project was to perform a market analysis and forecast for key commodities used in the highway and bridge construction industries in Pennsylvania. The focus to date centered on oil and its inherent relationship to asphalt, concrete, cement and aggregates, and steel. The project should serve as a basis for recommendations on future commodity use, new technologies, environmental issues, and construction practices and/or substitution commodities for PennDOT to consider for future development.

Project Title, ID, Cost, Duration	***Biodiesel Fuel Feasibility Study*** ***ID:*** 510601 WO17 ***Cost:*** $272,068 ***Project Duration:*** 6/25/08–4/24/10
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	PennDOT has recently undertaken a pilot study in Engineering District 8 (south-central Pennsylvania) investigating the use of biodiesel in its existing fleet. The experiences of District 8 will assist other districts in its potential biodiesel usage. The objective of this project was to assist PennDOT during their District 8 pilot fleet transition to biodiesel. During the project, PennDOT was provided information and recommendations on best practices for biodiesel (B5) implementation and for other possibilities for biodiesel implementation including additional biodiesel formulations (e.g., B20, B100) and the relationship between manufacturers' recommendations and warranties. The analysis also included information on the economic impacts and environmental impacts, along with evaluating performance, for the pilot study and Statewide implementation.

Project Title, ID, Cost, Duration	***Remote Sensing for Bridge Scour Projects*** ***ID:*** 510601 WO18 ***Cost:*** $119,826 ***Project Duration:*** 6/1/08–7/31/09
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	A large percentage of bridges within the State of Pennsylvania are located over waterways. For such bridges, much of the supporting structure is positioned within the river or stream bed of the waterway. As a result, these bridges are susceptible to bridge scour, the washing away of fill around structures, which compromises the safety of the structure. Bridge inspections have a limited frequency at which they can occur. In between these inspections, unmonitored and difficult to detect events may happen which create an immediate danger to the general public. The purpose of this project was to create a prototype system for bridge scour monitoring that could provide continuous monitoring. The technique utilized for this particular bridge scour monitoring was detection using float out devices. To realize this technique, a prototype remote sensing system was designed to have three main components that would work together to indicate bridge scour.

Project Title, ID, Cost, Duration	***Evaluation of Striped Vertical Panels in Temporary Traffic Control Zones*** ***ID:*** 510602 WO3 ***Cost:*** $256,405 ***Project Duration:*** 4/16/07–4/15/09
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation (PennDOT) ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	When drivers are passing through a lane-closure work zone that extends through their exit or intersection, they must be able to determine where the exit is along the string of orange and white drums or panels. Often the only cue is a break between the devices. The foreshortening effect of viewing devices from the roadway makes it difficult to find that break at a reasonable distance and faulty placement or loss of a device due to other extraneous events that may look like an exit. This has resulted in reports of erratic maneuvers, driver confusion, and dangerous excursions into the work zone. PennDOT has desired a low cost safety strategy to deal with this problem and chose the use of alternate-color channelizing device colors to mark exits. The purpose of this project was to evaluate these devices that included a literature search, human factors evaluation, full-scale test track simulation using 80 subjects and full-scale field tests in 9 active work zones. Based on the results, it was the opinion of the authors that using non-standard color channelizing devices to delineate paths to freeway and arterial exits and arterial driveway entrances in work zones would provide a substantial safety benefit.

Project Title, ID, Cost, Duration	***An Analysis of Bicycle/Bus Conflict Zones*** ***ID:*** DVRPC-01 ***Cost:*** $75,000 ***Project Duration:*** 11/1/08–10/31/09
Submitter	***Agency, organization:*** Pennsylvania Department of Transportation ***Contact, e-mail:*** Michael Bonini, mbonini@state.pa.us
Research program	***Sponsoring agency or organization:*** PennDOT Research Program
Web link, if available	Final report can be accessed via the PennDOT Research Web site (www.dot.state.pa.us)
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Increasing bicycle use and bus ridership are both desirable policy goals from a sustainability standpoint, and a great deal of planning work in Philadelphia aims to accomplish both. On city streets, however, these two modes of transport are in several ways natural enemies, while occupying opposite ends of the size and weight spectrum, they often operate in the same space (right side of the road) and at roughly the same speeds over significant stretches of road. This report included a review of PennDOT crash data and an analysis of video logs along Walnut Street in University City, with an aim of documenting and highlighting the precise nature of this conflict in Philadelphia. After reviewing how other locales have dealt with these conflicts, the authors of the report proposed two specific strategies to address the problems observed: (1) street design changes (install left-side bike lanes on one-way streets where significant transit conflicts exist), (2) policy changes (pursue a citywide "Yield/Courtesy Pyramid" to clarify roles and responsibilities [whether legislated or advisory]).

