SCDOT State Planning and Research Program
Part II: Research

2017 Annual Report

Fiscal Year 2017
October 1, 2016 to September 30, 2017

South Carolina Department of Transportation

in cooperation with

U.S. Department of Transportation
Federal Highway Administration

Report Prepared by:
South Carolina Transportation Technology Transfer Service


SCDOT
Office of
Materials & Research

Table of Contents

List of Figures

List of Tables

RESEARCH CONTACTS

Address: Office of Materials and Research
1406 Shop Road
Columbia, South Carolina 29201
Phone: (803) 737-6681
Fax: (803) 737-6649

Merrill E. Zwanka, P.E. — Materials and Research Engineer
Phone: (803) 737-6681
E–mail: zwankame@scdot.org

Terry L. Swygert, A.P.E. — Research Engineer
Phone: (803) 737-6691
E–mail: swygerttl@scdot.org

Meredith W. Heaps — Program Manager
Phone: (803) 737-1969
E–mail: heapsmw@scdot.org

Judy P. Hundley — Program Coordinator I
Phone: (803) 737-6652
E–mail: hundleyjp@scdot.org

OVERVIEW

The Research Unit handles the day-to-day operations of the research program. The Unit assists with fulfillment of South Carolina Department of Transportation's (SCDOT's) mission and goals by conducting applicable research, disseminating information, and promoting national research programs. Specific goals established for the Research Unit in FFY 2017 were:

- Develop research projects approved by the Research and Development Executive Committee (RDEC).
- Create guideline documents, checklists, and document templates for SPR project proposals and reports.

This annual report provides a description of the FFY 2017 SPR Research Program that includes the period from October 1, 2016, through September 30, 2017. The report is divided into four parts.

Part 1: Provides a description of the program and project funding, and a summary of all items included in the FFY 2017 Research Program.

Part 2: Provides a summary of the Research Unit's accomplishments.

Part 3: Gives a description of each study started during the year.

Part 4: Contains project summaries of studies completed during FFY 2017.

PART 1

Research Program/ Project Funding and Research Program Summary

PROGRAM FUNDING

In FFY 2017, the SPR Research Program received $3,406,151 in Federal funds. Figure 1 provides a general breakdown of items funded and amounts, including appropriate matching funds, in FFY 2017.

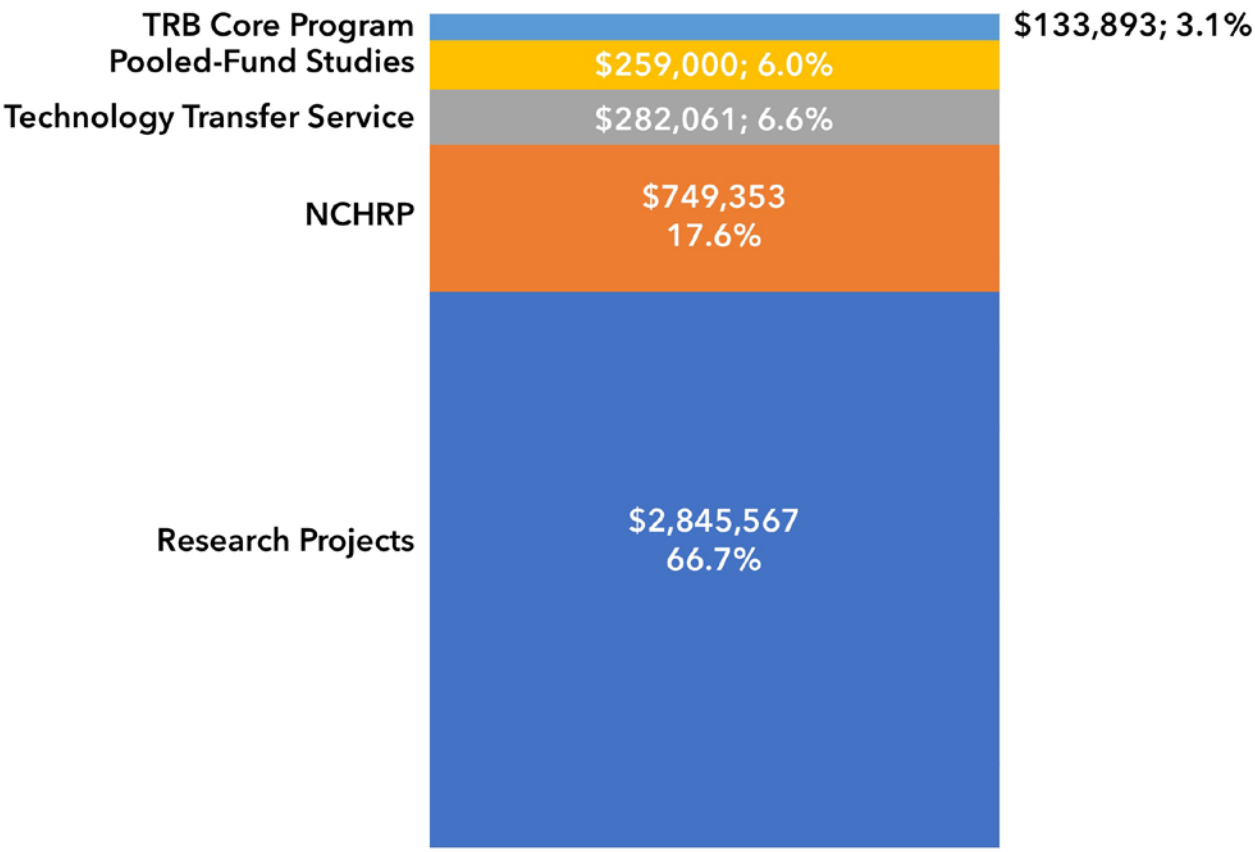

Figure 1. FFY 2017 Research Program Funding

PROJECT FUNDING

A total of twenty-nine (29) projects were included in the program. Four (4) research projects were started during FFY 2017. Eight (8) studies were completed during the year. Figure 2 shows how the funds were obligated for research projects in FFY 2017 and distributed by general area and amounts.

- Pavement Design – $1,762,300.00
- Hydrology– $493,612.00
- Construction/Materials – $395,159.00
- Traffic/Safety – $197,496.00

