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Item 1

Technical Evaluation of Photo Speed Enforcement for Freeways

ARIZONA DEPARTMENT OF TRANSPORTATION

ADOT-AZ-05-596 • 2006

Extreme speeding on urban-area freeways contributes to increased crashes resulting in fatalities, property damage, and increased maintenance and public safety costs. Photo speed enforcement systems (speed cameras) that automatically sense a speeding vehicle and photograph it and its driver have proven effective at reducing speeding violations, primarily on city streets and arterials. The use of this technology on high-volume, high-speed, multi-lane freeways is technically much more challenging, and largely untested. This research investigates if the current offerings of vendors can provide a viable technical solution in this freeway environment. Twelve ideal characteristics were established that are needed for a speed camera system to operate on Phoenix, Arizona, metro-area freeways. Six vendors were interviewed. Thirteen agencies that use speed camera systems were interviewed, although none were found with sufficient freeway operating experience to provide definitive information to design a field trial. Therefore, only a conceptual field trial and accompanying test plan were developed to explore the technical aspects of potential systems. Public opinion and countermeasures on speed camera systems were researched and reported. No current vendor offering meets all of the twelve ideal characteristics that were established. Advancements in speed camera systems continue, and it is logical to predict that they can be met in the future. One new technology that shows promise is “point-to-point,” which tracks average speed between two points on a roadway. This research did not address the violation processing and management activities, but noted that these must be addressed before a field trial can proceed.

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http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ596.pdf

Item 2

Procedures for Winter Storm Maintenance Operations

ARIZONA DEPARTMENT OF TRANSPORTATION

FHWA-AZ-05-461 • 2006

The purpose of this research is to review ADOT's existing snow and ice control practices and procedures and to make recommendations to improve snow and ice control. The research uses the level of service (LOS) goals from a maintenance management system (MMS) to make recommendations for improving procedures and acquiring resources in order to attain the LOS goals. The main recommendations in applying de-icing and anti-icing chemicals include Where level of service goals and site conditions allow, ADOT should implement anti-icing as a standard strategy. The reasonable amounts of chemicals in anti-icing operations should be based on current and expected conditions The concentration of chemicals applied can change over time, i.e., become diluted, with the interaction of the chemicals, precipitation and accumulated snow or ice. Care should be taken in applications of chemicals when the dilution potential is medium or high. The recommended treatment strategy for localized icing conditions is pre-treating with a liquid ice control chemical 6 to 66 hours before the potential event. Liquid ice control chemicals are also effective in treating black ice that has already occurred if the pavement temperature is above 23°F (-5°C). The research has found that the current ADOT snow and ice fleet size, character, and associated support resource are not adequate to provide the level of service desired. It is recommended that 30-50 additional snow and ice trucks should be acquired. ADOT also should conduct a route-by-route analysis to realign existing resources to be compatible with highway priority and cycle time. In order for ADOT to successfully attain its level-of-service goals, it needs to adopt a chemical priority policy for the use of chemicals in snow and ice control where possible. This policy would apply to both anti-icing and deicing strategies. This will require additional cost for chemicals and reduced cost for cinders. It is also recommended that ADOT should establish a formally programmed, user driven, and continuous technical training program for snow and ice control. The training goals and objectives should be established. By establishing such a program, consistent practices and procedures can be implemented effectively and efficiently.

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Item 3

Development of Statewide GIs-Based Features Inventory System

ARIZONA DEPARTMENT OF TRANSPORTATION

FHWA-AZ-05-474 • 2006

The Arizona Department of Transportation (ADOT) has developed and implemented a component of a Maintenance Management System (MMS) called the Features Inventory System (FIS). With this system ADOT has the capability of tracking and maintaining an inventory of its highway features. These features can include anything found on or along a highway such as a guardrail, sign, lighting or other appurtenances. ADOT also needs to track the inventory of its highway features for the state legislative mandate in the maintenance appropriation (ARS 28-101) to provide level-of-service (LOS) conditions. These LOS condition measurements only have value if the population of the item, and how much of that population is in compliance, is known. The Feature Inventory System interfaces with the LOS System. In the past, ADOT used numerous methods of tracking the highway features. Early on, a mainframe system was put in place to track the inventory. This system is now antiquated and difficult to update, and Maintenance District offices have turned to other technologies including the use of Access databases and Excel spreadsheets. In order to standardize and bring all of the highway features inventory information into one place, ADOT's Maintenance Section has replaced the antiquated mainframe system with a browser-based system to track, maintain and account for its highway features. Utilizing funding from this research project, the FIS was built around a comprehensive features inventory database and is a core component of ADOT's MMS. This new system provides an application that is easier to utilize, and a database to store geographic information and other attributes of the highway features. This system also provides interfaces to other MMS modules, and is more robust than the mainframe system, incorporating an administrative function that allows key administrators to add new feature types, and define individual attributes for each feature type, as needed.