South Carolina Department of Transportation

Project Title, ID, Cost, Duration	***Magnitude and Frequency of Rural Floods in the Southeastern United States: Volume 3, South Carolina*** ***ID:*** USGS Scientific Investigation Report 2009-5156 (SCDOT - SPR 664) ***Cost:*** $402,000 ***Duration:*** 41 months
Submitter	***Agency, organization:*** South Carolina Department of Transportation (SCDOT) ***Contact, e-mail:*** Mike Sanders, Research Engineer, sandersmr@scdot.org
Research program	***Sponsoring agency or organization:*** SCDOT
Web link, if available	www.clemson.edu/t3s/scdot/ and http://pubs.usgs.gov/sir/2009/5156/
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	For over 50 years, the U.S. Geological Survey (USGS) has been developing regional regression equations that can be used to estimate flood magnitude and frequency at ungauged sites. These estimates are needed by highway engineers for design of bridges and other drainage structures as well as by others for effective planning and management of land and water resources, to protect lives and property in flood-prone areas, and to determine insurance rates. Historically, flood frequency studies have been conducted on a Statewide basis using hydrologic regions that represent areas of relatively homogeneous flood characteristics determined for the particular State of interest. This has resulted in separate regression equations being published for every State that are typically not coordinated between neighboring States, thus, sometimes producing hydrologic regions that are not contiguous at the State boundaries. Therefore if flood frequency estimates are needed for a basin that crosses State boundaries, engineers and water resource managers may have to work with several equations based on an assortment of basin characteristics with results that have varying degrees of uncertainty.

	To address this issue in a portion of the southeast, the USGS Water Science Centers in South Carolina, North Carolina, and Georgia worked cooperatively with the departments of transportation in these States to develop flood frequency techniques and equations that are applicable across their common boundaries. This regional approach provided a larger number of gauged stations in each particular hydrologic region to use in developing equations for estimating the magnitude and frequency of floods at ungauged sites within a region. This was particularly beneficial to South Carolina that has far fewer gauged stations than Georgia or North Carolina. Of the 828 gauges used in developing the rural flood frequency relations, only 64 were actually located in South Carolina. By having a larger dataset, a portion of the Piedmont region in South Carolina that previously appeared to be unique was found to be well within the scatter of the data for similar regions in the other States allowing the new equations to be used throughout that region. The study resulted in development of flood frequency techniques for rural basins that are more accurate and applicable across the borders for South Carolina, North Carolina, and Georgia. The equations developed in the study are being used by SCDOT hydraulic engineers and consultants working on department projects.

Texas Department of Transportation

Project Title, ID, Cost, Duration	***Impact of Overhang Construction on Girder Design*** ***Report number:*** 0-5706 ***Project Cost:*** $388,483.89 ***Project Duration:*** 3 years
Submitter	***Agency, organization:*** Research & Technology Implementation Office, Texas Department of Transportation (TxDOT) ***Contact, e-mail:*** Lewis Gamboa, TxDOT Bridge Division, lgamboa@dot.state.tx.us (Duncan Stewart dstewart@dot.state.tx.us)
Research program	Research & Technology Implementation Office, TxDOT
Web link, if available	Full report will be posted soon at http://library.ctr.utexas.edu/index.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Economics necessitate the use of as few girders as possible across a bridge's width. The girders are typically uniformly spaced transversely with the deck extending past the fascia girders, thereby resulting in an overhang. While designers commonly employ rules of thumb with regard to the geometry of the overhang, they lack research justification and the actual girder behavior is not well understood. The purpose of this study was to identify problematic geometries for both steel and concrete girder systems. The laboratory and field tests provided valuable data for validating finite element analytical (FEA) models for both the steel and concrete girder systems. For steel girder systems, the research-derived equations for balancing the overhang load provide the engineer with a simple method of accounting for the unbalanced load from the overhang. With the balanced load, the engineer can then use equations from the research for predicting the buckling capacity of the steel girder system in the system mode of buckling. For concrete girder systems, the recommended design methodology has been incorporated into a

	spreadsheet tool providing the designer with a way to evaluate the performance of the concrete girders during placement of the concrete deck.

Project Title, ID, Cost, Duration	***Curved Plate Girder Design for Safe and Economical Construction*** ***Report number:*** 0-5574 ***Project Cost:*** $410,248.03 ***Project Duration:*** 3 years
Submitter	***Agency, organization:*** Research & Technology Implementation Office, Texas Department of Transportation (TxDOT) ***Contact, e-mail:*** Amy Eskridge, TxDOT Bridge Division, aeskrid@dot.state.tx.us (512) 416-2261)
Research program	***Sponsoring agency or organization:*** Research & Technology Implementation Office, TxDOT
Web link, if available	ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/5574.pdf Full report will be posted soon at http://library.ctr.utexas.edu/index.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The critical stage for the stability of horizontally curved steel I-girder bridges generally occurs during early stages of erection and construction when little or no bracing may be present. Design and erection engineers are typically faced with the difficult task of assessing the stability of the girders during these early stages. The Texas Steel Quality Council recommends a flange width to girder depth ratio of 1/3. This recommendation is twice the limit of 1/6 that is in the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design Bridge Construction Specifications (2008). The goal of this research was to provide guidance on girder proportioning as well as the need and placement of temporary supports such as shoring towers or holding cranes. Parametric analytical studies showed that the TxDOT preferred practice of limiting the flange width to girder depth ratio to 1/3 often leads to relatively stocky girders that

	were often stiffer than necessary. However, the researchers also found that girders close to the AASHTO flange width to girder depth ratio of 1/6 were likely to experience problems with stability during construction. A limit closer to 1/4 is more likely to provide better behavior from both economy and ease of erection. Two computer programs were developed to aid in design and erection.