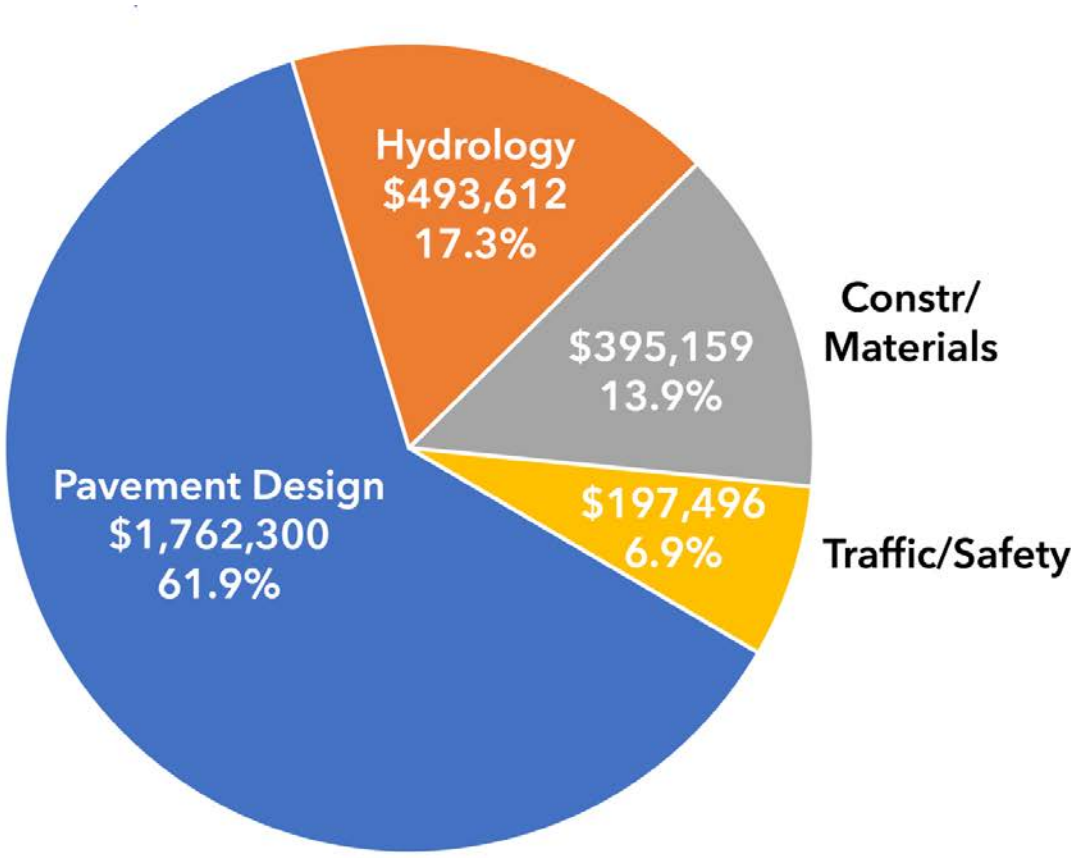

Figure 2. Distribution of Funds by General Area for all Research Projects in the Program during FFY 2017

RESEARCH PROGRAM SUMMARY

Table 1 (beginning on the next page) lists all items included in the FFY 2017 SPR Research Program. The total funding, with amount obligated previously and/or during the year, is given for each item. Also, the percent split between Federal and State funds is shown for money obligated in FFY 2017.

Table 1. FFY 2017 SPR Program

SPR No.	Item	Previously Funded	FY 2017 Funds	% Split Fed–State
690	AASHTO Terminal Service Programs	$550,000.00	$281,000.00	80-20
702	Compliance with USEPA Effluent Limitation Guidelines – Turbidity Control and Surface Outlets	$498,629.00		80-20
707	A GIS Based Mitigation Forecasting Tool and Study on Advanced Mitigation Processes used by DOTs	$413,837.00		80-20
710	Determination of Changes in Water Quality, Streambed Settlement, and Benthic Macroinvertebrates as a Result of Stormwater Runoff from Selected Bridges in South Carolina	$993,563.42		80-20
711	Applying Successfully Proven Measures in Roadway Safety to Reduce Harmful Collisions in South Carolina	$273,896.00		80-20
712	Development of SC Databases and Calibration Factors for the Highway Safety Manual (HSM)	$181,020.00		80-20
713	Professional Services Contract Manager On-Line Training and Best Practices	$379,741.00		80-20
714	Implementation of the U.S. Geological Survey's StreamStats Application for South Carolina Department of Transportation	$698,183.00		80-20
715	Operational and Economical Analysis of Access Management	$345,301.00		80-20

Continued

Table 1. FFY 2017 SPR Program *(continued)*

SPR No.	Item	Previously Funded	FY 2017 Funds	% Split Fed–State
716	SCDOT Asset Collection	$473,803.00		80-20
717	Cost Effective Strategies for Estimating Statewide AADT	$370,027.00		80-20
718	Best Practices for Assessing Culvert Health and Determining Appropriate Rehabilitation Methods	$199,966.00		80-20
719	Cross-Slope Verification Using Mobile Scanning on SCDOT Interstates	$299,593.00		80-20
720	Characterization of Asphalt Concrete Dynamic Modulus	$383,166.38		80-20
721	Better Construction Project Management Through Better Scheduling	$200,988.00		80-20
722	Characterization of Portland Cement Concrete Coefficient of Thermal Expansion in South Carolina	$146,351.00		80-20
723	Effect on Asphalt Quality Due to Nighttime Construction	$100,670.50		80-20
724	Feasibility Study for Rapid Condition Assessment of Bridge Decks and Other Structures	$247,500.00		80-20

Continued

Table 1. FFY 2017 SPR Program *(continued)*

SPR No.	Item	Previously Funded	FY 2017 Funds	% Split Fed–State
725	Evaluation of Open Graded Friction Courses: Construction, Maintenance, and Performance – Phase II	$481,849.00		80-20
726	Laboratory Performance of Liquid Anti-Stripping Agents in Asphalt Mixtures Used in South Carolina	$198,581.69		80-20
727	Sign Life Expectancy	$180,686.00		80-20
728	Best Construction Practices for Longitudinal Joint Construction and Compaction	$107,074.00		80-20
729	Effects of Culverts on the Natural Conditions of Streams in South Carolina	$898,000.00		80-20
730	The Financial Effect of Regulatory Requirements and Intervening Groups on Road Construction in South Carolina	$36,755.00		80-20
731	Deep Soil Test Borings to Determine Shear Wave Velocities Across South Carolina	$532,107.00		80-20
732	Calibration of the AASHTO Pavement Design Guide to SC Conditions – Phase II		$1,762,300.00	80-20
733	Updating Techniques for Estimating Magnitude and Frequency of Floods for Rural Basins in the Southeastern United States		$493,612.00	80-20
734	SCDOT Crash Analysis Using Precisely Geocoded Crashes		$197,496.00	80-20
736	Characterization of Bases and Subbases for AASHTO ME Pavement Designs		$392,158.64	80-20

Continued

Table 1. FFY 2017 SPR Program *(continued)*

SPR No.	Item	Previously Funded	FY 2017 Funds	% Split Fed–State
Pooled-Fund Studies and Other Items Funded in FFY 2017				
5(212)	Southeast Transportation Consortium		$10,000.00	100-0
5(228)	SuperPave Regional Center, SE Region		$20,000.00	100-0
5(267)	Accelerated Performance Testing for the NCAT Pavement Test Track		$120,000.00	100-0
5(296)	Simplified SPT Performance-Based Assessment of Liquefaction		$2,000.00	100-0
5(305)	Regional and National Implementation and Coordination of ME Design		$10,000.00	100-0
5(316)	Traffic Control Device (TEC) Consortium		$10,000.00	100-0
5(330)	No Boundaries Roadway Maintenance Practices		$10,000.00	100-0
5(338)	Simplified CPT Performance-Based Assessment of Liquefaction and Effects		$22,000.00	100-0
5(345)	Pavement Surface Properties Consortium – Phase II		$20,000.00	100-0
5(354)	Improving the Quality of Highway Profile Measurement		$20,000.00	100-0
5(357)	Connecting the DOTs: Implementing ShakeCast Across Multiple State Departments of Transportation for Rapid Post-Earthquake Response		$15,000.00	100-0
5(417)	NCHRP		$749,353.00	100-0
5(360)	TRB Core Program Services (TRB FY17)		$133,893.00	100-0
-	AASHTOWare Project 3.01		$500,000.00	100-0
-	Transportation Technology Transfer (T3) Service (LTAP Center)		$282,061.00*	80-20

*Additional $150,000 funded by LTAP

PART 2

Accomplishments

ACCOMPLISHMENTS

The Research Unit identified two areas of emphasis for the FFY 2017 program.

