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## Research Results

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The mission of the New Mexico Department of Transportation’s (NMDOT) Research Bureau is to perform high quality, applied transportation research which provides innovative solutions to transportation problems confronting our customers in the NMDOT, the people of the State of New Mexico, our Nation and the Community of Nations. The Bureau seeks to accomplish this mission through close coordination with our partners and customers, consistent with strategic goals and key principles established by the Department.

Effective, organized and well-executed research often provides the means to address the increasingly complex transportation problems encountered by NMDOT. While some of these problems are resolved at the local level by district personnel and organizational sub-units, many are best addressed through a systematic program of coordinated research. This research is administered by the NMDOT Research Bureau.

Research Categories:

Administration and Finance - Improvements in policy and information transfer
Construction - Improvements in construction methodology
Design - Highway, structure, and intermodal system design
Environment - Complex interaction between the environment and transportation
Maintenance - Transportation maintenance activities
Material Science - Improvements in construction material
Multimodal - Modal connectivity and operations
Planning - Forecasting, modeling, and inter-agency collaboration
Safety - Improvements to transportation safety and security
Structures - Bridge design, construction and maintenance

Special Projects - All other areas of research
Technology Transfer - Acquisition of promising new technologies
Pooled Fund Studies - Jointly funded by several federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms.
On-call - Quick turnaround, short term, high priority projects
Feasibility Analysis of Ultra High Performance Concrete (UHPC)
NM09MSC-01

AASHTO 2012 Sweet 16 High Value Research Award
Budget: $598,084  Duration: 74 months

Properties of UHPC
Increased durability: This UHPC mixture was found to have adequate resistance to freezing and thawing, delayed ettringite formation, and alkali-silica reaction.

High compressive strength: Compressive strength tests used 4” and 2” cubes. Average compressive strengths were ≥ 20,000 psi.

Improved tensile strength: High strength steel fibers are added to the mixture proportions to provide ductility and post-cracking tensile strength.

Benefits of UHPC
Due to the advanced properties of UHPC, implementation in bridge design provides many benefits:
• Increased life span and decreased maintenance
• Reduced/eliminated mild steel reinforcement leading to simpler detailing
• Reduction of girder lines and/or girder size
• Reduction of material quantities

Phase I: Complete
Investigate the feasibility and benefits related to the implementation of UHPC into prestressed bridge design.

Phase II: Complete
Develop mixture proportions and a curing regimen for UHPC that uses material local to New Mexico.

Phase III: Ongoing
Large-scale tests will be conducted on prototype prestressed bridge girders based on procedures developed to incorporate UHPC into the design. Specifications will be developed for the implementation of this material to precast plants.

UHPC and HPC prestressed girders will be placed on a bridge in District 1 to conduct short and long term studies on the behavior and performance of the bridge.

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Transportation Library Connectivity Pooled Fund Study TPF-5(105)
NM10TPF-02

Budget: $75,000  Duration: 60 months

Project Summary
Accessible, reliable, and timely information is critical for transportation agencies and stakeholders. Yet, a vast amount of transportation-related information is neither collected nor made available for use. Effective library and information services are critical for getting needed information in the hands of practitioners and decision-makers within state departments of transportation.

Pooled fund members are supporting the formation and growth of regional Transportation Knowledge Networks, the development of centralized direction and services through the National Transportation Library, and cooperation among diverse elements of the transportation information community.

This pooled fund project on Transportation Library Connectivity focuses on making transportation information more readily available through better communication and coordination among state, federal, academic and private sector libraries. The study aims to institutionalize the best practices of individual transportation libraries and regional Transportation Knowledge Networks.

Study members receive the following benefits:
• Obtain reimbursement by the pooled fund for travel to additional qualifying meetings.
• Apply part of the pooled fund contribution to OCLC membership.
• Receive a site visit and tailored recommendations from the librarian consultant.
• Serve as a host site for pooled fund workshops.
• Suggest and vote on research and technology transfer projects.
• Participate in bimonthly TAC teleconferences.
• Receive all e-mail and written communications and hard copies of study products, such as the Transportation Librarian’s Toolkit.
• Obtain reimbursement by the pooled fund for travel to annual meetings.
• Suggest research and technology transfer projects on library and information service topics for transportation.

Pooled Fund Quarterly Reports are on the project website: http://www.libraryconnectivity.org/about.html

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Development of a Right-Of-Way Carbon Sequestration Program - Phase II
NM10ENV-01

Budget: $398,000  Duration: 24 months

Project Summary
The project is designed to answer the following questions:

- Can vegetation within NMDOT rights-of-way be managed and enhanced in a cost effective manner to maximize carbon sequestration?
- Can this technique generate a reliable number of annual carbon credits that the NMDOT could trade profitably on the global carbon market to make the program financially self-sustaining or even produce revenue for the Department?

State and the federal governments are looking for ways to reduce emissions of greenhouse gases, particularly carbon dioxide (CO2). Because vegetation naturally removes (“sequesters”) CO2 from the air, state transportation agencies have an opportunity to reduce their total emissions and even earn revenue by changing vegetation-management practices in their state department of transportation (DOT)-owned rights-of-way. To explore this potential, the Federal Highway Administration’s (FHWA) Office of Natural and Human Environment has selected New Mexico for a Carbon Sequestration Pilot Project; however, no funding was attached to this designation. The goals of the project are to quantify the amount of carbon that can be sequestered using native vegetation management on NMDOT lands and to estimate the revenue that could be generated through the sale of “carbon credits” on an emissions trading market.