Project Title, ID, Cost, Duration	***Development of Infrared Photography and Ground Penetrating Radar Procedures for Identifying Mixture Segregation*** ***Report numbers:*** 4577-2 and 5-4577-01-1 ***Software:*** PaveIR ***Hardware:*** Infrared Bar ***Project Cost:*** $270,000 ***Project Duration:*** 2 years
Submitter	***Agency, organization:*** Texas Department of Transportation (TxDOT) ***Contact, e-mail:*** Dr German Claros, gclaros@dot.state.tx.us
Research program	***Sponsoring agency or organization:*** Texas DOT-Construction, Pavements an Maintenance Research Committee (RMC-1)- Research and Technology Implementation Office (RTI)
Web link, if available	

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Segregation can be loosely defined as the separation of coarse and fine aggregate particles in hot mix asphalt concrete mixture. Segregation has been recognized as a significant mat deficiency problem that can cause long-term performance problems. There are several different procedures available to mitigate segregation in hot mix asphalt concrete. What is not available is the means to detect and measure segregation in an objective and effective manner. Infrared photography and Ground Penetrating Radar technologies are promising in providing objective answers, through effective and user-friendly procedures. Procedures need to be developed for data-collection and acceptable limits of accuracy need to be established for these technologies. The objective of this project was to develop the means to collect temperature data continuously during the laying down operation of asphalt mixes. This project developed an Infrared Bar that attaches to the paver and measures the temperature using an array of 12 infrared sensors. User-friendly software processes and displays the temperature data in real time so construction and inspection personnel can take the corrective measures to reduce temperature segregation. The software and hardware is easily installed in any paver. TxDOT has included this device in the new asphalt mix specifications. It is estimated that the performance of asphalt mixes will be increased and a projected savings of 3 million a year is expected.

Project Title, ID, Cost, Duration	***Development of an Advanced Overlay Design System Incorporating Both Rutting and Reflection Cracking Requirements*** ***Report numbers:*** 5123-1, 5123-2, 5123-3 ***Software:*** TxACOL Overlay Program ***Project Cost:*** $424,106 ***Project Duration:*** 4 years
Submitter	***Agency, organization:*** Texas Department of Transportation (TxDOT) ***Contact, e-mail:*** Dr German Claros, gclaros@dot.state.tx.us

Research program	***Sponsoring agency or organization:*** Texas DOT-Construction, Pavements and Maintenance Research Committee, Research and Technology Implementation Office
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Selecting the appropriate overlay thickness and the combination of aggregates and binder types are important decisions that TxDOT engineers make on a routine basis. However, this selection is a difficult balancing act. To perform well in the field, the hot mix asphalt (HMA) overlay must have a balance of both good rut and crack resistance. Also, it must have sufficient thickness to withstand the traffic loads and environmental conditions. TxDOT already has the Hamburg wheel tracking device to screen out mixtures that are susceptible to rutting. Meanwhile, a new device, the upgraded overlay tester, has been developed for TxDOT engineers to characterize the reflection cracking resistance of asphalt mixtures. Therefore, the primary goal of this research is to develop and recommend a process to integrate the upgraded overlay tester into TxDOT's current mixture design system. The secondary goal is to develop a HMA overlay thickness design methodology and provide a material selection guide for district use. TxDOT uses about 300 million on asphalt mixes. It is projected that the use of TxACOL software will produce as minimum 5 percent reduction on the use of asphalt mixes per year due to the improved performance of the overlays. This will add to about $15 million savings per year for TxDOT.

Project Title, ID, Cost, Duration	***Traffic Control Device Evaluation and Development Program*** ***Report number:*** 0-6384-1 ***Cost:*** $165,227 ***Duration:*** 1 year

Submitter	**Agency, organization:** Texas Department of Transportation (TxDOT) ***Contact, e-mail:*** Michael Chacon, Traffic Operations Division, mchacon@dot.state.tx.us
Research program	***Sponsoring agency or organization:*** TxDOT Research Management Committee for Safety and Operations
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This project was established to conduct small-scale research activities on an as-needed basis so that the results could be available within months of starting the specific research, allowing needed research to be conducted at a fraction of a full-scale research project. This is a summary of four primary small-scale research activities that were conducted last year: • A temporary sign support with cross bracing was developed and crash tested to meet National Cooperative Highway Research Program 350 requirements, and has been implemented. • Researchers developed retroreflective classifications for an American Association of State Highway and Transportation Officials (AASHTO) sign sheeting material specification. The specification was balloted through AASHTO in early 2010 and passed. • Researchers conducted human factors research on sign sheeting materials by testing white on black signs to determine if they can create discomfort glare for motorists on rural low volume roads using high beams. More work is being conducted this year as part of another research project to analyze the results. • Researchers monitored lead-free pavement markings on test decks and determined that the nighttime color of yellow lead-free thermoplastic has fallen out of TxDOT color box and is approaching limits of the Federal Highway Administration color box. Researchers will continue to monitor the existing lead free thermoplastic pavement marking test decks.