1. Develop research projects approved by the Research and Development Executive Committee (RDEC).

The Research Staff began development on the projects approved and prioritized by the RDEC in December 2016. During FFY 2017, contracts were signed on four (4) projects and twenty-five (25) others are in various stages of development.

2. Create guideline documents, checklists, and document templates for SPR project proposals and reports.

The Research Staff began a revision and creation of project management documents to aid in streamlining information submitted for active projects. After completing a thorough review of the methods and formats of how other state DOT Research Units required information for active SPR projects, existing templates were revised and new templates were created. Additionally, guideline documents were created to aid the Principal Investigators with submitting concise reports using the new and revised formats. The following areas are currently under development:

- Research Proposal
- Quarterly Report
- Final Report
- Executive Summary

Once an internal review of all documents, checklists, and templates has been conducted, the Research Staff will invite representatives from In-State Universities of Higher Learning to offer feedback. The new templates and guidelines will be integrated into the active management of the SPR projects that were approved and prioritized by the RDEC in December 2016.

PART 3

Description of the Four Studies Initiated in FFY 2017

SPR 732	Calibration of the AASHTO Pavement Design Guide to SC Conditions – Phase II	

Organization: University of South Carolina

PI: Dr. Sarah Gassman

Start Date: January 6, 2017

Completion Date: July 5, 2021

Objective

The overarching goal of this multi-phase research effort is to reduce design bias and increase precision of the model predictions used in MEPDG with full consideration of South Carolina local conditions. The objective of Phase II will be to build upon the studies in Phase I to obtain local calibration factors and improve distress predictions by collecting new data of high priority.

SPR 733	Updating Techniques for Estimating Magnitude and Frequency of Floods for Rural Basins in the Southeastern United States	

Performing Organization: U.S. Geological Survey

PI: Mr. Toby Feaster

Start Date: August 25, 2017

Completion Date: August 25, 2021

Objective

The objectives of this research project are to: (1) update magnitude and frequency of peak flows for rural, unregulated USGS stations in South Carolina where adequate data are available; (2) when appropriate and based on reviews of the data, update magnitude and frequency of peak flows at regulated USGS gages in South Carolina; (3) in coordination with the USGS South Atlantic Water Science Center NC and GA offices and the USGS Office of Surface Water, update the regional generalized skew coefficient for NC, SC, and GA; 4) in coordination with the USGS South Atlantic Water Science Center NC and GA offices, update the regional rural flood-frequency equations for the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedance flows; (5) update the StreamStats application to include the new gage flood-frequency estimates and the new regional regression equations; and (6) develop procedures for updating the flood-frequency estimates for stations on an annual basis with the results being provided through the StreamStats application.

SPR 734	SCDOT Crash Analysis Using Precisely Geocoded Crashes	

Performing Organization: Clemson University

PI: Dr. Wayne Sarasua

Start Date: September 11, 2017

Completion Date: March 11, 2019

Objective

Recent research has shown that the new SCCATS has resulted in dramatically improved crash positioning that can facilitate broad-based statewide safety analysis. Currently, the SCDOT's method for safety analysis is primarily through the Department's Road Inventory Management System (RIMS). RIMS has extensive information, but is challenging as a primary tool for crash analysis of midblock segments. This research will use a fixed-length segmentation approach to identify the Top 500 midblock segments that have the highest crash incidents in the state. Each of the fixed length segments will be analyzed for potential counter measures using Crash Modification Factors developed in recent SCDOT research. Benefit-cost ratios will be identified for different alternatives. Research results will identify high crash patterns involving driveways and other access management issues and will be designed to work in conjunction with RIMS.

SPR 736	Characterization of Bases and Subbases for AASHTO ME Pavement Designs	

Performing Organization: Tri-County Technical College

PI: Dr. Seji Amirkhanian

Start Date: September 1, 2017

Completion Date: August 31, 2019

Objective

The goal of this research is to identify material level 1, level 2, and level 3 inputs and properties for Graded Aggregate Base (GAB), Cement Stabilized Aggregate Base (CSAB), Cement Modified Recycled Base (CMRB), Soil-Cement, Cold in Place Recycling (CIR) with Foam, CIR with Emulsion required for use in the MEPDG. In addition, the research will investigate relationship between laboratory and field testing properties for each material type by comparing lab results to field results.

PART 4

Summaries of SPR Studies Completed in FFY 2017

SPR 701	Assessing Potential Scour Using the South Carolina Bridge – Scour Envelope Curves	

Performing Organization: U.S. Geological Survey

Authors: Stephen Benedict, Andral Caldwell, and Toby Feaster

Report No.: *Scientific Investigations Report 2016-5121*

Date: September 2016

The Issue

Bridge-scour equations presented in the Federal Highway Administration Hydraulic Engineering Circular No. 18 (HEC-18; Richardson and Davis, 2001) reflect the current state-of-the practice for predicting scour at bridges. Although these laboratory-derived equations provide an important resource for assessing scour potential, there is a measure of uncertainty when applying these equations to field conditions. The uncertainty and limitations have been acknowledged by laboratory researchers (Breusers and others, 1977; Ettema and others, 1998; Melville and Coleman, 2000) and confirmed in field investigations (Mueller and Wagner, 2005; Benedict and others, 2006; Benedict and Caldwell, 2006, 2009).

Because of the uncertainty associated with bridge-scour equations, HEC-18 (Richardson and Davis, 2001) recommends that engineers evaluate the computed scour depths obtained from the equations and modify the resulting data if they appear unreasonable. Perhaps the best way to evaluate the reasonableness of predicted scour is to compare it to field measurements of historic scour. Historic field data show scour depths resulting from high flows and provide a reference for evaluating predicted scour. It is rare, however, that such data are available at or near a site of interest, making the evaluation of predicted scour as compared to field data difficult if not impossible.

Realizing the value of historic scour measurements, the U.S. Geological Survey (USGS), in cooperation with the South Carolina Department of Transportation (SCDOT), conducted a series of three field investigations (Benedict, 2003; Benedict and Caldwell, 2006, 2009, 2012) to collect historic scour data with the goal of understanding regional trends of scour at riverine bridges in South Carolina.

Historic scour measurements, including measurements of clear-water abutment, contraction, and pier scour, as well as live-bed contraction and pier scour, were made at more than 200 bridges (fig. 1). These field investigations provided valuable insights into regional scour trends and yielded regional bridge-scour envelope curves that can be used as supplementary tools for assessing all components of scour at riverine bridges in South Carolina.

The application and limitations of these envelope curves were documented in four reports (Benedict, 2003; Benedict and Caldwell, 2006, 2009, 2012). Because each report addresses different components of bridge scour, it was recognized that there was a need to develop an integrated procedure for applying the envelope curves to help assess scour potential at riverine bridges in South Carolina. The result of that effort is detailed in Benedict and others (2016) and summarized in this fact sheet.