Justification
Since the FHWA selected New Mexico as the site for the experimental Carbon Sequestration Pilot Project, the NMDOT has the opportunity to be the national leader in this effort. As part of the program, the NMDOT is required to research the potential to increase plant density in order to maximize carbon sequestration, through development of an experimental systematic seeding and planting program at selected sites within NMDOT rights-of-way.

Anticipated Benefits
The intent of the project is to develop a sustainable carbon sequestration program that generates a reliable number of annual carbon credits to be used by NMDOT to offset greenhouse gas emissions, as required by the state’s membership on the Chicago Climate Exchange, and to sell excess carbon credits on the Exchange to offset the ongoing costs of the program, as well as generate additional income for the NMDOT to use for other transportation purposes.

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Evaluation of Materials Response in Hot Mix Asphalt Based on Field Instrumentation
Phase II
NM11MSC-03

Budget: $675,000    Duration: 48 months

Project Summary
The objective of the project is to continue uninterrupted the data collection and analysis which began in Phase I on an instrumented section of Interstate 40, at mile marker 141, east bound. Sensors were installed during construction to collect pavement stress and strain, materials response to, air and pavement temperature, humidity, traffic volume and weight (load), pavement performance. The data is used as inputs for calibration of Pavement ME design software and distress models. Since July 2012, these sensors have been recording data which are inputs for the calibration of the Mechanistic Empirical Pavement Design Guide (MEPDG) software. The data has been collected, analyzed, and interpreted by researchers at the University of New Mexico.

The outcome of this proposed project will help calibrate the Pavement ME Design Guide subroutines for New Mexico's conditions. Specifically, this research will yield more accurate distress prediction subroutines in the Pavement ME Design Guide. Then, the probable distresses such as rutting, alligator cracking, top-down cracking, thermal cracking etc. can be predicted more accurately considering New Mexico's climate, materials and needs. This will provide a cost effective design section by ensuring the optimum design.

This project will also evaluate the current weather station locations specific to New Mexico within the Mechanistic-Empirical Pavement Design Guide (MEPDG), determine if more locations are necessary and provide recommendations for enhancing the MEPDG- Integrated Climatic Module (ICM) software to recognize the new weather stations.

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Long Term Effects of the Use of Recycled Asphalt Pavement (RAP) in Hot Mix Asphalt (HMA): Mechanical and Rheological RAP Characterization of NMDOT Mixes
NM12MSC-01

**Budget:** $500,000  **Duration:** 48 months

**Project Summary**
This project will determine the influence of Reclaimed Asphalt Pavement (RAP) in Hot Mix Asphalt (HMA) mixes. Among the tasks are as follows:

- Document the state of the practice of RAP stockpile management and RAP processing in the state.
- Study the PG grading of the virgin, recovered, and blended binders pertaining to the percentages of RAP used in the mix design.
- Evaluate the MEPDG input parameters for the blended binders.
- Conduct elemental analyses of the blended binders.
- Determine physical and mechanical properties including gradation, soundness and insoluble residue of virgin and extracted (from RAP) aggregates.
- Test field compacted specimens from selected sites.

**Justification**
Since 2008 NMDOT has allowed up to 35 percent RAP materials in HMA mixes. However no state-specific, in-depth evaluation of the influence of this much RAP has been performed. While reusing asphalt pavement has environmental and cost benefits, it may be creating cracking problems, the primary distress in NMDOT pavements. In addition, there are wide variations in RAP quality and laboratory/field performance of asphalt mixes with high RAP content.

**Anticipated Benefits**
Identifying the optimal highest percent of RAP to use in Hot Mix Asphalt will maximize the environmental and cost benefits of the practice without sacrificing pavement quality.

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Use of Falling Weight Deflectometer and Ground Penetrating Radar in Pavement Design, Maintenance and Management

NM12SP-01

**Budget:** $611,000   **Duration:** 36 months

**Project Summary**
This project will determine the benefits to pavement design, maintenance, and management from the use of non-destructive pavement testing technology, namely falling weight deflectometer (FWD) and ground penetrating radar (GPR), rather than destructive coring.

**Justification**
FWD data can be used to report existing pavement condition as reported by modulus index. Such an index could be used to determine a necessary treatment to prolong pavement life...i.e. general maintenance, rehabilitation, reconstruction. The FWD may be used to develop a modulus for existing Hot Mix Asphalt, base course, and subgrade to provide a more reliable approach to pavement rehabilitation based on mechanistic (multi-layer linear elastic) principles. GPR will provide quick, accurate pavement section thicknesses to aide in the FWD determination.

**Anticipated Benefits**
These technologies will enable the Department to determine the life of a pavement from a mechanistic standpoint. Refining pavement design according to actual field condition is expected to significantly reduce maintenance costs and extend pavement life.

