Research Digest

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In this Issue:
Recent State DOT Research Reports (not Texas)

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Research Digest

Item 1

Determining the Cost/Benefit of Routine Maintenance Cleaning on Steel Bridges to Prevent Structural Deterioration

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT)

WA-RD 811.1 • 2013

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. The objective of this study is to identify the key variables necessary in estimating the impact of regular washing of steel bridges on the paint and service life, recommend methods for recording data in order to most effectively estimate the benefits of bridge washing, and to develop a framework for assessing the impact of bridge washing on paint life. A literature review was conducted to learn more about the mechanisms of corrosion. Then a nationwide survey was sent out to state transportation agencies. A follow-up survey was conducted in order to obtain more detailed information about certain washing programs. It was concluded that little information on the effects of bridge washing exist and it is only deemed beneficial based on anecdotal assumptions. An experiment is proposed for WSDOT that will provide hard data to make a decision.

This report is available for free download (1.23 MB):
http://www.wsdot.wa.gov/research/reports/fullreports/811.1.pdf

Item 2

Determining the Limitations of Warm Mix Asphalt by Water Injection in Mix Design, Quality Control and Placement

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

FHWA/OH-2013/9 • 2013

In this project, a comprehensive study was conducted to evaluate the laboratory performance of foamed WMA mixtures with regard to permanent deformation, moisture-induced damage, fatigue cracking, and low-temperature (thermal) cracking; and compare it to traditional HMA. In addition, the workability of foamed WMA and HMA mixtures was evaluated using a new device that was designed and fabricated at the University of Akron, and the compactability of both mixtures was examined by analyzing compaction data collected using the Superpave gyratory compactor. The effect of the temperature reduction, foaming water content, and aggregate moisture content on the performance of foamed WMA was also investigated. Furthermore, the rutting performance of plant-produced foamed WMA and HMA mixtures was evaluated in the Ohio University (OU) Accelerated Pavement Load Facility (APLF), and the long-term performance of pavement structures constructed using foamed WMA and HMA surface and intermediate courses was analyzed using the Mechanistic-Empirical Pavement Design Guide (MEPDG).

This report is available for free download (7.8 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Materials/134576_FR.pdf

Item 3

Development of funding project risk management tools

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NCDOT). RESEARCH AND ANALYSIS GROUP
FHWA/NC/2012-06 • 2013

In this project, the research team has investigated current risk management and funding risk management processes, and evaluated the best practices among DOTs in the US. An in-depth study has been conducted to appraise the potentials for possible implementation of the best practices. A funding project risk management tool, funding risk register, has been developed with optimization and simulation capability. This register can produce a potential adjustment of the project let schedule under 15 preset funding change scenarios as well as a user-specified funding change, which can help NCDOT staff members and Executive Management Leaders to make better decisions in budget management, cash management, and project management.

This report is available for free download (6.2 MB):
http://www.ncdot.gov/doh/preconstruct/tpb/research/download/2012-06finalreport.pdf

Item 4

Evaluation of Innovative Traffic Safety Devices at Short-Term Work Zones -- REVISED FINAL REPORT
KANSAS DEPARTMENT OF TRANSPORTATION
K-TRAN: KU-09-5R • 2013, ©2013

The objective of this study was to investigate and evaluate the usage and effectiveness of innovative traffic control devices that can be used in short-term work zones. Any device to be used in short-term work zones should command the respect of drivers, be durable, have an easily understood meaning, be low cost, be quick and easy to install and remove, and be reusable. This study was conducted in three sections: a literature review of previously published research, a nationwide usage survey, and a field test for a selected device, portable plastic rumble strip (PPRS). PPRSs, which have been tested on a closed course, were found to be a device potentially suitable for use at short-term work zones. This field study was to investigate the effects of the PPRSs and drivers' response to them at three short-term maintenance work zones in Kansas. The results showed that the effect of PPRSs in speed reductions was more significant on cars than on trucks. The PPRSs reduced car speeds by 4.6 to 11.4 miles per hour. They also created 5.0 to 11.7 miles per hour mean speed reduction for trucks, but the reductions were only at two test sites. It was observed that 30 to 80 percent of truck drivers activated their brakes (indicated by brake light illumination) when they approached the PPRSs. In addition, about five percent of car and truck drivers swerved around the PPRSs. This indicates that additional signage or other supplemental traffic devices would be needed when the PPRSs are implemented.