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Item 4

Arizona Department of Transportation Project Delivery Cycle Time Analysis

ARIZONA DEPARTMENT OF TRANSPORTATION

FHWA-AZ-05-518 • 2006

The Arizona Department of Transportation (ADOT) conducted research to quantify project delivery cycle time. The purpose of this research was to compare ADOT with other state departments of transportation. This research found that there are significant challenges in establishing measures of project delivery cycle time from data in ADOT's various information systems. These challenges limited the ability of the research to provide a meaningful comparison with other states. The principal recommendation from the study was the need to determine standardized procedures across all ADOT program areas for establishing project schedule baselines and for recording information on accomplishments and project durations.

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Item 5
Critical Factors in the Development of Transit Systems in Rural Arizona
ARIZONA DEPARTMENT OF TRANSPORTATION
FHWA-AZ-05-530 • 2006

The report's findings indicate seven factors that influence rural public transit systems. The factors that were reported by the survey recipients match relatively closely with the predominant literature: 1. Showing need and demand is the most important factor in creating a rural public transit system. 2. Funding is the major barrier. 3. Citizen participation and support is very important to the process, along with…. 4. Political and/or city council support. 5. Expert or technical help was necessary, as was… 6. Fare box recovery rate 7. And finally, the ability to connect with other modes of transportation. Within the literature, the study found that there were many other barriers to an effective rural public transit system. Coordination almost always seems inadequate, although difficult because of the inherent needs of the rider, such as a special needs rider that cannot be accommodated by a regular van provided by a transit partner. Also, many times there has been mention of the "true costs" of establishing a system or the difficulties of obtaining funding or working with a local department of transportation. Especially interesting was the inherent difficulties experienced by the Indian tribes in providing service on the reservations and meeting the requirements to obtain funding.
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Item 6
The Impact of Red Light Cameras (Automated Enforcement) on Safety in Arizona
ARIZONA DEPARTMENT OF TRANSPORTATION
FHWA-AZ-05-550 • 2006

Red Light Cameras (RLCs) have been used in a number of US cities to yield a demonstrable reduction in red light violations; however, evaluating their impact on safety (crashes) has been relatively more difficult. Accurately estimating the safety impacts of RLCs is challenging for several reasons. First, many safety related factors are uncontrolled and/or confounded during the periods of observation. Second, "spillover" effects caused by drivers reacting to non-RLC-equipped intersections and approaches can make the selection of comparison sites difficult. Third, sites selected for RLC installation may not be randomly selected, and as a result may suffer from the regression to the mean effect. Finally, crash severity needs to be considered to fully understand the safety impacts of RLCs. With these challenges in mind this study was designed to estimate the safety impacts of RLCs on traffic crashes at signalized intersections in the state of Arizona and to identify which factors are associated with successful installations. RLC equipped intersections in the cities of Phoenix and Scottsdale are examined in detail to draw conclusions as to the relative success of RLC programs in these two jurisdictions. Both jurisdictions are operating successful installations of RLCs. Factors related to RLC effectiveness appear to include crash type and severity, left-turn phasing, presence of warning signs, approach speeds, and signal timing. Recommendations are made as to under what conditions should RLCs be considered.
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Item 7
Driver License Manuals Best Practices
ARIZONA DEPARTMENT OF TRANSPORTATION
FHWA-AZ-05-553 • 2006

Each motor vehicle jurisdiction in the United States has an established process by which it assesses the required knowledge of driver license applicants to determine whether they are able to operate their vehicles safely and thus qualify for a driver's license. Corollary to that assessment process is the jurisdiction's responsibility to provide drivers with the information for which they are to be held responsible during the licensing exam and subsequently while operating their vehicle on our nation's roadways. The primary means of providing this information to drivers is the jurisdiction's basic driver license manual. This study was directed at identifying best practices with regard to the basic driver license manuals produced by motor vehicle jurisdictions. To identify best practices, three types of information sources were consulted: (1) driver license manuals produced by motor vehicle jurisdictions throughout the country; (2) driver safety information produced by relevant government agencies and private organizations; and (3) research, news, education, and popular literature. Of 212 knowledge items recommended by the American Association of Motor Vehicle Administrators (AAMVA) for inclusion in driver manuals, 119 were addressed by a majority (51% or more) of the manuals reviewed and are considered best practices in subject matter content. Additional topics that should be considered best practices in subject matter content are: intersection safety, particularly with regard to red light running; sharing the road with trucks, particularly emphasis on their "No-Zones"; road rage and aggressive driving; driver distraction; seatbelt usage, particularly with regard to the jurisdiction's primary or secondary seatbelt laws; and following distance, with emphasis on the need for a three- or four second gap. With regard to factors other than subject matter content, it was found that most jurisdictional manuals (77%) are smaller than the 8 1⁄2" x 11" size of the Arizona manual, with 48% opting for the compact 5 1⁄2" x 8 1⁄2". More than half the jurisdictions produce a version of the manual in Spanish, and more than a third of the jurisdictions produce a specialized driver manual directed at teen learners and their parents and encouraging parents' active involvement in their teen's learning process.
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Item 8