Utah Department of Transportation

Project Title, ID, Cost, Duration	***Open-Graded Friction Courses*** ***ID:*** 0092-07-01 ***Cost:*** $40,000 ***Duration:*** 2 years, 3 months
Submitter	***Agency, organization:*** Utah Department of Transportation (UDOT) ***Contact, email*** – Rukhsana Lindsey, rlindsey@utah.gov
Research program	UDOT
Web link, if available	http://www.whrp.org/research-areas/flex/flex_0092-07-01.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Researchers set out to determine whether the latest generation of open graded friction courses, or OGFCs, can be successfully and economically used in Wisconsin's winter climate. Specifically, they investigated whether the wet-weather benefits of these porous asphalt mixtures—including less water spray, improved wet weather traction and reduced noise—outweighed a possible increase in required winter maintenance and reduction of pavement life. They performed a literature review on the use of OGFCs in 17 States and 4 Canadian provinces with cold weather climates, as well as a cost comparison to asphalts currently used in Wisconsin. Results showed that the latest generation of OGFCs generally cost 21 percent more to construct than standard hot mix asphalt pavements, and are generally being discontinued in northern States and provinces. Researchers recommend that Wisconsin not make use of OGFCs until they are enhanced for viability in colder weather. However, similarly porous stone matrix asphalt (SMA) mixtures should be considered if research shows that here are a large number of wet weather accidents on hot mix asphalt pavements without a corresponding number of winter accidents. If these accidents continue on SMA pavements, OGFC surfaces should be considered, with the understanding that extra efforts will be required to modify deicing and snow removal procedures.

Project Title, ID, Cost, Duration	***Practical Design*** ***Project Cost:*** Internal coordination of process ***Project Duration:*** Refining the details to implement this idea for 6 months
Submitter	***Agency, organization:*** Utah Department of Transportation (UDOT) ***Contact, e-mail:*** Rukhsana Lindsey, rlindsey@utah.gov
Research program	UDOT
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Before Practical Design, most projects followed strict guidelines on the parameters of a project. All roadways with the same classification type and traffic volume would have the same depth of pavement, same shoulder type, etc. The concept of Practical Design was initiated in 2005, which required designers to start looking at projects on a case-by-case basis instead of strictly adhering to standards. Another aspect of Practical Design was that the road would be built to meet the needs, not necessarily to the highest of standards used if there was an unlimited budget. Although it should be noted that one of the fundamental principles of Practical Design is that safety will never be compromised. While the concept of Practical Design was in place prior to Hurricane Katrina, the increased construction costs amplified the need to locate cost-saving measures wherever possible.

Project Title, ID, Cost, Duration	***Precast Pavements*** ***Project Cost:*** $800,000 ***Project Duration:*** 2 years
Submitter	***Agency, organization:*** Utah Department of Transportation (UDOT) ***Contact, e-mail:*** Rukhsana Lindsey, rlindsey@utah.gov
Research program	UDOT
Web link, if available	
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	1. Provide design and construction services to support a Highways for Life Research Test Section for precast concrete pavement replacement. 2. Support Research and Development efforts to evaluate the performance and effectiveness of an alternate non-proprietary precast paving system. Specifically, this research project is intended to evaluate the following goals: • Evaluation of leveling screws • Evaluate the use of urethane leveling grout • Evaluation of need and details for Load Transfer Devices • Evaluation of need and details for longitudinal tie bars • Evaluation of details for lifting devices • Evaluation of production rates and impact on accelerated construction performance • Capture Lessons Learned for future development of Utah Standards for precast paving systems

Vermont Agency of Transportation

Project Title, ID, Cost, Duration	***Evaluation of Concrete Bridge Rail Cracking*** ***ID:*** 2009-5 ***Cost:*** $12,253.17 ***Duration:*** October 2007–October 2009
Submitter	***Agency, organization:*** Vermont Agency of Transportation (VTrans) ***Contact:*** Jason Tremblay, jason.tremblay@state.vt.us
Research program	***Sponsoring agency or organization:*** VTrans
Web link, if available	http://www.aot.state.vt.us/matres/Documents/ACROBAT.pdf/R&DDox/Evaluation%20of%20Concrete%20Bridge%20Rail%20Cracking1.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Cracking of newly cast concrete bridge rails has been an ongoing problem throughout the State of Vermont, one that has been observed to be severe and rapidly occurring upon curing in some cases. This study reports on the current status with regards to cracking and condition of 11 concrete bridge rails, 8 previously cast since 2001 and 3 which were monitored from casting through their first year of service. Through field observations it was determined that all bridge rails showed signs of cracking. For rails with windows (cut-outs), the crack density was around 0.8 cracks per linear foot, while for solid section rails it was around 0.5 cracks per foot. Through monitoring of the three rails from casting, it is apparent that the cracking develops very quickly and increases rapidly during the first months. Corollary statistics show some general trends with respect to geometric, functional, and materials data. It is apparent that there is a widespread problem, one that needs to be alleviated before resources are poured into a currently inconsistent product. Future research should be performed or

	policy changes enacted to further improve the materials and placement methods of these structures.

