



Research Digest

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Research Digest

Item 1

Estimating the Cost of Overweight Vehicle Travel on Arizona Highways

ARIZONA DEPARTMENT OF TRANSPORTATION

FHWA-AZ-06-528 • 2006

This study quantifies state highway damage on the basis of the impacts of overweight vehicles. Each year, millions of dollars of damage associated with life span, design, and maintenance of state highways and structures are attributed to vehicles that exceed state weight limits. Our best guess is that overweight vehicles impose somewhere between \$12 million and \$53 million per year in uncompensated damages to Arizona roadways. Arizona currently budgets about \$5.8 million per year for mobile enforcement efforts aimed at, among other things, penalizing and deterring overweight vehicle operations. If a doubling of the mobile enforcement budget were 50% effective toward the objective of eliminating illegally overweight vehicles from Arizona roadways, the savings from avoided pavement damage would range from \$6 million to \$27 million per year. At the lower figure, the expansion of mobile enforcement would be a little better than a “break-even” proposition. The savings from avoided pavement damage would slightly exceed the cost of the program. Any safety gains from detecting and taking out-of-service vehicles with safety deficiencies would come on top of the pavement damage avoidance gains. At the higher figure, the expansion of mobile enforcement would have about a four- or five-to one benefit/cost ratio. That is, for every dollar invested in motor carrier enforcement efforts, there would be \$4.50 in pavement damage avoided. Furthermore, we introduce a new truck lane design that may ultimately improve safety and optimize pavement usage in Arizona and other states.

Full-text PDF of this report is available for free download at

http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ528.pdf

Item 2

Evaluation of Shrinkage Cracking Potential of Concrete Used in Bridge Decks in Florida

FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT BC354-26 • 2005

The main objectives of this research are (1) to develop an effective and convenient laboratory set-up and procedure for evaluating concrete mixtures for their resistance to shrinkage cracking in service of bridge decks in Florida, (2) to evaluate the different concrete mixtures that have various different admixtures added for reducing the shrinkage in the concrete, and (3) to make recommendations for concrete mix designs for improved resistance to shrinkage cracking in service. The constrained long specimen apparatus, which was previously developed for the FDOT by the University of Florida to evaluate resistance to shrinkage cracking of concrete, was further refined and evaluated. The major refinements included (1) using a load cell to measure the induced force in the constrained long specimen, (2) using an embedment strain gage to measure the strain of the long specimen, (3) using an automatic data acquisition system to collect the load and strain data continuously, and (4) using a water-resistant and low-friction Teflon sheet as a base plate to minimize the friction between the concrete specimen and its supporting base and (5) a modification to the test procedure to correct for the specimen contraction. The results of the laboratory testing program indicated that the use of a shrinkage reducing admixture was effective in reducing the free shrinkage strains and shrinkage induced stresses of all the concrete mixtures tested, while the compressive strength, splitting tensile strength and elastic modulus of the concrete were not significantly affected. The addition of fly ash as a mineral admixture was found to be effective in reducing the free shrinkage strain and shrinkage induced stresses of all the concrete.

Full-text of this report is available for viewing at

http://www.dot.state.fl.us/research%2Dcenter/Completed_Proj/Summary_SMO/FDOT_BC354_26_rpt.pdf



Research Digest

Item 3

Traveling Smart: Increasing Transit Ridership by Automatic Collection (TRAC) of Individual Travel Behavior Data and Personalized Feedback

FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT BD549-02 • 2005

This final report is the first in a series to describe a new joint collaboration research effort between the Transportation Demand Management Program at CUTR, and the Computer Science Engineering Department, at the College of Engineering at USF. The research focuses on using innovative technology to better understand and pattern household travel behavior for the purposes of educating, promoting and encouraging households to utilize other alternatives to driving in general and to driving alone in particular. This study documents Phase 1 of the research effort; the development and preliminary testing of a prototype unit and a travel feedback advisory system. The scope of Phase 1 called for preliminary development and testing of a portable unit consisting of a personal digital assistant (PDA), a global positioning system (GPS) device, and a wireless card, all in one unit nicknamed "TRAC-IT." With innovations emerging daily in this field of technology, a GPS-enabled cellular phone was briefly investigated as a possible alternative for the PDA TRAC-IT unit and showed promise. Phase 2 will investigate and analyze the impact of the travel feedback advisory system on household travel behavior. Phase 3 in this research effort will be dedicated to the design, development, and testing of the GPS-enabled cellular phone as a TRAC-IT unit. The TRAC-IT unit was designed to collect comprehensive individual trip data including; start time, end time, origin, destination, travel speed, trip route, and trip distance with minimal input from participants. Limited field-testing was conducted to validate that the technology works. The project also developed a preliminary personalized feedback system that provides suggestions and encourages participants to utilize other modes than the drive-alone option. These suggestions were sent to participants after the trip data has been transferred from the TRAC-IT unit into a database developed to pattern travel behavior and generate appropriate feedback to participants.

Full-text PDF of this report is available for free download at

<http://www.nctr.usf.edu/pdf/576-16.pdf>



Research Digest

Item 4

Impact of Transit Oriented Development on Public Transportation Ridership

FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT BD549-05 • 2005

The purpose of Phase I of this study was to develop a research design to better establish the relationship between transit oriented development (TOD) and travel mode share. The initial hypothesis that good quality transit combined with good quality TOD would succeed in shifting travelers from single-occupant vehicle travel to transit was found to be an oversimplification. Good quality transit service is necessary and good quality TOD is likely helpful and important to shifting mode share but not sufficient. Other necessary factors include supporting elements of the larger urban spatial structure, disincentives to driving alone, favorable marketability of TOD for non-transportation reasons, and incentives to use transit. Research literature suggests that elements of urban form are perhaps not the most important determinants of travel behavior, specifically mode choice, number of trips taken and length of trips. However, urban form does appear to exert some kind of influence, and for that reason, it is worthwhile to further specify the relationship to ascertain how policy initiatives relating to TOD can support the goal to balance mode share in the direction of greater transit use. To better define the elements of TOD that shape travel behavior, this study describes a research design for the development of a panel survey, using recently developed cell phone technology, to track the same individuals and households over time. Using a pre-test post-test design, the survey data collected for a region in Florida would be a sound investment for improved travel forecasting, modeling and other uses.

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Item 5

Effective Strategies for Comprehensive Corridor Management

FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT BD544-06 • 2006

Despite the increasing importance of comprehensive corridor management at the state and local government level, questions remain regarding effective methods for developing and implementing corridor management plans. Further insight is also needed into how best to coordinate FDOT and local government policies and procedures. Obtaining answers to these questions is important to managing land development and access on the Florida's newly designed Strategic Intermodal System (SIS) and other state highways. This study documents success stories in comprehensive corridor management and identifies best practices that can be applied by the Florida Department of Transportation, metropolitan planning organizations, and local governments. The emphasis is on policy, regulatory, and funding strategies to accomplish alternative access and other important corridor management objectives.

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http://www.dot.state.fl.us/research%2Dcenter/Completed_Proj/Summary_PL/FDOT_BD544_06_rpt-web.pdf



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Item 6

Update Methodology for ADA Demand Estimates: Lessons Learned

FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT BD 549-08 • 2005

The current and accepted standard for determining local impacts of ADA is found in the ADA Paratransit Handbook published in September 1991 (UMTA-MA-06-0206-91-1). This methodology was developed from surveys taken in 1978 and 1987, along with 1980 U.S. Census data. The current methodology may represent the population that is potentially ADA-eligible; however, it does little to assist transit agencies in determining actual paratransit demand. Additionally, transit systems now have vehicles that can accommodate many disabilities, making it possible for many of the potential ADA-eligible population to ride the fixed route. Information regarding methodologies used to forecast ADA paratransit demand among transit agencies have been gathered in order to provide an understanding of certain practices and an assessment as to which methodologies are to be considered best practices has been completed.