Atmospheric Effects Associated with Highway Noise Propagation

ARIZONA DEPARTMENT OF TRANSPORTATION

FHWA-AZ-05-555 • 2006

The primary questions investigated in this project were: What are the atmospheric conditions in the Phoenix valley that contribute to higher than normal sound levels? Are the conditions unique to the Phoenix valley? Can the atmospheric effects be anticipated? The main components of the project were: (1) a review of literature relevant to sound propagation, (2) detailed noise measurements in a Scottsdale neighborhood along the East Loop 101 Freeway, (3) computer modeling of sound propagation under various measured and inferred atmospheric conditions, (4) noise measurements before and after installation of an asphalt rubber friction course (ARFC) on the Pima Freeway by the ADOT Quiet Pavement Pilot Program, and (5) a pilot study investigating parametric models of tire/pavement noise. Some key conclusions are: nighttime thermal inversion conditions that are common in the Phoenix valley from October through March cause sound level increases of 5 to 8 dB at distances greater than 1/4 mile from freeways, nighttime down-slope drainage flows off the mountain ranges surrounding the Phoenix valley cause localized focusing and de-focusing of sound levels, sound level variations under inversion conditions appear to be greatest at locations that are upwind relative to the down-slope flows, the highest sound levels during the October to March period will usually occur right around sunrise when high traffic volumes coincide with strong inversion conditions, and installation of the ARFC reduces sound levels by 8 to 10 dBA both close to the roadway and at distances of 1/4 mile and greater. A final tentative conclusion is that, based on the computer modeling, there may be a rapid onset of refraction effects between about 200 and 300 m (650 to 1000 ft) from Phoenix valley roadways.
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Item 9

Bridge Deck Preservation Procedures for the Arizona Department of Transportation

ARIZONA DEPARTMENT OF TRANSPORTATION

FHWA-AZ-06-520 • 2006

The primary objective of this project is to identify several common bridge deck maintenance activities that are performed by contract, review the current Arizona Department of Transportation (ADOT) specifications for those maintenance activities, modify the specifications where appropriate to reflect current accepted practice, and to serve as a model to guide future efforts at updating specifications. To complete the project, all of ADOT's bridge deck maintenance specifications were reviewed. The following repairs were identified for further evaluation: Temporary repair of expansion joints. Minor collision damage repair of concrete I-beam girders. Hole in deck repair (with and without asphalt overlay). Bridge railing repair (concrete and aluminum). Bridge preservation specifications from other agencies were then collected and reviewed. This led to the selection of two treatments to develop new draft specifications: Bridge Deck Repair: Full-Depth Patch. Prestressed Concrete I-Beam: Minor Repair by Patching and Epoxy Resin Base Adhesive Injection. Draft specifications were developed and submitted to ADOT for review and possible implementation, thereby completing the project.
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Item 10

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.