This report is available for free download (2.8 MB):
http://idmweb.ksdot.org/PublicLib/publicDoc.asp?ID=003813661

Item 5

Evaluation of Renewable Energy Alternatives for Highway Maintenance Facilities

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

FHWA/OH-2013/13 • 2013

A considerable annual energy budget is used for heating, lighting, cooling and operating ODOT maintenance facilities. Such facilities contain vehicle repair and garage bays, which are large open spaces with high heating demand in winter. The main goal of the project was to recommend renewable energy and energy efficiency strategies for ODOT maintenance facilities that will reduce energy costs and reduce greenhouse gas (GHG) emissions. The research team developed a 3-phases screening process for evaluating renewable energy technologies and developed a decision support tool for use in each phase.

This report is available for free download (7.3 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Environmental/134706_FR.pdf

Item 6

Has Motorization in the U.S. Peaked? Part 2, Use of Light-Duty Vehicles

UNIVERSITY OF MICHIGAN. TRANSPORTATION RESEARCH INSTITUTE

UMTRI-2013-20 • 2013

The main contribution of this study is an examination of recent trends in distances driven by light-duty vehicles (cars, pickup trucks, SUVs, and vans) in the U.S. fleet. This is in contrast to several other recent studies that analyzed distances driven by all vehicles (including medium and heavy trucks, buses, and motorcycles). The period examined was from 1984 through 2011. This is a follow-up study to Sivak (2013), in which I analyzed the recent trends in the number of registered light-duty vehicles. Although the report also presents trends in the absolute distances driven, of primary interest were the distances driven per person, per licensed driver, per household, and per registered vehicle. All of these rates reached their maxima in 2004—four years prior to the beginning of the current economic downturn—and decreased by 5% to 9% by 2011. These reductions likely reflect, in part, noneconomic changes in society that influence the need for vehicles (e.g., increased telecommuting, increased use of public transportation, increased urbanization of the population, and changes in the age composition of drivers). Because the onset of the reductions in the driving rates was not the result of short-term, economic changes, the 2004 maxima in the distance-driven rates have a reasonable chance of being long-term peaks as well. An exception is the rate per registered vehicle. Should the numbers of vehicles per person, per driver, and per household continue to fall (Sivak, 2013), it is possible that the distance driven per vehicle would eventually start to increase and thus this rate has a better chance in the future of surpassing the 2004 maximum. The combined evidence from this and the previous study (Sivak, 2013) indicates that—per person, per driver, and per household—we now have fewer light-duty vehicles and we drive each of them less than a decade ago. The best estimates of the current annual distance driven rates by light-duty vehicles are as follows: 8,500 miles per person, 12,500 miles per licensed driver, 22,100 miles per household, and 11,300 miles per registered vehicle.

This report is available for free download (329 KB):
http://deepblue.lib.umich.edu/bitstream/handle/2027.42/98982/102950.pdf

Item 7

Improving Work Zone Safety Through Speed Management

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

FHWA/OH-2013/5 • 2013

Safety hazards are increased in highway work zones as the dynamics of a work zone introduce a constantly changing environment with varying levels of risk. Excessive speeding through work and maintenance zones is a common occurrence which elevates the dangers to both drivers and motorists in the work zone. Although most work zones are controlled by reduced speed limits or state law enforcement, driver adherence to these regulations and laws in very minimal, especially in work zones. Several studies have shown a correlation between speeding in work zones and traffic crashes which lead most traffic safety professionals to conclude that excessive speeding and speed variance are the contributing factors in a large percentage of traffic crashes, injuries or fatalities. The most influential factor in achieving speed compliance in the work zone is the driver's perception of heightened risk. The main objective of this study was to determine the safest and most effective countermeasure for the reduction of vehicular speeds within construction and maintenance work zones. The purpose of the simulator experiment was to determine the effectiveness of a 20 countermeasures on the reduction of speed through work zones in a controlled laboratory setting. The literature review identified several past research studies utilizing speed reduction countermeasures in work zones and under normal traffic conditions. From this review, 20 countermeasures were selected for evaluation based upon discussions with ODOT personnel.The post hoc tests indicated that the presence of construction workers, presence of construction vehicles, law enforcement, speed photo enforcement and shifting lanes were most effective at reducing speeds in work zones. The least effective speed reduction countermeasures included 3 sets of 3 rumble strips, concrete barriers, other channelizing devices and changeable message signs with speed reductions less than 10 mph.