Project Title, ID, Cost, Duration	***Evaluation of Measuring Methods of Traffic Sign Retroreflectivity*** ***ID:*** 2009-8 ***Cost:*** $36,236.33 ***Duration:*** July 2008–December 2009
Submitter	***Agency, organization:*** Vermont Agency of Transportation (VTrans) ***Contact, e-mail:*** Wendy Kipp, wendy.kipp@state.vt.us
Research program	***Sponsoring agency or organization:*** VTrans
Web link, if available	http://www.aot.state.vt.us/matres/Documents/ACROBAT.pdf/R&DDox/SS%20RR%20Final%20Report%20Web%20Version%201.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The primary objective of this research initiative was to establish a retroreflectivity assessment protocol for sign sheeting in order to meet new Federal requirements. This study focused on examining two of the Manual on Uniform Traffic Control Devices assessment strategies including measured sign retroreflectivity and expected sign life. Field data collection efforts focused on evaluating the condition of several sheeting types and colors, including four non-fluorescent ASTM Type III colors, including green, white, red, and yellow and two ASTM 

	Type IX fluorescent sheeting colors including yellow and yellow-green. A total of 618 signs, stretching across 14 counties and all geographical regions in Vermont were evaluated. Data correlation was performed where retroreflectivity was measured as a function of time to identify variables affecting long-term performance including orientation, offset, wind exposure, and roadway type. These variables were not found to have any significance in determining life-cycle projections and a direct correlation between sign condition and retroreflectivity could not be established. Based on the results, in all cases, the projected life expectancy for the Type III and Type IX sign sheeting exceeds 15 years, therefore the blanket replacement method in combination with measured sign retroreflectivity appears to be the most cost-effective methods for the State of Vermont.

Virginia Department of Transportation

Project title **ID, Cost, Duration**	***An assessment of the Virginia Department of Transportation's Animal Carcass Disposal Practices and Guidance for the Selection of Alternative Carcass-Management Options*** ***Report number:*** VTRC 10-R7 ***Cost:*** $47,332 ***Duration:*** September 15, 2008–September 14, 2009
Submitter	***Agency, organization:*** Virginia Transportation Research Council ***Contact, e-mail:*** Michael A. Perfater, mike.perfater@VDOT.Virginia.gov
Research program	***Sponsoring agency or organization:*** Virginia Department of Transportation (VDOT)
Web link, if available	http://www.virginiadot.org/vtrc/main/online_reports/pdf/10-r7.pdf
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This study developed cost-efficient options to address the growing problem of disposing of animal carcasses. More than 54,000 deer-vehicle collisions occurred in Virginia in 2007 and 2008. Given the magnitude of animal-vehicle collisions, some carcass-disposal methods available to many VDOT maintenance areas are becoming increasingly impractical. The researchers evaluated several carcass-management methods, including on-site burial, disposal facilities, contracts for removal and disposal, incineration units and composting. The results of surveys distributed to VDOT maintenance areas indicated that most (77 percent) use a disposal facility, such as a landfill, and nearly half of these users must travel from a their routine maintenance routes to these facilities. The research team developed cost models that allow maintenance managers to evaluate their costs for the various methods. They also developed a "decision tool" to guide the selection of the most suitable method. Implementing carcass management at VDOT maintenance areas

	may be an effective approach for reducing labor inefficiencies, such as long trips to dispose of carcasses. The study recommended compost windrows—or static-pile composting—as an easily managed technique that can be located at a maintenance area. If VDOT area headquarters that frequently take animal carcasses to disposal facilities employed compost windrows, the report estimates VDOT could avoid $515,440 per year in costs, or it could reallocate those funds elsewhere within the maintenance areas. If space for compost windrows is unavailable, an automatic compost vessel is also a practical option. Locations have already been identified in two rural VDOT districts for pilot composting studies to increase implementation prospects. This second carcass composting project is already under way.

Project title **ID, Cost, Duration**	***Understanding Cattail (Typha spp.) Invasion and Persistence in Forested Wetlands Created by the Virginia Department of Transportation*** ***Report number:*** VTRC 09-CR10 ***Cost:*** $81,586 ***Duration:*** November 1, 2005–July 30, 2008
Submitter	***Agency, organization:*** Virginia Transportation Research Council ***Contact, e-mail:*** Michael A. Perfater, mike.perfater@VDOT.Virginia.gov
Research program	***Sponsoring agency or organization:*** Virginia Department of Transportation (VDOT)
Web link, if available	http://www.virginiadot.org/vtrc/main/online_reports/pdf/09-cr10.pdf

Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	The researchers found that the hydrology, or depth of the water, in a created forested wetland would determine whether cattails would dominate over the woody vegetation in such ecosystems. Some State and Federal regulatory permit requirements still mandate cattail control in these wetlands via mechanical removal and/or herbicide treatment, because the permitting agencies say cattail removal will prevent interspecies competition between cattails and desirable tree species. This rule adds significantly to VDOT's costs for wetland compensation and mitigation. The team designed this study to determine if the current emphasis on cattail eradication is necessary to ensure the success of VDOT's wetland-mitigation sites. Team members analyzed the vegetation at 20 VDOT-created forested wetlands in the Hampton Roads region. The findings did not support the current rationale for cattail removal in created wetlands in Virginia. In this study, cattail dominance did not limit diversity within the vegetation community and did not decrease growth of planted bald cypress. Instead, deeper water inhibited other species from colonizing, thereby allowing cattails to colonize in the deeper water. The researchers said that given proper hydrologic conditions, forested wetlands would develop better at many mitigation sites without costly and potentially hazardous cattail control efforts. The study concluded that the resources used to eradicate cattails—except where the hydrology has been compromised—are better spent on seeding and/or planting woody species, such as bald cypress, black willow, river birch and red maple, that are better adapted to the conditions of drawdown, planting and flooding these sites frequently encounter. Thus, the report recommended that VDOT's Environmental Division should place additional emphasis on ensuring that hydrologic conditions are correct at VDOT-constructed wetland sites. The study also recommended devoting fewer resources to eradication. Acceptance of these recommendations by the U.S. Army Corps of Engineers and Virginia Department of Environmental Quality would result in monetary savings and ultimately in more successful development of forested wetland sites.

Project title **ID, Cost, Duration**	***Geotechnical Data Management at the Virginia Department of Transportation*** ***Report number:*** (not published yet) ***Cost:*** $120,296 ***Duration:*** January 15, 2009–April 30, 2010
Submitter	***Agency, organization:*** Virginia Transportation Research Council ***Contact, e-mail:*** Michael A. Perfater, mike.perfater@VDOT.Virginia.gov
Research program	***Sponsoring agency or organization:*** Virginia Department of Transportation (VDOT)
Web link, if available	Not posted yet
Brief summary of project and impact, or potential impact of implementing research results	The fully operational, production-level based Geographic Information Systems (GIS)-based geotechnical database management system (GDBMS) developed in this study is now available for use at VDOT. It allows VDOT personnel and consultants quick access to geotechnical data. The study recommends that all VDOT geotechnical projects use GDBMS and associated processing software and that VDOT's Materials Division maintain the database. Transportation projects routinely require subsurface exploration to acquire data needed for foundation design. This project developed a practical, comprehensive, enterprise-wide system for entry, storage, and retrieval of this data. The resulting application satisfies VDOT's workflow requirements and streamlines delivery of geotechnical information. The system includes the latest version of gINT software for geotechnical data processing and ESRI Arc Internet Map Server (ArcIMS) for distributed GIS data delivery via a Web browser. Custom command scripts and configuration files were developed in the form of an extensible applet framework called the "geotechnical database management system," or GDBMS, to manage and process geotechnical data. The expertise of VDOT geologists, engineers, and Information

	Technology staff contributed to this user-friendly and rugged system that is relatively easy to maintain and capable of delivering required data in a consistent format across operating divisions. Cost savings associated with fully implementing GDBMS are expected to be long term, resulting primarily from increased efficiency of data entry and retrieval. It is conservatively estimated that the labor-cost savings would be approximately $600 for each average small- to mid-size bridge project. GDBMS can be applied to all bridge subsurface data that VDOT processes. Truly significant savings can be realized on large new projects planned around existing infrastructure, where proximate subsurface data already are available. Additional exploration is often very expensive, with many over-water drilling projects costing more than $10,000 per day to carry out. GDBMS can provide a more detailed picture of local conditions, and its use can reduce the need for drilling additional boreholes, minimizing the overall cost of subsurface exploration.

Project title **ID, Cost, Duration**	***Performance of Virginia's Warm-Mix Asphalt Trials*** ***Report number:*** VTRC 10-R17 ***Cost:*** $103,262 ***Duration:*** August 20, 2007–January 31, 2010
Submitter	***Agency, organization:*** Virginia Transportation Research Council ***Contact, e-mail:*** Michael A. Perfater, Mike.Perfater@VDOT.Virginia.gov
Research program	***Sponsoring agency or organization:*** Virginia Department of Transportation (VDOT)
Web link, if available	http://www.virginiadot.org/vtrc/main/online_reports/pdf/10-r17.pdf
Brief summary of project	This study evaluated the initial two-year performance of three warm-mix