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Item 7

Measuring Pavement Friction Characteristics at Variable Speeds for Added Safety

FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT DO-51684 • 2005

This study assessed the feasibility of using high-speed, laser-based sensors to quantify the texture and friction characteristics of asphalt pavements.

Full-text PDF of this report is available for free download at http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_SMO/FDOT_DO2022_rpt.pdf

Item 8

Mechanistic Approach to Evaluate Contribution of Prime and Tack Coat in Composite Asphalt Pavements

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

FHWA/NC/2004-05 • 2005

This investigation was undertaken to develop a mechanistic design procedure for selection of tack and prime coat type in relation to traffic loading, pavement temperature and the AC overlay required thickness. The methodology used in this study to compare the performance of different tack and prime coats required the development of a 3-D computer program that takes into account the horizontal shear stresses induced on the pavement surface due to vehicle braking effects (acceleration and deceleration). Taking into account the induced shear loading, the shear stresses at the interface layers were computed. Next, these shear stresses were compared to the bond strength of the tack or prime coat under consideration. This research study provides a methodology and design guide based on mechanistic analysis to select appropriate tack or prime coat for given field conditions. Based on the AC layer thickness a suitable tack or prime coat can be chosen (or vice versa in some cases) to minimize the delamination distress.

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<http://www.ncdot.org/doh/preconstruct/tpb/research/download/2001-04FinalReportPart1.pdf>

<http://www.ncdot.org/doh/preconstruct/tpb/research/download/2001-04FinalReportPart2.pdf>



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Item 9

Bridge Management System Update

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

FHWA/NC/2005-06 • 2005

The objective of this project was to assist the NCDOT in updating parameters used in analysis of bridge inspection data for purposes of bridge management. Various parameters are used in OPBRIDGE, a bridge management system decision support program for predicting optimum use of funds budgeted and for predicting performance of the bridges of the State of North Carolina in future years under various level of funding. In particular, the project examined and developed parameters for:

1. Unit costs of replacements;
2. Unit costs for rehabilitation;
3. Maintenance effort as a function of element condition;
4. Deterioration rate for major bridge elements;
5. ADT growth rates for the bridge functional classifications and locations;
6. Bridge-related accident unit costs; and
7. Vehicle operating costs.

In most cases, improvements over the previous parameter values were possible as documented in this report.

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<http://www.ncdot.org/planning/development/research/download/2001-18FinalReport.pdf>



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Item 10

Impact of Price Reductions on the Long Term Pavement Performance of Hot Mix Asphalt Mixes in North Carolina

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

FHWA/NC/2005-09 • 2005

Article 105-3 of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Road and Structures provides guidance on price adjustments for hot mix asphalt pavements that are not within reasonably close conformity with the specifications but for which the work is to be accepted and remain in place. The primary objective of this research is to refine these price adjustments. The research objective will be accomplished by conducting both field and laboratory analyses of deficient pavements and specification pavements with similar structures and traffic history. The types of deficiency to be addressed in this research include asphalt content and in-situ density. Both fatigue and rutting performance will be evaluated. The field study will include the analysis of condition survey data and available Falling Weight Deflectometer (FWD) data for remaining life prediction. The remaining life prediction algorithm using FWD deflections that will be used in this report was determined by a related Research Project 2000-04, "Use of Falling Weight Deflectometer Multi-Load Data for Pavement Strength Estimation." The laboratory study will be performed on cores obtained from eight selected pavements as well as laboratory fabricated specimens of the hot mix asphalt (HMA) mixtures for those pavements. The laboratory test program will include: 1. Indirect tension tests for fatigue performance evaluation 2. Repeated load triaxial tests for rutting evaluation 3. Accelerated pavement tests on laboratory pavement slabs for fatigue and rutting evaluation using the third scale Model Mobile Loading Simulator Both field and laboratory analysis results will be compared to develop prediction models for fatigue and rutting performance of asphalt concrete. Two levels of economic analysis will be performed to determine appropriate pay adjustment factors. The first level uses the ratio of the service lives of specification and deficient HMA mixtures determined from laboratory testing and accelerated pavement testing. The second level involves the life cycle cost analysis of specification and deficient pavements. If necessary, recommendations will be made for revisions to the NCDOT Standard Specifications for Roads and Bridges. In addition, the system comprised of pavement performance prediction models and economic analysis that will be developed from this study will establish a framework on which a future pavement design, rehabilitation design, and performance-related specification (PRS) may be built.