This report is available for free download (5.2 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Traffic/134625_FR.pdf

Item 8

In-Place Voids Monitoring of Hot Mix Asphalt Pavements. Follow-Up

COLORADO DEPARTMENT OF TRANSPORTATION (CDOT)

CDOT-2013-19 • 2014

In order to validate the policy of allowing the adjustment of the asphalt cement to reduce the laboratory air voids up to one percent, cores were taken over a period of four years on 19 paving projects and tested for air voids. After being compacted by traffic over several years, the average air voids in these pavements were 3.8%. Since the design air voids are required to be between 3.5% and 4.5%, the monitoring validates the effectiveness of the policy. However, there was significant scatter in the data with most of the in-place voids falling out of this design range.

This report is available for free download (255 KB):
http://www.coloradodot.info/programs/research/pdfs/2014/voids.pdf

Item 9

Land Development Risks Along State Transportation Corridors

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT)

WA-RD 805.1 • 2013

Land development that is not coordinated with transportation planning can compromise the performance of Washington's state routes. Identifying land risk for development along state routes can provide opportunities for proactive, collaborative planning to improve access, mobility, and safety while supporting economic development. This project, described in two parts, provides tools to help turn adverse risks of land development into opportunities to make route improvements.

In part one, systems for identifying land at risk for development were developed for the state and local levels from relevant literature and expert input. Risk factors at the state level include historic population and job growth, population and job forecasts, and traffic conditions. Additional risk factors at the local level include regulatory constraints, critical areas, vacant and underdeveloped lands, recent sales history, building permit history, and sewer and water utilities. The local level system was applied to three case study areas. Results generally agreed with local knowledge, yet the method offered an objective and systematic means for comparing corridors across the state fairly.

In part two, a menu of strategies for responsibly developing state routes was developed from current WSDOT practices, literature on standard approaches, and reports of novel solutions. Strategies were classified as planning and coordination activities, non-engineering and engineering strategies, and funding/enforcement strategies.

This report is available for free download:
http://www.wsdot.wa.gov/Research/Reports/800/805.1.htm

Item 10

Linking Land Use, Transportation and Travel Behavior in Ohio

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

FHWA/OH-2013/7 • 2013

This study developed a Regional Land Use Allocation Decision Analysis Tool, which enables decision makers to quantify the impacts of population and employment distribution in terms of the resulting VMT (Vehicle Miles Traveled). The study addresses the need for improving our understanding of the links between land use and transportation and provides ODOT a user-friendly modeling tool to develop forecasts based on different land use, transportation, and policy scenarios. The Regional Land Use Allocation Decision Analysis Tool developed through this study has two main components: a Land Allocation Component and a Transportation Component. This tool forecasts the impacts of future land-use policies in Ohio, based on alternative assumptions of highway and mass transit corridor development, zoning and environmental constraints, regional growth or decline projections, and changes in travel associated with auto trip generation rates and trip distances.

This report is available for free download (5.4 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Planning/134624_FR.pdf

Item 11

Long Term Validation of an Accelerated Polishing Test Procedure for HMA Pavements

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

FHWA/OH-2013/3 • 2013

The Ohio Department of Transportation (ODOT) has set strategic goals to improve driving safety by maintaining smooth pavement surfaces with high skid resistance. ODOT has taken the initiative to monitor pavement friction on Ohio roadways and remedy the pavement sections with low skid resistance. However, this is a passive and reactive approach toward the problem. A more proactive approach would be to test hot mix asphalt (HMA) in the laboratory during the mix design stage to ensure that the aggregates used will provide adequate friction over the life of the pavement. With the validity of a research-grade polishing machine established in a previous study, ODOT has initiated this project to conduct a long-term field study to collect field performance data over a longer time period. The research effort was aimed at further validating the applicability of the previously developed laboratory test protocol and acceptance criteria through a correlation and comparison study with long-term field performance data. This research has produced the following deliverables: (a) a new commercial grade accelerated polishing machine called "The Polisher," (b) models for predicting the field performance of asphalt pavement friction under traffic, and (c) supplemental notes with draft specifications for polishing HMA samples and for testing friction properties. The commercial grade polishing machine and the supplemental notes were recommended for ODOT implementation.