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Item 11

Alternative Methods to Trench Backfill

LOUISIANA TRANSPORTATION RESEARCH CENTER

FHWA-LA.05-404 • 2005

Conduit structures dealing with hydraulic drainage needs in the Louisiana highway system include pipe culverts, pipe arch culverts, storm drains, sewers, etc. Although the Louisiana Department of Transportation and Development (LADOTD) has standard specifications for furnishing and installing these conduit structures to guarantee their proper functions, unexpected pavement surface dips still occur at some locations of highway cross-drain culverts and cause the deterioration of pavement ride comfort. The goal of this study was to develop recommendations for design and construction procedures to eliminate such pavement surface dips above highway culvert crossing structures. Researchers conducted a literature search and field investigation on existing pavements at various cross-drain locations with and without the pavement surface "dip" problem. In addition to conventional laboratory tests, full-scale trench backfill tests at the Louisiana Transportation Research Center's (LTRC) Pavement Research Facility (PRF) site evaluated different backfill materials in a controlled environment. Four construction projects accommodated field trench backfill testing sections with various backfill materials to further verify the findings obtained previously. The field testing sections used concrete pipes varied in size from 36 to 54 inches. Using different field compaction equipment and methods, the study explored and evaluated factors that influence the quality of highway cross-drain trench backfill. Relevant cost information is also included for future reference. The results from this study indicate that pavement surface dips at highway cross-drains on Louisiana highways involve many complex factors. The field probing tests revealed that the occurrence of the pavement dip depended largely on the relative stiffness of trench backfill materials with respect to their adjacent natural soils. The occurrence and magnitude of pavement surface dips depended also on other factors such as the stiffness of the pavement structure and truck traffic loading, etc. When a dip occurred at the surface, the trench backfill underneath was weaker than adjacent subgrade soils. Construction environment, contractors' workmanship, backfill materials, and compaction are the major factors controlling the quality of trench backfill compaction. Sand used in Louisiana is not a good backfill for highway cross-drains due to its very poor gradation and difficulty in compaction. Alternatives such as crushed limestone and flowable fill should be used for highway cross-drains because of their good performance after placement. The DCP device can be useful in evaluating the quality of trench backfills. LADOTD has implemented the results from this study by modifying the current specifications and standard design detail plans to accommodate the complicated field construction condition

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http://www.ltrc.lsu.edu/pdf/2005/fr_404.pdf

Item 12
Impact of Edge Lines on Safety of Rural Two-Lane Highways
LOUISIANA TRANSPORTATION RESEARCH CENTER
LTRC Report 414 • 2006

This report documents the results of the project for "Impact of Edge Lines on Safety of Rural Two Lane Highways." This research project was initiated in the effort of compliance with the updated version of the Manual on Uniform Traffic Control Devices (MUTCD Millennium Edition, 2000) in the subject of edge line implementation in Louisiana. The objective of this study is to investigate if the marking of edge lines on rural narrow two-lane highways would result in any negative effect on drivers' behavior that in turn may debase highway safety. The before-and-after measurements show that: (a) edge lines help drivers confine their traveling path, particularly at night, and (b) edge lines have no or little effect on drivers' operating speed. Conclusively, this study found that the presence of edge lines has a positive impact and the magnitude of the impact is influenced by such factors as roadway width, operating speed, time of the day, frequency of heavy vehicles, pavement condition, roadway alignment, and traffic in the opposing direction. The results obtained from this project can serve as a guideline for implementation by transportation agencies in Louisiana for general conformance with the MUTCD on edge line markings for narrow rural roadways.
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Item 13
Evaluation of Cross Median Crashes
NEW JERSEY DEPARTMENT OF TRANSPORTATION
FHWA-NJ-2005-004 • 2005

The objective of this research project has been to evaluate the post-impact performance of two different median barrier systems installed in New Jersey: (1) a three-strand cable median barrier system installed on I-78, and (2) a modified three beam median barrier system installed on I-80. The subject research program has evaluated the performance of the I-78 and I-80 median barrier designs in three ways – (1) through finite element modeling, (2) through field investigation of crashes into the subject barriers, and (3) through a survey of the median barrier experience of other state DOTs. Although the focus of this study has been on the I-78 and I-80 median barrier designs, the results of this study are expected to provide new insight into the performance of and potential improvements to the design of future median barrier in New Jersey.
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Item 14

Computer Modeling and Simulation of New Jersey Signalized Highways

NEW JERSEY DEPARTMENT OF TRANSPORTATION
FHWA-NJ-2005-008 • 2005

Development and implementation of intelligent transportation systems along highway corridors includes deployment of various, usually considerably expensive technologies. In the area of traffic control, these technologies were used to optimize an array of signal cycle lengths, phasing, splits, and offsets, while considering dynamic traffic conditions (e.g., fluctuations in traffic volume, speed, and density). In order to facilitate cost efficient traffic signal control on New Jersey highways, this study developed computer models to optimize the array of aforementioned variables, evaluate the benefits of optimized array, and determine the resulting level of service prior to actual implementation in the studied corridors. The objective of this study was to assess and optimize corridor performance through enhancements of existing signal timing plans for the studied corridors, which has been achieved through performing the following activities: Review, investigate, and summarize the state-of-the-art methodologies for signal optimization; Identify studied corridors and collect necessary data for developing signal optimization and traffic simulation models; Develop computer models to optimize traffic signal cycle lengths, phasing, splits, and offsets for the studied corridors; Develop simulation models to simulate and assess the recommended signal timings prior to field implementation on the studied corridors; Assist NJDOT in producing timing directives for recommended signal timings; and Provide training and technology transfer to NJDOT. In this study, SYNCHRO (version 5.0) was applied to evaluate the operations of traffic control systems for individual or group of intersections along the corridor. However, due to the dynamic nature of traffic operations, the results of SYNCHRO are not effective in responding to continuously changing real-time traffic conditions. Therefore, SimTraffic was applied to validate the results of SYNCHRO. With SYNCHRO and SimTraffic, before and after scenarios for implementing the optimized signal timings were assessed, while the “savings” in travel times, number of stops, fuel consumption, and vehicle emissions were calculated.
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Item 15