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Item 11

Phase III AUTOTRACK: Integrated CCTV/VIVDS Prototype Field Test: System Refinement and Development of Shoulder Detection

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

FHWA/VTRC 06-CR2 • 2006

The Virginia Department of Transportation (VDOT) has invested in extensive closed circuit television (CCTV) systems to monitor freeways in urban areas. Generally, these devices are installed as part of freeway management systems (Smart Traffic Centers, STCs). While CCTVs have proven to be very effective in supporting incident management, they simply provide images that must be interpreted by trained operators. Recent studies completed by the University of Virginia (UVA) and the Virginia Transportation Research Council (VTRC) concluded, however, that it is feasible to integrate CCTV with video image vehicle detection systems (VIVDS), which are currently on the market, to provide the ability to measure traffic conditions. Given this positive result, it is advantageous to pursue other data collection applications of an integrated CCTV/VIVDS. The purpose of this project was to develop and field test a prototype CCTV/VIVDS integrated system (referred to as Phase III Autotrack) that adds the functionality of shoulder detection to the existing traffic data collection capabilities of the previous prototype (Phase II Autotrack). Shoulder detection allows STC operators to improve the safety and efficiency of the freeway system by rapidly responding to vehicles stopped or stalled on shoulders. Based on the results of this research, the following conclusions may be drawn concerning the feasibility of the new safety/security functionality of integrated CCTV/VIVDS systems:| An integrated CCTV/VIVDS system can be used to effectively identify shoulder events (stopped or slow moving vehicles) under clear weather conditions.| An integrated CCTV/VIVDS system can be used to effectively identify shoulder events (stopped or slow moving vehicles) under rainy conditions, if provisions are made to clear away drops from the camera lens. The Autotrack research program has proven that CCTV/VIVDS integration is feasible and beneficial. Benefits include the following:| Reduction in the number of devices installed in the field (and requiring maintenance) to support transportation management.| Reduction of the workload on operators in STCs by automating security scanning.| Increase in the safety and security of the traveling public by allowing for more comprehensive monitoring of shoulders.| Stimulation of CCTV/VIVDS commercial product development.

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http://www.virginiadot.org/vtrc/main/online_reports/pdf/06-cr2.pdf



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Item 12

Creep and Fatigue Characteristics of Superpave Mixtures

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

FHWA/VTRC 06-R5 • 2006

Laboratory creep and fatigue testing was performed on five Superpave surface hot-mix asphalt mixtures placed at the Virginia Smart Road. Differences in creep and fatigue response attributable to production and compaction methods were investigated. In addition, changes in creep response resulting from differences in specimen size were evaluated. Further, an evaluation of the effects of loading frequency, presence of rest periods, and specimen location within the pavement on fatigue life was conducted. Creep compliance values were determined using viscoelastic-based calculations, and time-temperature superposition was used to generate mastercurves. Reported creep compliance response models from the literature were found inadequate for accurately describing the creep compliance mastercurves generated during this study. Differences in creep response between specimens of different sizes were found to be due to specimen and test variability, rather than size. An evaluation of the effects of laboratory and plant production and laboratory and field compaction was inconclusive as material variability appeared greater than production or compaction variability. Simple regression models were found to be satisfactory for use in the development of prediction models for fatigue, although test data are necessary for calibration to particular mixture types. No relationships were found between fatigue model coefficients and volumetric properties of the mixtures tested because of the limited range of volumetric properties. Variability in volumetric properties between the mixtures produced at the plant and those produced to match the job mix formula did not significantly influence the predicted laboratory fatigue performance. Laboratory fatigue lives were similar between the laboratory-compacted fatigue specimens and specimens cut from the pavement; differences observed in performance were attributable to different air void contents. Predicted fatigue life was found to be statistically independent of the frequency of the applied loads or presence of rest periods for the mixtures, frequencies, and rest periods considered in this study. Minimal differences were observed between fatigue life predictions for plant-produced, field-compacted specimens cut from different locations in the pavement. This study contributes to the understanding of the factors involved in creep and fatigue performance of asphalt mixtures. The mixture responses characterized by this study are related to the rutting and fatigue performance of asphalt pavements. The choice of appropriate asphalt materials to resist rutting and fatigue deterioration will result in reduced maintenance needs and longer service lives for pavements.