CONTENTS

This report is available for free download (6.1 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Pavements/134413_FR.pdf

Item 12

PCR Evaluation: Considering Transition from Manual to Semi-Automated Pavement Distress Collection and Analysis

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

• *2013*

"This study is designed to assist the Ohio Department of Transportation (ODOT) in determining whether transitioning from manual to state-of the-practice semi-automated pavement distress data collection is feasible and recommended. Statistical and numerical comparisons are detailed between the pavement distresses, severities, and extents determined for 44 representative test sites by ODOT raters and those provided by three participating vendors. In response to the moderate to low initial distress (72 percent), severity (33 percent) and overall (14 percent) correlations, detailed methods for correlation improvement are provided. These methods are based on extensive interactions with ODOT pavement condition raters and participating vendors. Evaluations of system implementation costs and productivity rates offer supplemental information critical to ODOTs implementation decisions. Surveys of six vendors and 18 State agencies reveal the systems, processes, and experiences of those who provide and use automated methods for pavement distress data collection. Based on this information, recommendations for implementation activities, pavement management adjustments, procurement specifications, and equipment specifications are included."

This report is available for free download (6.1 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Pavements/134668_FR.pdf

Item 13

Rapid Orthophoto Development System

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

FHWA/OH-2013/6 • 2013

The DMC system procured in the project represented state-of-the-art, large-format digital aerial camera systems at the start of project. DMC is based on the frame camera model, and to achieve large ground coverage with high spatial resolution, the output image is formed from four independent images acquired by four cameras. DMC procured for OCMS was carefully tested to assess its performance level. From test flights by ODOT, three different blocks were selected, representing different flying condition and flight geometry. Five methods were used for the performance evaluation, including two methods where self-calibration was also introduced. The analysis of the results confirmed that the DMC meets the manufacturer?s specification. To maintain consistent performance in normal operations, periodical calibration flights and the use of ground controls as check points is highly recommended. In addition to further support QA/QC, the use of automated aerial triangulation is also suggested. The main product of the ODOT Office of Mapping and CADD Services is orthophoto, which is widely used in many applications at ODOT and other State offices. Since ODOT primarily acquires data over the transportation network, the orthophoto production has some specific needs, such as dealing with bridges and occlusions, besides the general tasks of the orthoimage workflow. In this project, an innovative method was developed to support the orthoimage generation at bridges. The concept is built around the development of a precise bridge model, which is formed from the DMC imagery and LiDAR data. In addition, a true orthophoto generation process was implemented. The initial versions of both software tools installed at Office of CADD and Mapping Services for testing provided valuable feedback for algorithmic refinements.

This report is available for free download (4.8 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Aerial/134414_FR.pdf

Item 14

Road Usage Charge Pilot Project Final Evaluation Report for Washington State Participants

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT)

WA-RD 807.1 • 2013

This report provides a summary of evaluation results of Washington's participation in the Road Usage Charge Pilot Program (RUCPP). The RUCPP was a trial of various approaches and technologies for motorists in the states of Washington, Oregon, and Nevada to measure and report mileage as the basis for a per-mile road usage charge (RUC). Beginning in November 2012, selected participants signed agreements, selected plans, and adopted in-vehicle devices to measure their road usage for the succeeding months. Washington participants received monthly invoices indicating their road usage and associated charges, less taxes paid on fuel as estimated by the system; however, they did not actually make any payments. The pilot was formally completed on January 31, 2013. This report represents the findings of the pilot test by the evaluation team under the direction of the Washington State Department of Transportation (WSDOT).