and impact, or potential impact of implementing research results	asphalt (WMA) trial sections that VDOT installed in 2006. Hot-mix asphalt (HMA) sections were used as controls. VDOT used the experiences with these trial sections to develop the agency's special provision allowing the use of WMA. WMA for two of the sections was produced using Sasobit, an organic additive (developed by Sasol Wax). WMA for the third section was produced using Evotherm ET (developed by MeadWestvaco Asphalt Innovations) as the modification method. The researchers analyzed cores and made visual inspections during the initial construction of each site and at intervals of 3 months, 6 months, 1 year, and 2 years. They assessed the initial performance of the WMA and compared it with that of HMA control sections constructed at the same time. From the results of this 2-year investigation, in general, WMA and HMA should be expected to perform equally. Any instances of improved performance of WMA, as compared to HMA, will depend on the WMA technology used. Some WMA technologies may contribute to reduced in-service binder aging, depending on production temperatures and the nature of the technology. Based on information gathered during this work, VDOT has incorporated the use of WMA technologies into Supplemental Sections 211 and 315 of its Road and Bridge Specifications beginning in 2010. Between February and October 2009, VDOT approved maintenance contracts using HMA surface mixtures valued at approximately $101 million. If, conservatively, VDOT replaced 10 percent of these mixtures with WMA with beneficial aging characteristics—and the apparent trend of a 1-year reduction in the rate of aging continues, resulting in deferring repaving by a year—VDOT could realize a one-time cost savings of approximately $1.15 million.

Project title **ID, Cost, Duration**	***Field Comparison of the Installation and Cost of Placement of Epoxy-Coated and MMFX 2 Steel Deck Reinforcement: Establishing a Baseline for Future Deck Monitoring*** ***Report number:*** VTRC 09-R9 ***Cost:*** $229,917, through Federal Highway Administration Innovative Bridge Research and Construction grant ***Duration:*** December 1, 2000–June 30, 2010
Submitter	***Agency, organization:*** Virginia Transportation Research Council ***Contact, e-mail:*** Michael A. Perfater, mike.perfater@VDOT.Virginia.gov
Research program	***Sponsoring agency or organization:*** Virginia Department of Transportation (VDOT)
Web link, if available	http://www.virginiadot.org/vtrc/main/online_reports/pdf/09-r9.pdf
Brief summary of project and impact, or potential impact of implementing research results	This study found that a corrosion-resistant reinforcement, MMFX 2, was more cost effective per unit in a bridge deck than epoxy-coated reinforcing (ECR) steel, when both the anticipated and unanticipated costs of the two materials were estimated for a bridge project in Northern Virginia (Route 123 over the Occoquan River). A full-scale reconstruction of a bridge was used to identify the differences in procedures and costs for installing both an ECR steel and a corrosion-resistant reinforcement, specifically MMFX 2. The reinforcing steel in a bridge deck often determines the length of a structure's operational life through corrosion-induced spalling of the concrete, which diminishes the deck's surface rideability. ECR relies on a flexible epoxy coating on black steel to impede chlorides from reaching the metal, while MMFX 2 is alloyed to improve the corrosion resistance of the steel itself. ECR also requires special handling during installation to avoid damaging the epoxy coating, which would allow chloride seepage to corrode the rebar. The use of deicing salts makes bridge deck corrosion more likely, thus increasing spall-related maintenance. Previous research (VTRC 06-R29) indicates MMFX 2

	could provide a service life that far exceeds that of ECR, potentially as much as 100 years. The research team determined that that ECR appears to have been far less cost-effective per unit than MMFX 2, when both the anticipated and unanticipated costs of ECR were estimated for this bridge project. For this project, MMFX 2 showed labor productivity and comprehensive in-place cost advantages over ECR, as well as road-user savings. The successful use of MMFX 2 on this particular bridge supports VDOT's Structure and Bridge Division previous decision to implement the use of corrosion-resistant reinforcement in new bridge decks.

Wisconsin Department of Transportation

Project Title, ID, Cost, Duration	***Specification and Design of Fiber Reinforced Bridge Deck Forms for Use on Wide Flange T-Girders*** ***ID:*** 0092-06-07 ***Cost:*** $94,735 ***Duration:*** 2 years
Submitter	***Agency, organization:*** Wisconsin Department of Transportation Research & Library Unit ***Contact, e-mail:*** Daniel Yeh, daniel.yeh@dot.wi.gov
Research program	***Sponsoring agency or organization:*** Wisconsin Highway Research Program
Web link, if available	http://www.whrp.org/research-areas/structures/structures_0092-06-07.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	This study developed performance specifications for testing nonmetallic stay-in-place formwork options and produced guidelines for their use in highway bridge deck construction. Previously, some contractors had begun making limited use of this formwork, which uses inexpensive, off-the-shelf materials to support wet concrete. Whereas traditional wooden formwork needs to be removed after the concrete has cured, which is both expensive and is one of the most dangerous tasks associated with bridge construction, stay-in-place formwork becomes a permanent part of the bridge. This research involved impact testing of several types of materials, including concrete slabs reinforced with various fibers, grids and bars, as well as fiber-reinforced plastic planks to determine the strength, serviceability, and behavior under accidental impact loads of the various formwork options. The study approved several types of panels for bridge deck construction and established design calculations and performance tests to ensure efficient and safe use of these panels for a given construction.

	The specification established will allow bridges to be built more quickly, will decrease construction costs and will increase the safety of construction workers. Because no other specification of this type was found to exist, the result of this project could be used as a National model.