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Research Digest

Item 13

The Role of Smart Traffic Centers in Regional System Operations: A Hampton Roads Case Study
VIRGINIA TRANSPORTATION RESEARCH COUNCIL
FHWA/VTRC 06-R6 • 2006

The objectives of this study were to define the role of smart traffic centers (STCs) in regional systems operations and to help identify performance measures for monitoring the performance of STCs in the scope of regional systems operations. Without proper measures of performance, it is difficult to determine if changes or additional resources could be employed to improve STC operations so as to enhance the performance of the regional transportation system. In this project, a general methodology was developed and applied to determine the role played by the Hampton Roads STC in regional systems operations in Virginia. A six-part framework for evaluating performance measures was developed. The findings of the study were generalized to the greatest extent possible to be applicable to other STCs in Virginia. It is expected that the recommended framework for developing measures of performance developed in this study will assist the Virginia Department of Transportation in documenting the benefits of the investment made in STCs and allow STC operators to identify areas where improvements can be made or resources need to be adjusted.

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Item 14

High-Performance Fiber-Reinforced Concrete in a Bridge Deck December 2005
VIRGINIA TRANSPORTATION RESEARCH COUNCIL
FHWA/VTRC 06-R11 • 2006

The purpose of this research was to compare the performance of high-performance fiber-reinforced concrete (FRC) with that of conventional concrete in a bridge deck. FRC is expected to increase toughness, provide enhanced residual strength, and minimize the occurrence and width of cracking in bridge decks. This report describes the development and testing of concrete mixtures containing synthetic fibers in the laboratory and the plant and the placement in the deck of the bridge carrying Route 11 over the Maury River in Lexington, Virginia. The deck was on steel beams. FRC was placed over one of the four piers. Comparisons with the control section without the fibers over a 5-year period indicated that FRC has fewer and narrower cracks, even though higher shrinkage occurred in the FRC specimens. Evaluation of fibers in continuous decks, especially over steel beams, should continue. However, particular attention must be devoted to mixture proportioning, slump, and air content. Further, the workability lost by the addition of fibers should be regained by the addition of a high-range water-reducing admixture, not water, or durability may decrease. Fibers can control cracking and minimize corrosion of the reinforcement in the concrete, thus extending the service life of the structure and reducing maintenance costs, leading to substantial savings.

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Research Digest

Item 15

First Bridge Structure with Lightweight High-Performance Concrete Beams and Deck in Virginia *VIRGINIA TRANSPORTATION RESEARCH COUNCIL* *FHWA/VTRC 06-R12 • 2006*

This study involved the construction and early performance of the first bridge in Virginia constructed with lightweight high-performance concrete (LWHPC) having a density of 120 lb/ft³ in the beams and deck. The design strength and permeability were 8,000 psi and 1500 coulombs, respectively, for the beams and 4,000 psi and 2500 coulombs, respectively for the deck. The concretes were tested for slump, density, air content, compressive strength, flexural strength, permeability, elastic modulus, freeze-thaw durability, and shrinkage. The effectiveness of using fibers to control cracking over one of the two piers in the continuous deck was also investigated. The results indicate that LWHPC can be produced such that the material is workable, strong, volumetrically stable, and resistant to cycles of freezing and thawing, thus leading to a long service life with minimal maintenance. After 4 years of exposure, there was limited cracking in areas both with and without fibers. LWHPC is recommended for use in beams and decks for reduced weight. The volumetric method for measuring air content is time-consuming and can cause adverse delays when a continuous deck is placed. Density measurements to control the air content of the LWHPC are recommended after a relationship is established. The enhanced durability of LWHPC is expected to lead to extended service life with minimal maintenance costs. The lower initial cost due to the lighter weight concrete elements and the increase in the service life of the bridge because of the enhanced durability should result in significant savings.