This report is available for free download (799 KB):
http://www.wsdot.wa.gov/research/reports/fullreports/807.1.pdf

Item 15

Safety Performance Functions for Freeway Merge Zones

COLORADO DEPARTMENT OF TRANSPORTATION (CDOT)

CDOT-2013-12 • 2013

This report documents the results of a research project to support CDOT in the area of Safety Performance Function (SPF) development. The project involved collecting data and developing SPFs for ramp-freeway merge zones categorized as isolated, non-isolated and weave. For each of these three categories, data for the period 2007 to 2011 were collected at sites selected to ensure statewide geographical representation and coverage of the range of traffic volume and other variables in each category. The development of SPFs for the three categories of ramp-freeway merge zones was successful. Separate SPFs were developed for Total, fatal+injury (FI) and Property Damage Only (PDO) crashes.

This report is available for free download (338 KB):
http://www.coloradodot.info/programs/research/pdfs/2013/spf.pdf/at_download/file

Item 16

Standard Practice for Washing and Cleaning Concrete Bridge Decks and Substructure Bridge Seats including Bridge Bearings and Expansion Joints to Prevent Structural Deterioration

WASHINGTON STATE TRANSPORTATION CENTER (TRAC)

WA-RD 811.2 • 2013

This study is a supplement to a previous study of bridge washing practices that focused on steel superstructures. This study examined the perceived costs and benefits of routine washing of both steel and concrete bridges, with emphasis on substructure seats and bridge decks, by exploring current practices around the U.S. A literature review was conducted in order to learn more about these elements and their failure mechanisms. Then a nationwide survey was conducted with state DOTs around the U.S. regarding the washing practices of decks, expansion joints, and bearings. A follow-up survey was conducted soon afterward to collect more detailed information. A summary of the common washing practices is given in conclusion.

This report is available for free download (2.3 MB):
http://www.wsdot.wa.gov/research/reports/fullreports/811.2.pdf

Item 17

Summary Report on the Performance of Open-Graded Friction Course Quieter Pavements: I-5 Lynnwood, SR-520 Medina, I-405 Bellevue

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT)

WA-RD 817.1 • 2013

This document summarizes the acoustic properties and pavement performance of three asphalt quieter pavement projects. Each of the projects included open graded friction course pavement built with sections of crumb rubber and polymer modified asphalt binders. Performance was compared to control sections of HMA Class 1/2 inch. The open graded friction course sections were audibly quieter than the control section between one and fourteen months after construction. The rutting/wear on the open graded friction course sections was higher than the control section. On two of the projects the rutting/wear exceeded the depth of the overlay and reached a level that would require early replacement of the pavement. The increases in noise and rutting/wear occurred primarily during the time periods when studded tires are legal in the state and are believed to be the primary cause of these increases. Based on the results of the research, WSDOT has concluded that open graded friction course pavements are not a viable option as a noise mitigation strategy for the State of Washington.

This report is available for free download (1 MB):
http://www.wsdot.wa.gov/research/reports/fullreports/817.1.pdf

Item 18

Uncontrolled Concrete Bridge Parapet Cracking

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

FHWA/OH-2012/15 • 2013

The Ohio Department of Transportation has recently identified the problem of wide-spread premature cracking of concrete bridge parapets throughout its District 12 region (Northeast Ohio). Many of the bridge decks that contain these prematurely cracked parapets are of relatively recent construction. In severe cases, replacement of the parapet may be required before replacement of the bridge deck itself. This incurs a sunk cost upon the bridge owner, as the parapets will again be replaced during the regularly scheduled replacement of the bridge deck. In a recent instance, the replacement of a cracked parapet (without replacing the deck) cost District 12 approximately $140,000. In addition, parapet walls are a crucial safety feature of roadway bridge construction, and severe deterioration of these barriers could introduce a significant safety hazard.

Premature cracking of concrete bridge parapets is a potentially complex problem, with a number of possible causes. The objective of this study was to determine the reasons for uncontrolled concrete bridge parapet cracking, and to provide recommendations to ODOT to prevent such cracking in the future. Potential factors examined in this study included: properties of the concrete mixtures used, construction methods, joint details, composite structural action, and durability of the concrete and reinforcement. Identifying the cause of, and avoiding this problem in the future, has several benefits, including: a potential cost savings for the district, increasing the safety of these structures in future construction, and increasing the overall understanding of the durability of these structures.

This report is available for free download (18.3 MB):
http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/Reports/2013/Structures/134602_FR.pdf