Study Objectives

A primary objective of the investigation by Benedict and others (2016) was to synthesize the findings of previously published reports into a single guidance manual providing an integrated procedure for applying the South Carolina bridge-scour envelope curves. In addition to the guidance manual, a companion spreadsheet was developed to facilitate application of this integrated procedure. Additional objectives of the investigation were to (1) evaluate the South Carolina bridge-scour envelope curves by comparing them with bridge-scour data outside of South Carolina from previously published sources, (2) develop 500-year recurrence-interval flow bridge-scour envelope-curve coefficients for each scour component, and (3) merge the three previously published databases (Benedict, 2003; Benedict and Caldwell, 2006, 2009) into a format that later could be incorporated into an integrated Web-based GIS application such as StreamStats (Ries and others, 2008) to provide a user-friendly format for accessing the data.

Benefits

The results of this investigation can benefit the SCDOT by (1) evaluating the South Carolina regional bridge-scour envelope curves with other sources of field data providing verification of the envelope curves; (2) developing an integrated procedure for utilizing the South Carolina regional bridge-scour envelopes to assess scour potential at riverine bridges in South Carolina; and (3) developing a spreadsheet that will automate the computational

components of the integrated procedure to help evaluate scour potential at a given bridge in a consistent and timely manner. Although the scour assessing procedures developed in this investigation are directly applicable to South Carolina, they may be applicable to streams in other States where stream characteristics are similar to those in South Carolina.

The investigation also can benefit the USGS and science, in general, by investigating the trends of scour within field data collected in South Carolina and other States and, thus, providing increased understanding of general and regional trends in scour. Additionally, the procedures developed for utilizing the regional envelope curves for assessing scour potential in South Carolina could be applicable to other States with similar regional characteristics. For States with regional characteristics that are distinctly different from South Carolina, the procedures may not be directly applicable but can still provide some guidance and insights into scour trends in general.

SPR 707	Geospatial Wetlands Impacts and Mitigation Forecasting Models	

Performing Organization: University of South Carolina

Author: Dr. Michael Hodgson and Dr. John Kupfer

Report No.: *FHWA-SC-17-05*

Date: July 2017

Introduction

The South Carolina Department of Transportation (SCDOT) develops near (3-5 years) and long (15-20 years) range plans for road widening, alignment, bridge replacement, and new road construction. Each road/bridge project may impact wetlands or streams typically through (but not limited to) placement of fill, clearing of vegetation, installation of pipes or culverts, or excavation of the wetland/stream feature. Most wetlands and streams are protected in the United States under Federal regulations (i.e., Clean Water Act). Enforcement of this protection is through the U.S. Army Corp of Engineers (USACE) and Environmental Protection Agency (EPA).

Destruction of wetlands or impacts of wetlands/streams is permitted by the USACE for road/bridge projects if the transportation project is the least environmentally damaging of all options for construction, and if compensatory mitigation for impacts are greater than or equal to the associated impacts. Compensatory mitigation activities can be in the form of creation, restoration or enhancement, or preservation of a wetland/stream. There is a "credit" amount applied to each compensatory activity which is typically derived from the area of the feature, the quality of the feature, and the timing of the compensatory actions. These credits can then be utilized to offset impacts to wetlands/streams at a prescribed ratio dependent upon the impacted feature.

Conclusions

Construction of transportation projects cannot begin until the wetland/stream impacts are known, compensatory mitigation is sufficient and obtained, and activities are approved by the USACE. These linked actions can result in a very

long delay (often years or even cancelling of projects) in a transportation project until the SCDOT has an approved plan for wetland-stream compensatory mitigation. To reduce the risk of delays and better anticipate the need for compensatory mitigation can only be anticipated based on the prediction of future impacts within a watershed-ecoregion. Thus, mitigation forecasting models include large geographic scale dimensions with impacts at the site scale (i.e., road/bridge location), and mitigation actions at the mesoscale (i.e., watershed-ecoregion) with a very large geographic scope (i.e., the entire state of South Carolina).

This wetlands mitigation related project was initiated to assist the SCDOT plan for future environmental wetlands mitigation activities. A geodatabase representing the likelihood of wetlands (i.e., a wetlands likelihood layer) in South Carolina was developed after an evaluation of both digital and analog sources of wetlands data and proxies for wetlands. Data accuracy of spatial/attribute wetlands data (i.e., the jurisdictional wetland determination) from already permitted transportation projects, the National Wetlands Inventory (NWI), and (SSURGO)-based wetlands data were evaluated. A high spatial resolution database from LiDAR-derived elevation and products, hydrography, culverts, parcel-level zoning/use, and historical maps/imagery was used to model the likelihood of wetlands and streams for the state of South Carolina. The accuracy of the final wetlands likelihood layer was 83%, a dramatic improvement from the commonly used National Wetlands Inventory data at 51% accuracy.

A GIS-based road widening and bridge replacement tools were developed to model the existing and new wetland/stream impacts from the wetlands likelihood layer for each of the more than 300 future transportation projects with likely unavoidable impacts.

Aggregate impacts of wetlands and streams were summarized at the watershed-ecoregion scale for prediction of future mitigation needs.

A set of recommendations to the wetlands and stream impact forecasting were made, including: 1) incorporating other indicators of wetlands, such as historic maps, aerial photography, parcel data, 2) maintaining an evolving wetlands likelihood layer; and 3) maintaining SCDOT project layers. An online website (www.wetmit.org) describing the research with online impact mitigation tools was created.

SPR 711	Applying Successfully Proven Measures in Roadway Safety to Reduce Harmful Collisions in SC	

Performing Organization: Clemson University

Author: Dr. Jennifer Ogle, Dr. Wayne Sarasua, Dr. Ronnie Chowdhury, Kweku Brown, Dr. Natahn Huynh and Dr. Jeff Davis

Report No.: *FHWA-SC-17-08*

Date: June 6, 2017

Introduction

The overall goal of this research was to identify proven successful safety programs used in other states and assess the potential for safety improvement if similar programs were implemented in South Carolina. The search for proven safety programs began with an evaluation of existing crash problems, population characteristics, and driving environment. The research team not only sought out engineering solutions, but also expanded the search to include programs for enforcement, education, licensing, emergency services, and partners– therefore incorporating stakeholder groups such as SCDOT, South Carolina Department of Public Safety (SCDPS), Department of Motor Vehicles (DMV), Fire/Emergency Management Services (EMS), local transportation agencies (Metropolitan Planning Organization's (MPO's) and Council of Government's (COG's)), and private entities as necessary. In most instances, it was necessary to review policies and legislation for South Carolina in comparison to the model program state, as these could potentially be barriers to successful implementation of safety programs.

The term roadway safety refers to the data driven methods and measures used to prevent road users from being killed or seriously injured. South Carolina has consistently been among the top ten states for numerous safety problems including but not limited to road departure crashes, failure to use safety belts, impaired driving, and excessive speed. By reviewing successful initiatives in other states, South Carolina can learn from those successes and prioritize safety programming for substantial safety improvements on its own surface transportation system.