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Research Digest

Item 16

Development of Nondestructive Methods for Measurement of Slab Thickness and Modulus of Rupture in Concrete Pavements

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 06-CR9 • 2006

This report describes work to develop non-destructive testing methods for concrete pavements. Two methods, for pavement thickness and in-place strength estimation, respectively, were developed and evaluated. The thickness estimation method is based on a new hybrid approach that combines frequency domain (impact-echo) and time domain (seismic) data. This new method makes use of a fuller understanding of the dynamic wave phenomenon, which was developed during the course of the work. The effects of material property gradients (due to aggregate segregation and moisture variation) through the slab thickness are compensated for in the method. A field testing method is proposed, described, and experimentally verified. Verification tests carried out on full-scale concrete slabs cast on granular base show that the new method provides more accurate thickness estimates than those obtained by the standard impact-echo procedure. On average, the error between predicted thickness and actual thickness determined by cores is less than 6 mm, although some individual estimates exceed this error value. However, the new method does not work on concrete over asphalt or cement-treated base (which accounts for most concrete pavements) or on full-depth asphalt concrete pavements. The in-place strength estimation method is based on ultrasonic surface wave measurements. A field test method is proposed, described, and experimentally verified. Verification tests carried out on a range of concrete mixtures with varying aggregate type and cementitious material, all of which satisfy the requirements of "A3" concrete as specified by the Virginia Department of Transportation. Two data analysis procedures are proposed. One procedure predicts flexural strength within 50 psi of actual strength determined by direct strength measurement of beams, although the procedure requires 1-day strength and ultrasonic values to be known. The second procedure is more flexible but provides strength estimates with lower accuracy. Field tests, which were carried out at two pavement sites in Virginia, are reported for both methods. Finally, a detailed description of the required testing equipment and experimental and analytical procedures for both methods are included in the Appendix. Cost savings from implementing the methods are not obvious, since the methods cannot be used to measure the thickness of most concrete pavements for acceptance and payment. The methods can be used to nondestructively evaluate the modulus of rupture of pavements for analysis purposes, but savings would depend on the nature of the analysis.

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Research Digest

Item 17

Multimodal Statewide Transportation Planning:: A Survey of State Practices

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 06-R13 • 2006

Within the structure of state government, some amount of transportation planning is usually performed within separate modal administrations, which may include aviation, bus, highway, ports, and rail, as well as separate toll agencies. Some states coordinate these planning efforts through a single office responsible for statewide multimodal planning; other states work to achieve such coordination without a centralized unit (described herein as the decentralized approach). To determine if there is value to centralizing statewide multimodal planning efforts within a single office, representatives from 50 states were surveyed regarding the utility of centralized versus decentralized multimodal statewide planning. Responses, in the form of written questionnaires and/or telephone interviews, were obtained from 41 states. Advantages of centralization included consistency of modal plans, better modal coordination (including detection of modal conflicts earlier in the process), an ability to examine the entire transportation system holistically, collective attention brought to smaller modes that otherwise might be overlooked, economies of scale for service delivery and employee development, and a greater likelihood that long-range planning will be performed instead of being eliminated by more immediate tasks (which might occur if such planning were located in an operational division). Advantages of decentralization included greater ease of obtaining modal support for the long-range plan since the planners and implementers are in the same functional unit, greater ease of tapping modal-specific expertise, an ability to focus on the most critical mode if one such mode is predominant, and organizational alignment with mode-specific state and federal funding requirements. Equally important were respondents' explanations of how the question of a centralized versus a decentralized approach may be overshadowed by external factors. These included constraints on how various transportation funds may be spent; the fact that having persons in the same office does not guarantee multimodal coordination; the recommendation that some efforts should be centralized and some should be decentralized; the increasing importance of MPOs, districts, and public involvement in planning efforts; and the suggestion that even after a solid analysis of alternatives, there may be cases where the recommendation is the same as what it would have been under traditional planning. In some instances, the use of performance measures may change the recommended approach. Finally, a subset of the free responses indicated that centralized multimodal planning can be beneficial but only if four constraints are met: modal staff work collaboratively, the centralized unit has funding or other authority, necessary modal-specific planning is not eliminated, and there is a clear linkage between the centralized unit and the agencies that perform modal-specific planning such that the latter can implement the recommendations of the former.