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Enhanced Statewide and Independent Assurance Testing for Dynamic Modulus of NMDOT Superpave Hot Mix Asphalt Mixes for the Implementation of MEPDG
NM12SP-02

Budget: $450,000    Duration: 48 months

Project Summary
This project will enhance and supplement statewide materials’ modulus data from aggregate and asphalt binder sources statewide for the NMDOT designers’ immediate use and MEPDG implementation. Dynamic modulus (E*) of HMA and resilient modulus (Mr) of base course databases will be developed for local materials. By creating a database of local materials this project will permit application of MEPDG to Level 2 analysis.

Justification
Currently, testing is limited to materials in the Bernalillo County area and the testing is conducted by the University of New Mexico Civil Engineering Department. But New Mexico State University has recently purchased the testing equipment. NMSU is able to test materials in the southern part of the state. Moreover, having two testing facilities can introduce independent assurance to the database.

Anticipated Benefits
Asphalt dynamic modulus and base/subgrade resilient modulus are the key input parameters for structural design of flexible pavement according to MEPDG. Full benefit of implementing MEPDG requires development of a highly reliable and locally specific database of values. The net effect will be more efficient use of materials and increased reliability of pavement designs.

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Developing a Statewide Standard Process for the Use of Millings
NM12SP-03

Budget: $200,000  Duration: 36 months

Project Summary
This project was proposed and approved for the purpose of answering the question “How should the NMDOT manage and use recycled millings? Are the applications of millings durable, longlasting, and cost effective?”.

The research will result in development of a statewide, standardized methodology for the processing and optimal use of recycled millings. In addition, several District Six projects will be evaluated for longevity, cost effectiveness, durability, and ease of using millings. Implementation will be performed by district maintenance patrols.

Justification
There are no statewide guidelines for processing or using recycled pavement millings. This project is necessary to determine the optimal use for this valuable resource and to provide an efficient and effective set of guidelines for use by District personnel.

Anticipated Benefits
Recycled pavement millings constitute a valuable and potentially under-utilized resource. Optimal utilization of this resource may result in paving material cost savings as high as fifty percent. This would permit the agency to pave twice the roadway surface areas for the same HMA budget compared to using virgin asphalt hot mix and cold lay.

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On-Call Research Services
NM12SP-07

Budget: $100,000    Duration: 24 months

Project Summary
This project establishes an on-call contract to be executed between NMDOT and one or more of the public or private sector investigators. The contract will provide the means to leverage resources to provide literature searches for relevant information requested by Department staff, and to perform short and medium term research. This is envisioned as a long term, 4-year project.

Justification
A wealth of information on topics related to a broad variety of transportation issues is available through several sources, including the Transportation Research Board, AASHTO, NCHRP, and individual state DOT research divisions. Oftentimes a question or concern raised by NMDOT staff has been addressed through another agency, and a thorough literature search will reveal this information. This eliminates unnecessary and costly duplication of effort in finding solutions to these problems. Research Bureau staff regularly conducts literature reviews in response to requests from Department staff and subsequent to receipt of research project proposals. In the recent past the size of the NMDOT research program has grown exponentially while staffing has been reduced.

Anticipated Benefits
An on-call contract for research services will improve the volume and quality of investigation of previously conducted research, as well as short and medium term research. Existing operational procedures require a project-specific contract to be executed for each problem statement. This is often a time consuming process, both in preparing a contract and conducting research. A common remark from Department staff is that research takes too long, and that an expedited process for addressing immediate problems would be beneficial. Because the state’s many research universities and engineering firms have access to the same sources of information as the Research Bureau, short term research and literature searches could be performed by these staff.

Current on-call projects include:
The Use of Rumble Strips on New Mexico Roads
Research Peer Exchange

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**Advanced Statewide Mechanistic Empirical Pavement Design Guide (MEPDG) Calibration**

NM13MSC-02

**Budget:** $450,000  
**Duration:** 48 months

**Project Summary**

In previous years, NMDOT has allocated research funding to calibrate MEPDG to local materials. This is known as local calibration. While the initial local calibration proved beneficial, several significant assumptions including traffic and materials were made due to lack of quality data. With this project, the Department will apply all results of these previous research projects and continue to calibrate MEDPG. MEDPG distress predictions will be compared and evaluated from the actual pavement section and the associated distress functions within the program will be updated and revised.

The research objective is to further refine MEPDG fatigue predictions based on actual field performance.

Because MEPDG predicts the performance of pavements, the suggested approach for this research is to design a pavement section(s) by the MEPDG Level 3 methodology; conduct laboratory tests to characterize physical properties and characteristic data of actual materials used, and field monitor the performance of the section. Based on the field performance and the MEPDG predictions, adjustments to the predictive models will be made.

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Development of a Subgrade Stabilization Protocol for Design and Construction Control
NM13MSC-03

Budget: $225,000  Duration: 30 months

Project Summary
The purpose of this research is to develop a design and construction protocol on stabilization of subgrade soils and base materials designed specifically for New Mexico’s distinctive geologic composition. The protocol will enable geotechnical, pavement, materials, design, and construction engineers and project managers to apply the most cost-effective solutions for the various subgrade conditions encountered on projects.