Research

In 2015, there were 911 fatal collisions, 37,861 injury collisions, and 95,189 property damage only collisions in South Carolina. On average, fatal traffic crashes in South Carolina result in over $7 billion in economic loss each year. South Carolina has, for many years, had one of the highest mileage death rates of any state in the nation – far exceeding the national fatality rate. While SCDOT has a federal requirement to develop and maintain the Strategic Highway Safety Plan, which identifies the state's key safety needs and guides investment decisions toward strategies and countermeasures with the most potential to save lives and prevent injuries, South Carolina legislation and state policies have effectively blocked many paths to safety improvements. Tree protection ordinances, limited policies for graduated drivers licensing, bans on camera enforcement, and lack of universal helmet laws will continue to undermine efforts to improve safety in the state. SCDOT, along with other safety partners in the state, have continued efforts to reduce fatalities, but there are significant gains to be made. The following represent a few key program adoptions/changes that could bring about significant reductions in fatal crashes in South Carolina with notable benefit/cost ratios:

- **Tree-related Fatalities** (2015 - 191 Fatalities, 24.9%) - South Carolina ranked 1st in the nation for the highest fatality rate (0.32 per 100,000 population) for crashes involving trees. The national average tree-related fatality rate is 0.12 per 100,000 pop., thus SC is 165% above the national rate. Extensive research has been conducted nationally to determine the effect of allowing trees to re-establish in areas that were intended for clear zones. A prior SCDOT research study surveyed 131 randomly selected sites to determine if recommended clear zones (or safe recovery areas) were provided. Of these, only 12 sites met the recommended criteria, and researchers determined that the odds of a site having a tree-related crash are 42 times higher if the minimum clear zone is not met. Severe crash reductions range from 27% to 60% by reclaiming up to 50% or 75% of the recommended clear zone, respectively. Considering the magnitude of the roadside hazard problem, and the deficiency of the clear zones, it appears that by providing recommended clear zones for motorists who leave the roadway, South Carolina could realize a notable decrease in roadway fatal and injury crashes. Further, clear zone reclamation also has

potential benefits of decreased tree removal and reduced hazards accrued during natural disasters. For every dollar invested in tree clearing, $26-$38 will be saved.

- **DUI Fatalities** (2015 - 301 fatalities, 30.7%) - South Carolina has some of the weakest laws in the United States relating to DUI offenders. A driver's license is suspended for refusal to take a test for alcohol; however, a driver may obtain a temporary alcohol license or a route-restricted license upon release from jail. Emma's Law, passed in 2014, increased the penalties for DUI convictions, requiring first-time convicted offenders with a BAC of 0.15% or greater to complete the state's Ignition Interlock Device Program. The same law removed the hard suspension period for second and subsequent convictions, allowing drivers to get their licenses back sooner by completing an Alcohol and Drug Safety Action Program. A 2016 Impaired Driving Assessment (2016) refers to this SC statue as "…poorly drafted and archaic…and mandates unsafe roadside practices endangering the public and the officer making the stop" Further, South Carolina is one of only two states in the nation where police officers prosecute their own DUI cases. Nebraska and Arizona have implemented some of the strictest laws requiring first-time offenders and repeat offenders to install ignition interlock systems. Before the program was enacted in Arizona in 2007, DUI fatalities comprised 54% of the total fatalities. By 2012, DUI fatalities in Arizona had dropped to 28% of the total fatalities. This along with many programs (DUI courts, beverage server training, and solicitor case handling) could be implemented to reduce DUI-related factors in South Carolina. For every dollar invested in DUI courts, $49 will be saved.
- **Speed-related Fatalities** (2015 - 361 fatalities, 36.9%) -Almost 40% of the fatalities on South Carolina roadways were speed-related. Speed-related is defined as: exceeding authorized speed limit, and/or driving too fast for conditions. This is the 2nd highest rate in the nation. Speed is a behavioral issue that is must be managed through enforcement activities, and the reality is that drivers far outnumber enforcement officers. Auto-enforcement with cameras has the potential to expand speed management programs and reduce crashes - not only speed-related crashes, but all crashes. Unfortunately, in 2010, South Carolina banned the use of red light cameras and speed cameras in the state.

Camera enforcement began for the first time in 1987 in Arizona. Since then, speed cameras have been used in 12 states and the District of Columbia and have lowered fatal crashes up to a 25% at fixed camera sites and up to almost 50% with mobile camera operations. An added benefit is that they also foster better traffic flow with more uniform speeds. For every dollar invested in camera speed enforcement, $13 dollars will be saved.

- **Teen Driver Fatalities** (2015 - 40 fatalities, 6%) - In 2015, there were 37 fatal crashes among 15-17 year-old drivers, which produced a crash cost of $347.8 million in South Carolina. Traffic fatalities are the leading cause of death of teens, greater than homicide, suicide, and disease combined. Graduated Drivers Licensing programs have reduced teen crashes by 10-40% on average in the US through a three-stage criterion for granting young drivers full driver's license privileges. The three stages are: a supervised learning period, a restricted intermediate licensing stage, and a full license stage, in which the driver is granted an unrestricted license after fulfilling all requirements. The purpose of the GDL programs are to maximize experience while minimizing common risks that teens face while driving. Estimates by the Insurance Institute of Highway Safety indicate that at least 10 states, including South Carolina, could reduce their rate of teen driver related fatal crashes by nearly 50% or more by adopting the strictest GDL provisions. For South Carolina, a 45% reduction could be realized by adopting three stricter GDL criteria including: raising the permit age to 16 and the unrestricted licensing age to 17, raising the minimum number of practice hours to 70, and restricting teen passengers during the intermediate driving phase. For every dollar invested in adopting strict GDL provisions, $156 will be saved.

Conclusions

To make significant gains, all partners must have a complete vision of their role and responsibilities in the priority programs and seek collective efficacy through collaboration across the state. The development of this comprehensive safety program assessment, along with identification of funding sources, will enable forward movement on all fronts. Using a data driven approach to safety program selection will yield support for changes in programs, policies, and standards, and have positive impacts on safety,

operational, and economic aspects of the South Carolina roadway system. Further, the implementation of a data-driven safety management program will help to assure that the most appropriate strategies are implemented.

The successful implementation of this research will likely result in a substantial reduction in loss of life and injuries associated with motor vehicle crashes in the state of South Carolina. This research is expected to have significant benefits for SCDOT and the motoring public. These benefits fall into several categories, and are related to reduced numbers of crashes and the resulting deaths and injuries, improved system operations and reduced delay, decreased fuel consumption and emissions, as well as potential cost savings for SCDOT and other stakeholder agencies.

SPR 713	Professional Services Contract (Program) Manager On-Demand Training and Best Practices	

Performing Organization: Clemson University

Author: Dr. Mashrur Chowdhury and Dr. Dennis Bausman

Report No.: *FHWA-SC-17-02*

Date: March 2017

Overview

Every year the South Carolina Department of Transportation (SCDOT) spends millions of dollars hiring consultants to provide professional services in support of its planning, design, construction and maintenance operations. As a result of this demand, it is essential that professional service program managers have the experience and knowledge necessary to effectively and consistently procure and manage these professional consultants. In order to address program manager training needs that were identified during a pilot training session held in Columbia, SC in November 2012 for SCDOT employees, this research project was initiated with the following objectives: a) investigate the online training programs of state transportation agencies across the U.S. and develop a recommended "Best Practices" for online training; b) incorporate best practices to develop up to 10 (12-15 minute length) online training modules for program managers; and c) develop exam questions for each training module that could be used to test comprehension and understanding of the material covered by each module.

In order to create training sessions that addressed specific training needs and efficiently delivered the desired content, this research project solicited efforts for establishing the current practice of developing online training modules. The 10 online training modules developed in this research project are expected to meet the needs for training project managers in contract management at SCDOT, while ensuring consistent practices among employees and augmenting department leaders' training duties. The study of the current practices in the development, delivery, and assessment of online training at state DOTs and experiences gained through the concurrent development of the training

modules led to the conception of an asynchronous online training development process for SCDOT.