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Research Digest

Item 18

Operational Analysis of the Hampton Roads Hurricane Evacuation Traffic Control Plan

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 06-R15 • 2006

The Hampton Roads region of Virginia has developed a hurricane evacuation plan to facilitate the movement of large numbers of vehicles as they attempt to leave the region in advance of a storm. Although the plan considers many aspects of hurricane evacuation, this evaluation focuses on its impacts on traffic operations. A traffic control plan (TCP) was developed that describes the procedures to be followed in the event an evacuation is ordered. Ramps providing access to I-64 are designated as open or closed, and many are metered in an attempt to influence the route choice of evacuees and thereby balance the demand across available evacuation routes. Although considerable work has gone into the development of the TCP, it has not been evaluated from a microscopic perspective to determine the performance characteristics with respect to traffic flow. This study provides that microscopic analysis for the freeway portions of the evacuation routes. The evaluation found that under less severe hurricane conditions (Category 1 or 2), the TCP performs reasonably well under the assumptions made in this study. The most significant assumption made was that all background traffic, including individuals evacuating their homes but remaining within the region, will not use the interstates during the evacuation period. Although background traffic will likely exist, there was insufficient information available in this phase of the study to assign background traffic to the network in any reasonably accurate manner. As the intensity of the hurricane intensifies to a Category 3 or 4, the TCP begins to be less effective. Ramp metering rates, designed in the TCP to ensure free-flowing conditions on the interstate mainlines, result in significant queues at the ramps and back onto the arterial network. Under Category 4 conditions, these queues would likely result in gridlock throughout the arterial network and lead evacuees to search out alternative routes, possibly negatively impacting the performance of those routes as well. The evaluation concludes that lane reversal is warranted under any storm predicted to make landfall as a Category 4 or higher and should be strongly considered for any Category 3. The study further finds that when lane reversal is implemented, the ramp metering rates should be significantly increased to reduce ramp queuing and allow more efficient use of available mainline capacity. The recommendations offered in this report will help to ensure an efficient evacuation of vehicles from the Hampton Roads region, should one be required. The revised ramp metering strategies and guidance on the use of lane reversal will help to maximize the available capacity provided by the interstate routes. Assumptions made throughout the study could render the results uncertain. Background traffic using the interstate routes could add to the congestion reported here. In addition, conditions outside the bounds of the network modeled in this project could negatively impact evacuating vehicles leaving Hampton Roads.

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Research Digest

Item 19

Factors that Influence the Efficiency of Electrochemical Chloride Extraction During Corrosion Mitigation in Reinforce Concrete Structures