Unstable and unsuitable subgrade for pavements has contributed to large expenditures for remediation and loss of pavement structure due to inadequate design and/or construction management decisions. This is due to a wide range of conditions including pumping, high Plasticity Indices, high sulfate content and low Resistance Value (R-value). Each project has resulted in the need to “reinvent the wheel” with no consistent applications of subgrade stabilization with the best decision for the given conditions.

Project Deliverables
2. Geographical map identifying soil characteristics which are at high risk for subgrade failure

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Field and Laboratory Evaluations of Warm Mix Asphalt
NM13MSC-04

Budget: $590,000  Duration: To Be Determined

Project Summary
During the survey in Phase I, it was observed that the mixing and laydown temperature of all the foaming projects are too high (above 275o F) to define as WMA project, according to the field evaluation results of the selected WMA pavements in New Mexico. This raises a concern whether foaming at high temperature is detrimental to the binder or mix performance in the long run. If yes, then limiting foaming temperature will be justified. On the other hand, if no, the limiting foaming temperature is unjustified as it will eliminate several different foaming processes in the field.

The first phase of this project also found that the mixing and laydown temperature of the evotherm projects varies (starting 243o F to 275o F), very low compared to well defined WMA temperature of 275o F. This raises a concern whether evotherm is good for absorptive aggregate and binders as well as whether and how evotherm interacts with the polymers or additives or anti-stripping agents.

Phase I revealed that is difficult to evaluate real conditions of WMA pavement materials in the field, since most the WMA projects in New Mexico are covered by standard OFGC. Furthermore, the effects of RAP on the oxidation and properties of WMA materials are still unknown, particularly in comparison with conventional HMA materials and different WMA technologies used.

Based on the literature gathered in Phase I, it was concluded that the differences between WMA and HMA, the differences between different WMA technologies, and the best practices of mix design and laboratory testing for different WMA technologies used in New Mexico are not known. NMDOT needs to develop and adjust Department practices and specifications, define the advantages and disadvantages of different WMA technologies, and acquire data for pavement ME design in order to optimize life-cycle pavement performance.

Anticipated Benefits
This research will enable the NMDOT to select the best WMA technology and determine if such technology will result in adequate mix performance with respect to moisture susceptibility, fatigue, and permanent deformation. If the WMA mixes are adequate, it may result in more economical pavements in the present increasing fuel cost environment.

Lower temperatures will improve compaction and densities which may help increase the life of asphalt pavements.

WMA applications will be safer for workers because warm mix technologies allow for the reduction of mixing and compaction temperatures to values that are typically 50-100o F below those of traditional hot mix asphalt.
Development of a Bridge Information System - Phase II
NM13SP-01

Budget: $210,000   Duration: 24 months

Project Summary
The National Bridge Inventory (NBI) database constitutes the most comprehensive source of publicly available information on the condition of the nation's bridges over a twenty year period. The information is readily available through public sources, however the data is provided in an encoded text file format that makes the information difficult for casual users to understand. In FY08 the Department initiated development of a user-friendly software application that demonstrated the feasibility of using rapid application development (RAD) software tools to process this data and to produce maps and reports of commonly requested information of interest to a variety of end users, including researchers, state cultural resources personnel, and federal oversight agencies. A prototype of the application was completed in FY10.

In FY12, using the Microsoft™ .NET framework, the Research Bureau redesigned and recoded the application making it compatible with the 64 bit Windows 7 operating system and later versions. This ensures continuity of service for future program maintenance and enhancement needs. While the program as written serves as a functional prototype, a significant amount of evaluation, troubleshooting, customization and optimization of code remains in order to maximize the accuracy and efficiency of the program. Phase II of the project will build upon the success of Phase I by procuring professional services to provide coding support for a fully operational application that serves the needs of end users.

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Characterization of Unknown Bridge Foundations – A Full Waveform Approach
NM13STR-02

Budget: $389,000       Duration: 36 months

Project Summary
This research serves to develop a full-waveform based non-destructive, testing method to determine the subsurface bridge foundation characteristics for which the information is unavailable or limited. According to the FHWA, there are about 85,000 bridges nationwide that do not have any design or as-built plans identifying the type, depth, geometry, and materials of the foundations. Currently, NMDOT has 300 bridges with unknown foundations. This project is integral to FHWA Metric 18, “23 CFR 650.313 Inspection procedures – Scour Critical Bridges” and to the Department’s efforts to develop a scour analysis procedure manual.

The full waveform inversion method seeks to reconstruct the substructure geometry and material properties in an attempt to minimize the difference between measured and computed responses due to the prescribed excitation on the foundation’s surface. The measured and computed responses refer to the ones obtained from field experiment and computer simulation, respectively. The recovered geometry and material properties can be directly used to estimate the type and depth of the unknown foundation.

Phase I: Development and validation of the mathematical framework and computational details of the full waveform inversion approach.

Phase II: Field Experiments to obtain ‘real’ response measurements and used in the inversion framework to identify the unknown foundations.

Deliverable
Develop an instrumentation plan, equipment requirements, and full wave form approach to determine unknown pile foundation and ground responses that best convey the substructure information as well as the surrounding geological condition.