Results

The study of the current practice of design and delivery of online training has revealed that transportation agencies are shifting from traditional face-to-face training to online training programs. Findings from this research show that a majority of the participants from both the survey and telephone interviews had extensive online training programs for their employees. The remainder were making progress toward providing more online training options for employee use. Moreover, all of the DOTs that participated in the online survey and telephone interviews expressed their willingness to substantially increase online training programs. Two-thirds of the interviewed DOTs made online training compulsory for their employees, which depicts the inclination of these DOTs toward making online training programs a part of the core DOT capability building efforts. More than half of the interviewed DOTs mentioned that they offer certification through online training offerings. All but one of the interviewed DOTs have the capability to build and produce online training in-house; however, these DOTs also closely work and collaborate with consulting agencies, universities, and third party vendors to produce online training modules.

Effective strategies for building successful online training were also investigated in this research project. DOTs suggested that the use of interactive components in the training modules are key elements to engage the trainees for longer periods of time. In order to build interactive training modules, embedded learning games and audiovisual instructions are used to increase the learner's satisfaction with the online environment. An analysis of the responses from the interviewed DOTs revealed that training modules of shorter duration (i.e., 15-30 minutes) maintained the trainee's attention most successfully. Important considerations for selecting delivery platforms include interactive and user-friendly options. The DOTs were found to have a varied opinion regarding the use of mobile applications for training interfaces on tablets, which is likely because online training is considered an emerging concept for many state DOTs.

With accessible online modules, professionals have the ability to develop their skillset efficiently and effectively, which can facilitate capacity building for

transportation professionals. Online learning sustains its effectiveness if maintained and updated regularly. This research project revealed that online training can have a distinct impact on learning and it can be easily tailored to target individual needs.

The objectives were met by conducting a detailed review of relevant publications and past studies, development and distribution of an online survey that facilitated the collection of data from ten state DOTs, and a series of telephone interviews with nine state agencies in order to collect additional details concerning their online training programs. The information collected from the state agencies during this process permitted the research team to develop a knowledge base of the current practice of online training among transportation agencies. This insight coupled with the lessons learned from the literature search was utilized to develop 10 online training modules for SCDOT Professional Services Program Management. Upon completion of these training modules, each module was pilot tested to simulate the experience of a 'new' user. Feedback from the pilot tests was incorporated in the final modules, which were then posted on SCDOT's intranet for employee access. Additionally, the process established by this research effort for the development of online training can be applied to future implementation of asynchronous online training by other SCDOT divisions.

Conclusions

During the development of online training it was found that the training modules can be most effectively and efficiently produced when: a) foundational content is consolidated and approved upfront; b) stylistic choices are made with the audience in mind; and c) modules are designed, built, and approved by a combination of content experts, creative developers, and agency champions.

SPR 718	Best Practices for Assessing Culvert Health and Determining Appropriate Rehabilitation Methods	

Performing Organization: Clemson University

Author: Dr. Kalyan Piratla and Dr. Weichiang Pang

Report No.: *FHWA-SC-17-01*

Date: February 2017

Overview

Several culvert structures in the United States are in a deteriorated state needing immediate attention to prioritize critical culverts and rehabilitate them in a timely and economical manner. The overarching goal of this study is to provide technical guidance to SCDOT in effectively managing their culvert infrastructure. This study identified best practices for effectively inspecting deteriorating culvert infrastructures and choosing appropriate rehabilitation methods. The synthesis of literature on best practices for culvert rehabilitation is formulated into a simple decision-making architecture using the principles of analytical hierarchy procedure (AHP). Specifically, a Microsoft Excel-based Culvert Renewal Selection Tool (CREST) is developed to assist SCDOT in shortlisting suitable construction methods for the renewal of failing culverts. Furthermore, a multinomial logistic regression (MLR) model as well as an artificial neural network (ANN) model is developed to predict the condition scores of a culvert based on historic inspection data recorded into SCDOT's culvert inspection database. A simple analytical hierarchical procedure (AHP) is used to subsequently prioritize critical culvert structures based on their condition scores evaluated on various defect categories. The prioritization model has been demonstrated using the inspection data available in the SCDOT's culvert inventory database.

Results and Key Findings

Culvert inspection: Several advanced condition assessment techniques are currently available for inspecting culvert structures. They include but not limited to CCTV, Sonar, Laser, Ultrasonic, Infrared Thermography, and Ground Penetration Radar. While some of these techniques are matured to

sophisticated commercialization, some are yet to be thoroughly evaluated. The suitability of these techniques largely depends on the anticipated defect types, culvert material, size, and surround soil characteristics. Besides technology maturity, high cost is another reason for why these techniques are currently not popularly employed by DOTs.

Deterioration prediction: Condition assessment scores of culvert structures are predicted using MLR and ANNs based on 5,181 culvert inspection entries in the SCDOT's inventory database. While condition assessment categories such as cracking, separation, corrosion, alignment, scour, sedimentation, vegetation, erosion, blockage, and piping are used as prediction output variables, culvert material, shape, dimensions, number of barrels, inlet and outlet end type, end treatment, apron type, temperature, precipitation, pH, and runoff coefficient are used as input variables. While ANN performed better for reinforced concrete pipe (RCP), corrugated metal pipe (CMP), masonry and other culvert materials, LRM fared better for corrugated aluminum pipe (CAP) and high-density polyethylene (HDPE) culverts. The four environmental variables (i.e., temperature, precipitation, pH, and runoff coefficient) were found to be negatively correlated to various culvert condition categories. The prediction models produced are found to have a coefficient of determination ranging between 0.25 (for poorly correlated models) to 0.8 (for better correlated models) based on comparisons with the actual culvert score.

Risk-based prioritization: The prioritization model is mainly informed by the assessment scores from the SCDOT's culvert inventory database and defect weightings derived from a survey conducted as part of this project. The prioritization model is demonstrated on inspection scores of about 5,000 RCP and 225 CMP culverts available in the SCDOT's culvert inventory database. It was determined that about 61.3% of RCP culverts measured by length (≈ 55.1 miles) are at no risk and only about 4% measured by length (≈ 1.42 miles) are found to have reasonable failure risk estimates. Similarly, about 39% of CMP culverts measured by length (≈1.7 miles) are determined to be at no risk and 60.8% of CMP culverts measured by length (≈2.4 miles) have some level of risk.

Culvert renewal planning: The CREST model comprises a variety of renewal techniques including open-cut, internal and robotic grouting, internal and robotic shotcreting, sliplining, cured in place pipe lining, centrifugally cast concrete pipe lining, fold and form lining, spiral-wound lining, and pipe

bursting. These renewal techniques are evaluated based on cost, expected design life, capacity reduction, traffic impact, and environmental impact after being categorized into non-structural, semi-structural, and full structural groups. It has been determined that a variety of grouting techniques are suitable for addressing minor to moderate non-structural cracks and joint in/exfiltration issues, while shotcreting is suitable for minor to moderate non-structural and semi-structural invert deterioration issues. Cured-in-place-pipe (CIPP) lining, fold and form lining, or spiral wound lining were found to be suitable options for a variety of other semi-structural renewal needs. CIPP, slip-lining, spiral wound lining SWL, pipe bursting, or open-cut methods were found to be suitable options for a variety of full structural renewal needs. Furthermore, twenty six real world case studies are documented to validate the CREST model and it is found that CREST's prediction matched the actually employed renewal methods in 50% of the cases while the overall average accuracy measured using a validation score is 80%.