Project Title, ID, Cost, Duration	***Implementation and Application of the Federal Highway Administration's HIPERPAV Model to Wisconsin*** ***Report Number:*** 0092-06-08 ***Cost:*** $13,044 ***Duration:*** 1 year *HIPERPAV Wisconsin Implementation Support Phase IIa* ***Report Number:*** 0092-07-18 ***Cost:*** $15,000 ***Duration:*** 2 months *HIPERPAV Wisconsin Implementation Support Phase IIb* ***Report Number:*** 0092-08-33 ***Cost:*** $15,000 ***Duration:*** 1 year

Submitter	***Agency, organization:*** Wisconsin Department of Transportation Research & Library Unit ***Contact, e-mail:*** Daniel Yeh, daniel.yeh@dot.wi.gov
Research program	***Sponsoring agency or organization:*** Wisconsin Highway Research Program
Web link, if available	http://www.whrp.org/research-areas/rigid/rigid_0092-06-08.html http://www.whrp.org/research-areas/rigid/rigid_0092-07-18.html http://www.whrp.org/research-areas/rigid/rigid_0092-08-33.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	These three implementation projects aimed to encourage use of HIPERPAV concrete pavement design software by Wisconsin engineers, and to resolve technical issues to improve its performance and value. The first project (06-08) conducted workshops and training of engineers around the State to use HIPERPAV with inputs for local materials. The second project (07-18) corrected Federal Highway Administration-provided HIPERPAV coefficients to better work with Wisconsin fly ash. The third (08-33) solved a technical problem to allow multiple analyses of mixes without extensive data re-entry. The result is pavement that will minimize the risk of cracking, allowing crews to change mix designs or to put paving off to a day with weather more suitable to success. Pavements will enjoy a longer life and higher quality performance.

Project Title, ID, Cost, Duration	***Low Cost Strategies to Increase Truck Parking in Wisconsin*** ***ID:*** 0092-08-28 ***Cost:*** $64,500 ***Duration:*** 15 months
Submitter	***Agency, organization:*** Wisconsin Department of Transportation Research & Library Unit ***Contact, e-mail:*** Daniel Yeh, daniel.yeh@dot.wi.gov
Research program	***Sponsoring agency or organization:*** Policy Research Program, in collaboration with the University of Wisconsin-Madison Center for Freight and Infrastructure Research and Education
Web link, if available	http://www.wistrans.org/cfire/Research/CFIRE/GY01/04/index.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Truckers in and around the Wisconsin metropolitan areas are facing a shortage of overnight parking options. This shortage increases safety risks to both truckers and the traveling public. In order to address this problem, researchers sought to understand and analyze trends in truck parking, especially as they relate to: • Specific truck parking issues associated with stops for meals, bathroom breaks and such • Operational issues causing the need for parking • Locations where truck parking problems exist along specific U.S. and State trunk highway corridors in Wisconsin • Available low-cost solutions areas lacking parking Researchers created a geographical distribution of locations with parking issues ranked from low to high priority needs. Immediate solutions included restriping existing facilities to make more effective use of existing space, and the expansion and promotion of weigh-in stations as available parking locations. For longer-range technology solutions, researchers proposed several ideas such as mobile phone applications and in-vehicle displays to inform drivers of available parking. Madison, identified as one of the bottlenecks, will soon have expanded parking availability and bathrooms with 24-hour access at the Madison

	weigh-in station. Additionally, a new truck parking facility has been built outside of Madison; the facility is currently open and will continue to expand in phases.

Project Title, ID, Cost, Duration	***Open-Graded Friction Courses*** ***ID:*** 0092-07-01 ***Cost:*** $40,000 ***Duration***: 2 years, 3 months
Submitter	***Agency, organization:*** Wisconsin Department of Transportation Research & Library Unit ***Contact, e-mail:*** Daniel Yeh, daniel.yeh@dot.wi.gov
Research program	***Sponsoring agency or organization:*** Wisconsin Highway Research Program
Web link, if available	http://www.whrp.org/research-areas/flex/flex_0092-07-01.html
Brief Summary of the Research Project and Impact, or Potential Impact, of Implementing Research Results	Researchers set out to determine whether the latest generation of open graded friction courses, or OGFCs, can be successfully and economically used in Wisconsin's winter climate. Specifically, they investigated whether the wet-weather benefits of these porous asphalt mixtures—including less water spray, improved wet weather traction and reduced noise—outweighed a possible increase in required winter maintenance and reduction of pavement life. They performed a literature review on the use of OGFCs in 17 States and four Canadian provinces with cold weather climates, as well as a cost comparison to asphalts currently used in Wisconsin. Results showed that the latest generation of OGFCs generally cost 21 percent more to construct than standard hot mix asphalt (HMA) pavements, and are generally being discontinued in northern States and provinces. Researchers recommend that Wisconsin not make use of OGFCs until

	they are enhanced for viability in colder weather. However, similarly porous stone matrix asphalt (SMA) mixtures should be considered if research shows that here are a large number of wet weather accidents on HMA pavements without a corresponding number of winter accidents. If these accidents continue on SMA pavements, OGFC surfaces should be considered, with the understanding that extra efforts will be required to modify deicing and snow removal procedures.