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 06-R16 • 2006

Electrochemical chloride extraction (ECE) is an electrochemical bridge restoration method for mitigating corrosion in reinforced concrete structures. ECE does this by moving chlorides away from the reinforcement and out of the concrete while simultaneously increasing the alkalinity of the electrolyte near the reinforcing steel. Despite its proven success, ECE is not used extensively in part because of an incomplete understanding of the following three issues: 1. the time required for ECE with varying water-to-cement ratios (w/c) and cover depths 2. the cause of the decrease in current flow and, therefore, chloride removal rate during ECE 3. the additional service life that can be expected following ECE when the treated member is subjected to chlorides. This study addressed the first two issues. Plain carbon steel reinforcing bars were embedded in portland cement concrete slabs of varying w/c and cover depths and then exposed to sodium chloride solutions. A fraction of the slabs contained sodium chloride as an admixture. All slabs were subjected to cyclical ponding with a saturated solution of sodium chloride. ECE was then used to remove the chlorides from the slabs while electrical measurements were made in the different layers between the reinforcing bar (cathode) and the titanium mat (anode) to follow the progress of the ECE process. The resistance of the outer concrete surface layer increased during ECE, inevitably restricting current flow, and the resistance of the underlying concrete either decreased or remained constant. During ECE, a white residue, or surface film, formed on the surface of the concrete. The residue contained calcium carbonate, calcium chloride, and other yet unidentified minor components when calcium hydroxide was used as the electrolyte. The surface film can be removed mechanically or, to some extent, inhibited chemically. There was no obvious relationship among cover depth, w/c, and chloride extraction efficiency, although cover depth did influence the current density. The investigators recommend that the Virginia Department of Transportation's Structure & Bridge Division (1) require that contractors mechanically remove the latent surface layer of concrete prior to treatment using ECE and (2) discuss with corrosion consultants the potential for using a scale inhibitor during ECE to increase the efficiency of chloride removal. The benefits and costs assessment of treating a structure using ECE cannot currently be determined, but research currently underway will provide the necessary information for the assessment. Full-text PDF of this report is available for free download at http://www.virginia-dot.org/vtrc/main/online_reports/pdf/06-r16.pdf



Research Digest

Item 20

Detection of Polymer Modifiers in Asphalt Binder

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 06-R18 • 2006

This study addressed the evaluation of alternative test methods to identify the presence of polymer modifiers in performance-graded binders for the purpose of quality assurance. A method of identification is presented in AASHTO T302, Polymer Content of Polymer-Modified Emulsions and Asphalt Binders, that uses Fourier transform infrared (FTIR) spectroscopy to evaluate the constituent elements in binders or emulsions. With proper calibration, output from FTIR can be used to determine the presence and approximate content of polymers in an asphalt binder. AASHTO T301, Elastic Recovery Test of Bituminous Materials by Means of a Ductilometer, offers an alternative method to determine the presence of polymer by evaluating the elasticity of the binder. Samples of binder were collected from contractor tanks and tested in accordance with AASHTO T301 and AASHTO T302. The performance grade was verified in accordance with AASHTO M320. Test results were evaluated to identify calibration needs, test variability, and choice of preferred methodologies for adoption into the quality assurance program. Results of the study identified the use of either FTIR analysis or elastic recovery as a timesaving alternative to full-fledged performance grading in the initial investigation of concerns about the presence of polymer. Both methods identified binders containing varying polymer contents with no instances of false positive identification. However, based on the results of this study, neither method is suitable to determine binder grade. The investigator recommends that the elastic recovery and FTIR analysis be incorporated as quality assurance tests to verify the presence of polymer in mixtures that specify the use of polymer-modified asphalt binders. Following this, the frequency of quality assurance sampling of polymer-modified binders should be increased to ensure that inferior material is not being used in premium mixtures. Further, AASHTO T301 should be adopted in place of Virginia Test Method 104 for use with unaged binders. Incorporating the use of elastic recovery testing and FTIR spectroscopy as alternatives to performance grading will benefit VDOT by allowing increased quality assurance testing of premium asphalt mixtures. This will result in minimizing VDOT's risk of acceptance of inferior material and maximizing the benefits of using premium materials. Typically, performance grading is performed once per month on one binder sample from each active grade of binder in a VDOT district. This is estimated to result in testing less than 5% of the binder lots used in any district during a typical month. Although neither elastic recovery testing nor FTIR spectroscopy was shown conclusively to determine binder grade, almost all PG 76-22 binders shipped into Virginia contain polymer modifiers. Thus, the detection of the polymer is a first level indicator for quality assurance. The potential cost of these tests is approximately \$200 per test for elastic recovery and approximately \$120 per test for FTIR spectroscopy. Overall, the increased testing is expected to result in improved pavement quality by reducing the acceptance of inferior material.

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