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Evaluation of Plus Grades of Performance Graded (PG) Asphalt Binder Phase II
NM14MSC-01

Budget: $250,000   Duration: To Be Determined

Project Summary
The project would provide a detailed evaluation of Plus Grades of Performance Graded Binders (PG+) to validate use of PG+ binders in New Mexico projects.

In Phase I of this project, researchers reviewed literature on use of PG+ binders and concluded:

_NMDOT is strongly recommended to adopt Multiple Stress Creep Recovery (MSCR) into the binder specification and implement plus grades of PG asphalt binder, in light of very small cost increase and significant performance improvements in plus-grade asphalt pavement. To optimize the use of such binder in the State of New Mexico, NMDOT is recommended to investigate the appropriate use of PMBs that suit the local traffic and environmental conditions and the appropriate curing and mixing conditions to maximize long-term performance of such plus-grade binders in dense graded asphalt pavement._

The proposed Phase II of this project builds upon the literature review by evaluating PG+ binders through developing correlations of polymer content, MSCR, and PG+ tests. The evaluation would be completed in two sets of tests. In test set one, binder performance would be evaluated using current PG specification, PG+ tests such as Elastic Recovery (ER), Toughness and Tenacity, Ductility, as well as the MSCR and new tests to be developed. In test set two, mixture test results and field performance indicators would be evaluated to determine the accuracy of current tests and to develop new binder testing procedures.

Deliverables
The Final Report would help NMDOT identify optimal PG+ binders for use on NM roadways around the state as well as preferred testing methods to ensure that asphalt mixes with PG+ binders meet state specifications.

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Southern Plains Transportation Center (SPTC)  
NM14ADM-03

Budget: $500,000 (NMDOT Matched Funds)

Project Summary
The SPTC is a transportation research consortium including the University of Oklahoma, Oklahoma State University, Langston University, University of Arkansas, Louisiana Tech University, University of New Mexico, University of Texas at El Paso and Texas Tech University.

The SPTC focus objective is to improve the “State of Good Repair,” with an emphasis on research to mitigate the impact of weather extremes on transportation and freight infrastructure.

UTC research projects require a dollar-for-dollar match. The NMDOT Research Bureau set aside $500,000 over two years to provide the match for UNM’s share of the SPTC research award.

UNM Awarded Three SPTC Research Projects
- Evaluating Rutting and Stripping Potentials of Asphalt Mixes Using Hamburg Wheel Tracking Device
- Crash Severity Formulation and Analysis under Extreme Weather Conditions
- Improving Fatigue of Polymer Concrete Overlays Using Nanomaterials

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Project Descriptions

Evaluating Rutting and Stripping Potentials of Asphalt Mixes Using Hamburg Wheel Tracking Device

Project Summary
This study proposes to: (i) determine the rutting and stripping potential of New Mexico Department of Transportation (NMDOT) hot mix asphalt (HMA) and warm mix asphalt (WMA) mixes, and (ii) develop a specification of a Hamburg Wheel Tracking Device (HWTD) test for NMDOT that can be used to determine passing and failure criteria for a specific mix. The project will also develop a HWTD test protocol that is not complex but readily applicable for routine HMA and WMA mix screening/acceptance and Mechanistic Empirical Pavement Design Guide (MEPDG) use.

Crash Severity Formulation and Analysis under Extreme Weather Conditions

Project Summary
This study proposes to develop a new multinomial Logit model-Bayesian network hybrid approach to discover the underlying patterns behind crash data and identify significant contributing attributes related to severe crashes impacted by weather extremes in the southwest region. The proposed hybrid approach will outperform the existing methods due to its flexibility to capture cause-effect relationships between contributing attributes and crash severity outcomes to better interpret their heterogeneous impacts on crash severity outcomes from the attribute changes in terms of region-wide weather extremes, driver behavior, demographic features, and environmental characteristics. A comprehensive database will be designed and developed with region-wide crash data, roadway geometric data, weather condition data, and traffic data. The research findings are helpful for transportation agencies to develop cost-effective countermeasures to mitigate crash severities under extreme weather conditions and minimize the weather-related risks to traffic safety in the southwest region.

Improving Fatigue of Polymer Concrete Overlays Using Nanomaterials

Project Summary
This study proposes to improve the bond, fracture and fatigue performances of polymer concrete (PC) overlays using nanomaterials such as carbon nanotubes, graphene nanoparticles or alumina nanoparticles. In particular, surface functionalized nanomaterials will be used to alter the polymer matrix and create a new polymer nanocomposite having improved bond, shear and fatigue strength as well as improved fracture toughness. This will enable significant improvement in the mechanical and durability characteristics of PC. In essence, this study proposes to conduct a comprehensive experimental investigation to identify the most appropriate nanomaterial(s) and its optimal content for best performance of PC overlays. The proposed experimental program will include multi-scale characterization of PC through strength, fatigue and fracture testing of nanomaterial modified PC, and fatigue testing of PC overlay/steel plate composite beams.
Remote Culvert Inspection Device - Culvert Crawler
(Technology Transfer)
NM15TT-01

Budget: $65,550  Duration: To Be Determined

Project Summary
The project procured and implemented a remote culvert inspection device (culvert crawler), which is a small tractor with cameras and lights that can be operated remotely. It is an effective and safe way to inspect interiors of small (under 48”) culverts to identify areas of corrosion, deflection, collapse, etc. The new culvert crawler was purchased in summer 2015 and is available for use by district bridge and maintenance staff.