Conclusions and Study Limitations

The findings of this study provide preliminary guidance to the management of culvert infrastructure by maintenance departments at state and district levels. Specifically, the models developed for deterioration prediction, risk-based prioritization, and renewal selection would aid in effective short-term and long-term planning of deteriorating culvert infrastructure. Major limitations of this study that may be addressed in the future include: (a) the lack of age data to be included in the deterioration prediction modeling which could have helped with the accuracy of the model; (b) the limited number of survey responses that informed the defect-weightings used in the risk-based prioritization model; also the lack of consideration of the inlet and outlet structures as part of the failure risk assessment; (c) the performance evaluation of various culvert renewal techniques, which is an integral part of the decision making tool, is purely informed by the synthesis of published literature after reasonable interpretations were made; an objective performance evaluation informed by consistently documented renewal project case studies would have improved the quality of CREST's decision making.

SPR 722	Characterization of Portland Cement Concrete Coefficient of Thermal Expansion in South Carolina	

Performing Organization: Clemson University

Author: Dr. Amir Pourasee and Trent Dellinger

Report No.: *FHWA-SC-17-03*

Date: April 2017

Overview

With FHWA support, AASHTO recently officially adopted a new "mechanistic-empirical" process for designing pavements in which nationally calibrated models are used to simulate and predict pavement behavior that are best-fit approximations based on observations from across the US and Canada. Unfortunately, the predicted pavement outcomes using national models may not be accurate for specific locations. For this reason, virtually all states that use AASHTO pavement design methods are most strongly encouraged to perform a calibration of the new pavement models to local conditions. Because the new process is a complete break from the old procedure, the design inputs are totally different and frequently based on properties that the Department has not previously measured. While some inputs can be reasonably estimated, it is important to actually measure key properties that have been found to have the greatest impact on design predictions to ensure accurate pavement designs.

The South Carolina Department of Transportation (SCDOT) sought to regionally calibrate specific input parameter used by the Mechanistic Empirical Pavement Design (MEPDG) software. These properties include the coefficient of thermal expansion (CTE), compressive strength, and unit weight of typical SC concrete mixtures. Additionally, splitting tensile strength was included in the experimental program.

Results

This project determined the CTE of the most common pavement mixtures throughout the state of South Carolina using AASHTO T336-11 method. The data generated in this project provided a comprehensive overview of the CTE of concrete mixtures in South Carolina for direct implementation in designing PCC pavement and for the specification and testing of PCC materials. Laboratory produced mixtures were tested to identify the effective CTE value of the cement paste, sand, and coarse aggregate compotes typically used in SC concrete pavements. A 25 percent cement replacement of type F fly ash and a single source of natural sand was used in the mortar component of the concrete mixtures. A total three coarse aggregate sources were used in the form of no. 57 crushed stone product or a 75:25 blend of no. 57 and no. 789 crushed stone. The CTE values of the individual phases (i.e., cement paste, sand and coarse aggregates), and concrete mixtures were measured. The resulting CTE of paste and sand was 7.3 and 5.9×10^{-6} in./in./°F, respectively. The CTE of three coarse aggregates ranged from 2.96 to 3.83×10^{-6} in./in./°F. The range of average CTE values of the concrete was 4.82 to 5.32×10^{-6} in./in./°F. Results indicated that the CTE values were not directly related to the compressive strength on the concrete. The collected data were also used to calculate CTE values using the Tex-428-A method. Results from the Tex-428-A method in all but one data set, showed lower CTE values compared to the AASHTO T336-11 method. The maximum difference in CTE values between these test methods was 0.134×10^{-6} in./in./°F.

Field cored specimens were also taken from a section of SC - 80 in Spartanburg County, SC, and analyzed. Three pavement slabs were arbitrary selected along a 3.5-mile pavement section. The targeted slabs were of the outside travel lane, with cores taken between the wheel paths at the leading end, middle, and trailing ends of each slab. Results showed no significant differences between the average CTE values of pavement slabs. The effective CTE of SC - 80 concrete pavement was determined to be 5.05×10^{-6} in./in./°F. The compressive strength and unit weight properties of the SC - 80 specimens suggested that the laboratory produced concrete mixtures from the first part of this study were representative of the concrete pavements in South Carolina.

SPR 723	Effect on Asphalt Quality Due to Nighttime Construction	

Performing Organization: Tri-County Technical College

Author: Dr. Serji Amirkhanian and Mary Corley

Report No.: *FHWA-SC-17-09*

Date: June 2017

Overview

In many areas of the state, traffic congestion places a serious burden on the public and, in some cases, affects the economic vitality of the South Carolina and the region. One way to reduce the congestion effects of roadwork activities is to perform them during nighttime when there is a major reduced traffic demand. However, for many years, the perception has been that construction safety, quality and productivity are impacted by working at night. The major objectives of this project were to identify and analyze the nighttime paving traffic control standards in other states and compare the effects of daytime vs. nighttime paving on quality, safety, costs, and construction time. Tasks in this project included: a comprehensive literature review regarding this topic; a national survey of all State DOTs regarding nighttime paving issues; a survey of SC contractors regarding nighttime paving issues; an investigation of the safety issues involved with nighttime paving in South Carolina, including workers and the travelling public; an investigation of the quality measurements of nighttime paving vs daytime paving (e.g., core compaction data, ride quality, overall pay factors, etc.); an investigation of the costs and construction times of nighttime paving vs. daytime paving; and an investigation of a "reasonable detour" concept used by other states to determine the advantages and disadvantages of the process.

Literature Review

Louisiana DOT officials reported that there is an increase of construction cost ($5 to $10/ton) for the night compared to day time paving. Some of the challenges during night time paving include the following: a) road alignment;

b) mix segregation and temperature; c) truck beds not clean; d) distance between construction site and the plant; and e) fog. Concerns on the roadway included the following: 1) knowledge of the paving crew regarding the paving plan; 2) more difficult to keep the alignment straight; 3) matching the joint is more difficult; and 4) the workers can't see the mix in the paver and under the augers until it is behind the screed. All of these issues could cause problems with the quality and safety of the end product.

Results

A total of 1728 workzone accidents were analyzed and broken down into the cases that were used for district level analysis and then recombined for statewide analysis. An overwhelming amount of accidents occurred on projects bid as nighttime paving (1,198) compared to daytime bid projects (530). While it is difficult to make a solid conclusion, due to the absence of traffic data, it appears that nighttime paving operations do cause significantly more accidents.

A logit regression was performed on the entire dataset with exception of the missing injury severity data from District 4 to further quantify the difference between projects bid as nighttime paving or daytime paving. When plotted on a heat map, the data only has a range of probability between 62% and 69% (Figure 1). Figure 2 indicates that in every material type except for OGFC, the bid price for nighttime paving was higher than for daytime paving.

Conclusion

In general, nighttime paving operations cause statistically higher accident rates at various points throughout the day and night and with various injury severity. There is approximately a 65% chance that any given accident would be in a work zone that was bid as a nighttime paving operation.

The bid prices (cost of materials per ton) were higher for all mixture types except OGFC for nighttime paving projects compared to the daytime paving projects. However, the relatively large standard deviation for most of the bid prices makes any rigorous statistical comparison impossible.

Generally, the average PWL values for in-place density for daytime projects were higher than the average PWL values for nighttime projects, which could indicate that daytime paving operations lead to higher quality pavements. However, this conclusion is only general and not statistically significant.