Justification
“Out of sight, out of mind” – the traditional approach to culvert management – is changing currently under FHWA guidance. The National Cooperative Highway Research Program is currently drafting an update of the FHWA Culvert Inspection Manual (1986) that will recommend minimum inspection frequency and level of effort required to ensure safety of critical culvert assets (NCHRP Project 14-26 – Culvert and Storm Drain System Inspection Manual). The final document, to be completed by 2016, will provide detailed guidance for state DOT inspection of culverts. For smaller diameter pipes, the new manual may specify that the inspections should be completed using remote culvert inspection devices such as the equipment proposed for this project. Florida, Ohio, Oregon, Utah, Vermont, and Virginia are among the states that have developed, or are currently developing, statewide culvert inspection programs. Proactive inspection of culverts can improve transportation safety and decrease culvert and roadway repair costs. The culvert crawler is used to identify corrosion, deflection, collapse, or other damages in culverts. The video information from the crawler inspection is used to identify proactive repairs such as sliplining and to prevent a culvert collapse and subsequent replacement of the culvert and roadway.

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Research Results

Development of a Right-Of-Way Carbon Sequestration Program - Phase I
NM10ENV-01

Through a competitive process, NMDOT was selected to be the first state transportation agency to develop a carbon assessment protocol for ROWs and to determine what opportunities exist for management to increase carbon sequestration. Besides mitigating global climate change, increasing Soil Organic Compound (SOC) within ROWs could provide funding to NMDOT through sale of carbon credits within a cap-and-trade program.

Once the researchers discovered that the ROWs of New Mexico’s state highways store a significant amount of carbon, they examined techniques for managing ROWs to increase their stores of SOC. After conducting an exhaustive review of management treatments, the researchers recommended three treatments that seem to have the best potential.

1. Harvest Water by Imprinting Soils
2. Interseed with Legumes
3. Adjust ROW Mowing

Evaluation of Materials Response in Hot Mix Asphalt Based on Field Instrumentation
Phase I
NM11MSC-03

The recently developed AASHTOWare Pavement Mechanistic-Empirical (ME) Design Guide uses mechanistic properties of pavement materials, local climate, and traffic loading to determine stress-strain at different layers of pavements. Though the Pavement ME has not been calibrated to New Mexico’s conditions yet, a goal is to examine how the uncalibrated ME predicted stress-strain data compares with the field measured stress-strain. A section on Interstate 40 (I-40) has been instrumented with 32 sensors including strain gauges, pressure plates, moisture probes, temperature probes, axle sensing strips, weather station and Weigh-in-Motion (WIM). Data from the sensors are being collected continuously. Pavement materials were collected during the construction and were tested in the laboratory. WIM data were processed. In addition, routine field testing such as Falling Weight Deflectometer (FWD) and density tests, and field survey were conducted to monitor the in-situ properties and performances of the pavement section. Due to the fact that the pavement ME software was not able to generate stress-strain file in the past, a KENLAYER software was used to predict stress-strain. It is found that measured the vertical stress is less than the predicted stress and the measure horizontal strain differs very slightly from predicted strain. A goal of this project is to compare the ME predicted distresses with measured distresses. However, the measured performance data from this section are very small, which was expected from a newly constructed pavement such as this. Therefore, project data collection and monitoring are recommended for continuation.
Research Results

Improved Recycling of Maintenance Materials
NM11TT-03
The project served to purchase and evaluate the effectiveness of Broce Broom technology. The Department surveyed various maintenance equipment and selected for purchase the Broce MK-1 Transfer Sweeper manufactured by Broce Manufacturing Co. The Broce Broom will allow for the optimal retrieval of maintenance materials for recycling. It is anticipated that the use of this equipment will improve environmental and structural impacts, reduce current maintenance costs by reusing recycled materials and reduce loss control and third party claims.

Energy Assessment of District One Headquarters Complex
NM12SP-04
The results summarize three levels of detail regarding energy assessments performed for the NMDOT District One headquarters campus in Deming, NM. The first level of detail included low-cost and no-cost energy conservation measures as well as identified energy waste and existing good energy practices realized during site visits. The second assessment included detailed energy use calculations, energy meter location identifications, energy benchmarking against national standards, and moderate investment measures in existing facilities. The third assessment document included investment grade measures for lighting, HVAC, and oil tank heating and storage. These measures were evaluated using life cycle costing to determine recommended measures for implementation.

An implementation plan was also created to inform the District of measures to implement first, and those to implement when systems fail because of less attractive paybacks. A “How to Guide” was also created for other districts and state agencies to review when considering energy assessments or improvements in their buildings.

Implementation of these results has resulted in a 25% reduction in the District’s electrical bill.
Research Results

Implementation of Unfunded Mandate for Positive Train Control

NM13SAF-01

"Positive train control (PTC) is a set of highly advanced technologies designed to automatically stop a train before certain types of accidents occur. Specifically, PTC, as mandated by Congress in the Rail Safety Improvement Act of 2008 (RSIA), must prevent train-to-train collisions; derailments caused by excessive speed; unauthorized incursions by trains onto sections of track where maintenance activities are taking place; and movement of a train through a track switch left in the wrong position. PTC will not prevent accidents caused as a result of track or equipment failure; improper vehicular movement through a grade crossing; trespassing on railroad tracks; and some types of train operator error” (Association of American Railroads).

RSIA established an unfunded federal mandate for all Class I, intercity passenger, and commuter railroads, approximately 70,000 miles of track across the nation.

Because the NMDOT owns (and operates) the New Mexico Rail Runner Express commuter rail system (“NMRX”), it is subject to the PTC mandate. NMDOT’s PTC system must be interoperable with BNSF Railway and Amtrak that both operate as tenant railroads over NMRX.

The objective of this in-house project was to determine how other commuter rail systems were responding to the Federal Rail Administration mandate for installation of PTC by the December 31, 2015 deadline.

In October 2012 an online survey was sent out to 16 commuter rail systems. Of these, six completed the survey for a 37.5% response rate.

Among respondents’ concerns were: lack of funding, lack of bandwidth for communications, lack of system integration, and inability to meet the legal deadline for implementation. Only one commuter railroad expected to meet the December 2015 implementation deadline. Most systems did not submit a cost estimate. A few estimates ranged between $200-300 million.
Research Results

Load Rating Bridges with No As-Built Plans or Non-Engineered Bridges
NM13STR-01

There are an estimated 167 concrete bridges in the state bridge inventory, including reinforced and prestressed concrete types, that lack as-built plans or are considered non-engineered. These concrete bridges cannot be reliably modeled and rated without steel reinforcement data. This project was conducted to develop a load rating procedure for planless concrete bridges. In accordance with the AASHTO Manual for Bridge Evaluation, a reinforced concrete slab bridge and five prestressed concrete bridges (two double T-beam, two box girder, and one I-girder) were evaluated using load testing and/or non-destructive material evaluation techniques. A multi-step procedure was implemented that included estimating the material properties from past specifications and amount of prestressing steel via Magnel diagrams; verifying the steel estimate with a rebar scanner; testing the bridge at both diagnostic and proof loads based on strain and acoustic emission measurements; and rating the bridges using the proof test results. Rating factors were determined for AASHTO and New Mexico legal loads based on the serviceability limit state. Using the AASHTOWare Bridge Rating (BrR) program, rating factors were also computed for the strength limit state (i.e., shear or flexural capacity) based on the measured bridge dimensions and estimated material properties. For the reinforced concrete slab bridge, only the BrR evaluation was needed. The serviceability ratings from proof testing and strength ratings from the BrR program were ultimately compared to determine the final load ratings and need for posting the bridges.

In addition to answering the NMDOT research needs, the project generated research publications in the Transportation Research Record, ASCE Journal of Performance of Constructed Facilities, and Proceedings of the 94th Annual Transportation Research Board Meeting.

Implementing the Tow Plow
NM13TT-01

This study procured a Tow Plow for evaluation in a District with extensive four-lane highways and to compare the performance of the Tow Plow system with the traditional snow plow operation.

The Department surveyed various snow plow equipment and selected for purchase the TowPlow manufactured by Viking-Cives that will allow for the optimal removal of snow. It is anticipated that the use of this equipment will not only improve operations and operator/motorist safety but also reduce vehicle emissions (operator/motorist) and a reduction in economic impact due to road closures.

Equipment to Install and Repair Metal Barrier
NM13TT-02

This objective of this project was to purchase equipment for District One to install metal posts more efficiently. A commercial truck was purchased with a platform bed and attached guardrail installation unit, with a post driver and auger. The truck was designed to carry 1-2 employees, additional space for tools and supplies in order to conduct the necessary repair work on damaged guardrail.

District One employees report that guardrail repair is done quicker, safer, with minimal tools and less staff which allows for more time to complete other tasks.
Legalizing Increased Maximum Truck Weight

NM14ADM-01

The objective of this project was to document current knowledge and practice related to the multiple dimensions of weight limits for Specialized Hauling Vehicles (SHVs), with a focus on the scenarios of interest to the NMDOT. The study includes a discussion of the following issues: Legal Weight Limits by State, SHV Laws and Regulations in Selected States, Impacts of SHVs on Pavements and Bridges, Impacts of SHV on Bridge Posted Weight Limits and Enforcement, and Impacts on the Economy and Safety. It concludes with key findings and recommendations.

A Maintenance Paradigm Shift: Development of a River Restoration Plan to Reduce Post-Flood Maintenance Costs and to Stabilize the River at the US 180 Bridge, Mile Marker M 85.5: Gila, NM - NM14ENV-01

An assessment of the Gila River near the US Highway 180 Bridge in Cliff, New Mexico was performed to determine if developing and implementing a river restoration plan has the potential to reduce the need for post-flooding maintenance and/or reconstruction of transportation infrastructure near the bridge site. Historically, the NMDOT has relied on standard transportation maintenance techniques to address specific problems local to the bridge site but have found that these fixes tend to be short-lived as they only address symptoms and not the root cause of the problem.