However, in nearly every case, the standard deviation for in-place density PWL values for daytime paving was less than the standard deviation for nighttime paving. This suggests that even though no statistical comparison can be made of the averages, a more consistent construction procedure is taking place during daytime paving operations, which could lead to higher quality pavements.

With respect to ride quality, nighttime paving projects had significantly more bonus segments, while daytime projects had a significantly higher number of segments receiving 100% pay. Generally, the penalty and repair ride quality segment differences between daytime and nighttime projects was not substantial.

Detours are a viable option, but engineers must consider many factors including materials, traffic count and in-place density of the mat.

Reduced visibility during nighttime paving can adversely affect pavement quality and placement of pavement markings, which can adversely affect pavement life and safety of the driving public on the finished product.

SPR 730	The Effect of Regulatory Requirements and Intervening Groups on Road Construction in South Carolina	

Performing Organization: University of South Carolina

Author: Dr. Gwendelyn Geidel

Report No.: *FHWA-SC-17-02*

Date: May 2017

Overview

This study was designed to evaluate delays occurring during the highway construction process, specifically delays resulting from the Clean Water Act (CWA) permitting process, and to evaluate how other state Departments of Transportation (DOT) in the Southeastern Association of State Highway and Transportation Officials (SASHTO) (with the exception of Puerto Rico) respond to these impacts. The study focused on construction project delays that were caused by potential impacts to wetlands and streams under the CWA, in as much as these are the issues, based on information provided by South Carolina DOT (SCDOT), that have historically received challenges. Furthermore, for challenges to state agency decisions, an appeal to the Administrative Law Court (ALC) provides for an automatic stay, which may result in a delay in the construction process. While National Environmental Policy Act (NEPA) challenges have also been brought, the primary intent of this study is to evaluate those issues that require US Army Corps of Engineers (USACE) permitting and SC Department of Health and Environmental Control (DHEC) water quality certification. Although the focus of this study is on the delay impact to SCDOT and other SASHTO state DOTs, other government agency construction requests for CWA wetland permits were reviewed for delays and impacts related to the SC Administrative Law Court (ALC) actions.

Research

The researchers developed a questionnaire to obtain uniform information for each highway project studied and to ensure that necessary dates, time frames, and delay issues were reviewed. Information to complete the questionnaires

for SC projects was obtained by a review of the SCDOT files, the SCDOT website information, and from in-depth interviews with the appropriate project personnel. Information for projects in other states was obtained by interviews, electronic communication, DOT website reviews, and other publically available information (i.e., newspapers and non-governmental websites). Based on project information obtained from SCDOT and other information, five highway construction projects were reviewed in South Carolina; four of which experienced delays in their project timelines, and six projects were reviewed from other SASHTO states. The delays for all of the projects reviewed can be apportioned into four distinct categories: projects with no delays, projects with delays occurring at the stage of Section 401 Water Quality Certification (WQC), projects with delays occurring during the USACE section 404 permitting or permit modification process, and those delayed as a result of NEPA or other Federal statute challenges.

Summarizing the results of the five SC highway projects, the delays for four of the projects involved the ALC for an appeal of a DHEC decision of the WQC. Of the four projects, three were SCDOT projects: the I-85/I-385 Interchange, the Carolina Bays Parkway, and the 601 Bridge Replacement and the fourth was a county project: The International Drive project in Horry County. The fifth project, the ACE Basin, was delayed by USACE issues related to the CWA section 404 wetland permit. The 601 Bridge Replacement also was delayed by an appeal of USACE permit.

For those projects, which involved a delay related to the DHEC Section 401 WQC permit, the first project, the I-85/I385 Interchange, delay was due to a complaint filed by a landowner for a review of the DHEC Notice of Decision to issue the WQC permit. Although DHEC declined to review its initial decision and the landowner did not appeal the DHEC decision, the 30-day period available for a contested case to be filed with the ALC had been triggered. The process of awaiting decisions by DHEC, coupled with the plaintiff's time frame allowed for appeal, delayed the active project timeline by approximately 60 days. The second project, the Carolina Bays Parkway, involved a right-of-way disagreement with a developer. The case went to the ALC. According to available documents, the conflict was resolved via settlement approximately one month after the Section 401 WQC permit had been issued. The third project, the 601 Bridge Replacement, had delays related to the WQC issuance and appeal to the ACL as well as a third party appeal of the USACE finding in federal court. The combined appeals resulted in an approximately four-year

delay (two years related to the ACL WQC appeal and four years related to the USACE permit appeal). The 601 Bridge Replacement project was suggested for inclusion near the end of the grant and, while included, detailed interview materials are not as extensive. The fourth project delay, associated with the International Drive project, is approximately one year and includes the delay from the time that the initial notice that the Section 401 WQC permit would be issued on June 25, 2015 to the ALC court decision on July 7, 2016, which upheld the Section 401 WQC permit.

The second significant source of extended delays was with regard to USACE approval of Section 404 permits or permit modifications, and with mitigation and permitted area compliance. The Carolina Bays Parkway project, which has a delay of approximately two years, was due to a USACE prompted re-evaluation of mitigation requirements and compliance. The fourth project reviewed, the ACE Basin project, experienced a delay of 118 days due to necessary communications with USACE regarding wetland mitigation. The 601 Bridge Replacement had a delay of approximately four years.

In response to the SCDOT's and our team's request for information from 12 of the SASHTO states' representatives, project information for review was received from three SASHTO states, Louisiana (LA), Tennessee (TN), and Texas (TX). Eight states indicated that they had no sites that were delayed based on an automatic stay or a CWA certification or permit, and three states did not respond. Of the states that provided sites for review, the projects from LA did not involve litigation, but delays were incurred related to USACE-issued permits. One LA project was delayed in the design/planning stage for approximately four years due to additional environmental review and a change in the alignment of the I-12/1088 Interchange. The second LA project, the LA-3421 Highway, required a mitigation modification due to a deviation from the issued 404 permit; however, this modification was made in a three month (114 day) period and did not impact the overall project timeline. The projects from TN and TX involved delays with litigation at the federal level. The on-going status of the TX project presents a challenge, as future delays or continuations of current litigation are still possible. The lawsuit in TX for the TX-45-SW did not delay the selection of a contractor, which occurred while the case was being decided; however, the project is still in its early stages could be further delayed beyond the initial two-year delay.

Review of the Bonner Bridge Replacement Project in NC illustrated a similar use of the ALC by plaintiffs. While the main litigation of the project occurred in Federal court due to the challenge of NEPA regulations, the case also had a component in state court. When NC denied a request for a review of a state-issued bridge permit, it was taken to the Administrative Office of Hearings as a contested case. This prevented approval of a bridge permit from the Coast Guard while the lawsuit was ongoing, as the Coast Guard will not issue permits to projects with active legal challenges.

Summary

In summary, the environmental related delays reviewed for highway construction projects for this report, include: 1) no delay, 2) delays from challenges of the state WQC and state court actions, 3) delays resulting from challenges to the USACE section 404 permits or modifications in federal court and 4) delays from challenges to NEPA or Endangered Species Act in Federal court. Based on the construction projects reviewed in South Carolina, the average length of delay was slightly longer for Federal Court challenges related to 404 permits (1.6 years) versus state court 401 WQC challenges (0.9 years). However, based in all SASHTO construction projects reviewed, the length of delay was similar between Federal Court challenges and state court challenges with each being approximately 1.5 years.


SCDOT
Office of
Materials & Research