Utilizing the principles of natural channel design techniques, this project served to create an effective, functional and sustainable river corridor that minimizes impacts to its transportation infrastructure and also provides improved biological and ecological function to the restoration-affected area.

The Contractor prepared a plan that outlined necessary steps to restore 9,200 feet of the Gila River near the US Highway 180 Bridge in Cliff, New Mexico. The plan identifies seven phases, lists the parties responsible for each phase and includes estimated costs. Accompanying this plan are two six-page plan sets. The first details the proposed channel pattern and profile, structure locations, minimum sod transplant areas and wetland nursery zones. The second plan is essentially the same as the first but instead of sod transplant areas and wetland nursery zones, this plan set displays cut and fill areas.
Research Results

Evaluation of Plus Grades of Performance Graded (PG) Asphalt Binder
NM14MSC-01-008
This project served to document current knowledge and practice related to evaluation of plus grades of performance graded (PG) asphalt binder, with a focus on the scenarios of interest to NMDOT. This synthesis mainly includes a discussion of the following issues: history of polymer modified binders (PMBs) for asphalt pavement, selection of polymer for asphalt modification, evaluation of PMB properties, binder specifications for PMBs, cost analysis, recommendations, and future work. Recent years have seen the introduction of PG Plus Binders, the success of which hinges on the use of elastomer and/or rubber for binder modification. As a result of the findings, it is recommended that NMDOT apply elastomer modification while optimizing the formulation and adopt MSCR into the binder specification and implement plus grades of PG asphalt binder, in light of very small cost increase (less than 5%) and significant performance improvements (over 20% life extension) in plus-grade asphalt pavement.

Evaluating Rutting and Stripping Potentials of Selected HMA Mixes using Hamburg Wheel Tracking Device, Develop Mix Selection Guidelines and Specifications - ON-CALL
NM14MSC-02
This report summarizes the state of practice of using the Hamburg Wheel Tracking Device (HWTD) test for predicting and evaluating the rutting and moisture susceptibility potential of hot mix asphalt (HMA) and warm mix asphalt (WMA). This report was prepared based on the literature review, with emphasis on what has been reported and documented in the last 10 years. To date, at least nine state Departments of Transportation (DOTs) have incorporated the HWTD test into their specifications for mix design and/or for construction quality assurance and/or quality control. To require HWTD testing, the most common approaches are to specify the maximum rut depth measured in the HWTD test either 1) for a single number of wheel passes varying the test temperature according to the performance grade (PG) binder, or 2) for a given test temperature varying the maximum number of passes for various PG binders. Other HWTD test results, such as the stripping inflection point and the stripping slope, have also been used in evaluating mixture performance.

The findings of two documented long-term field monitoring and evaluation projects also confirmed the applicability of the HWTD test as a performance test.
Research Results

Determine Binder and HMA Aging Rates and Their Effects on Decline in Mixture Pavement Cracking Resistance - ON-CALL
NM14MSC-03
Asphalt aging is a complex process that derives from permanent compositional changes in the asphalt binder which result from its interaction with the atmosphere under prevailing environmental conditions. Hence, both constructed pavement properties and local environmental conditions determine the evolution of aging with time. The properties of asphalt binder change as it ages, leading to hardening of the asphalt pavement. These changes are believed to be a major contributor to pavement failure by cracking. Understanding the factors that drive binder aging and their impact on pavement performance, within the context of local climatic conditions and mix design methods, is important to assess current state practices and to guide the development of improved specifications for binder and aggregate selection. The broad objective of this research project is to develop an understanding of asphalt binder aging mechanisms. Isolating the most influential variables involved and analyzing the aging process within the context of geospatial conditions relevant to the State of New Mexico i.e., climate, typical materials, and construction practices.

NHI Portland Cement Concrete Pavement (PCCP) Training
NM14TT-01
This project provided a series of National Highway Institute (NHI) Portland Cement Concrete Pavement (PCCP) courses to NMDOT pavement inspectors and construction staff. Funding covered NHI tuition and participant per diem for multi-day training.

Safe Passage: Upgrade Wildlife Detection and Motorist Warning System,
NM 333 MM 3.9, Tijeras Canyon - NM14TT-02
On April 9-10, 2014 the NMDOT Research Bureau, NM Department of Game and Fish, and FHWA NM Division sponsored the Reducing Wildlife-Vehicle Collisions Workshop in Albuquerque. After two days of presentations, field site visits, discussions, and post-workshop analysis, the Project Technical Panel made recommendations to:
1. Develop and adopt a Design Directive that requires engineers to begin addressing a project’s impact on wildlife and opportunities to reduce wildlife-vehicle collisions during the initial project scoping site visit.
2. Develop a Wildlife Liaison position within the NMDOT Environmental Design Section.
3. Sign a Memorandum of Understanding with Arizona Game and Fish Department and the New Mexico Department of Game and Fish to permit coordination on monitoring wildlife-vehicle collision mitigation projects.
4. Begin Phase 2 of the Tijeras Canyon Research Project:
   • Install wildlife monitoring cameras at selected crossings on NM 333 and under I-40 in Tijeras Canyon and Juan Tomas Arroyo;
   • Collect and analyze camera data for two years.