Computer Modeling and Simulation of New Jersey Signalized Highways (Volume II - Cost and Benefit Analysis)

NEW JERSEY DEPARTMENT OF TRANSPORTATION
FHWA-NJ-2005-009 • 2005

This study developed a practical method to quantify costs and benefits associated with optimizing traffic signal timing plans. A benefit Analysis Tool (BAT) was developed for calculating the differences between existing and optimized traffic signal timing plans by interfacing the SYNCHRO results. A corridor for which data was recently collected and available is used as a case study to demonstrate the application of BAT. Results showed substantial benefit in reducing signal delay, fuel consumption, and vehicular emission.
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Item 16

Investigation of Long-Term Prestress Losses in Pretensioned High Performance Concrete Girders

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 05-CR20 • 2005

Effective determination of long-term prestress losses is important in the design of prestressed concrete bridges. Over predicting prestress losses results in an overly conservative design for service load stresses, and under-predicting prestress losses, can result in cracking at service loads. Creep and shrinkage produce the most significant time-dependent effect on prestress losses, and research has shown that high performance and high strength concretes (HPC and HSC) exhibit less creep and shrinkage than conventional concrete. For this reason, the majority of traditional creep and shrinkage models and methods for estimating prestress losses, over-predict the prestress losses of HPC and HSC girders. Nine HPC girders, with design compressive strengths ranging from 8,000 psi to 10,000 psi, and three 8,000 psi lightweight HPC (HPLWC) girders were instrumented to determine the changes in strain and prestress losses. Several creep and shrinkage models were used to model the instrumented girders. For the HPLWC, each model over-predicted the long-term strains, and the Shams and Kahn model was the best predictor of the measured strains. For the normal weight HPC, the models under-estimated the measured strains at early ages and over-estimated the measured strains at later ages, and the B3 model was the best-predictor of the measured strains. The PCI-BDM model was the most consistent model across all of the instrumented girders. Several methods for estimating prestress losses were also investigated. The methods correlated to high strength concrete, the PCI-BDM and NCHRP 496 methods, predicted the total losses more accurately than the methods provided in the AASHTO Specifications. The newer methods over-predicted the total losses of the HPLWC girders by no more than 8 ksi, and although they under-predicted the total losses of the normal weight HPC girders, they did so by less than 5 ksi.

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Item 17

Performance of a Bridge Deck with Glass Fiber Reinforced Polymer Bars as the Top Mat of Reinforcement

VIRGINIA TRANSPORTATION RESEARCH COUNCIL
VTRC 05-CR24 • 2005

The purpose of this research was to investigate the performance of glass fiber reinforced polymer (GFRP) bars as reinforcement for concrete decks. Today's rapid bridge deck deterioration is calling for a replacement for steel reinforcement. The advantages of GFRP such as its high tensile strength, light weight, and resistance to corrosion make it an attractive alternative to steel. The deck of one end-span of the Gills Creek Bridge was constructed with GFRP bars as the top mat and epoxy-coated steel bars as the bottom mat. Live load tests were performed in 2003, shortly after completion of construction, and again in 2004. In addition, tests were performed on the deck of the opposite end-span, which had all epoxy-coated steel reinforcing. The results of these tests were used to evaluate the girder distribution factors and impact factors of a GFRP reinforced bridge deck. In addition, a comparison of the results from the two test periods gives an indication of any changes in strains in the GFRP bars and if the deck is behaving differently than when first installed. The results were compared to the design standards specified by the American Concrete Institute in the Guide for the Design and Construction of Concrete Reinforced with FRP Bar to determine if the stresses in the deck were within the specified limits. The performances of the two end-spans were compared to determine if the GFRP reinforcement had any significant influence on overall bridge behavior. There were no significant differences in the behavior of the deck after 1 year of service and there was no visible cracking. The behavior of the two end-spans was similar, and the measured girder distribution factors were less than the AASHTO design recommendations. The impact factors were less than design values for the 2003 tests but higher than design values for the 2004 tests. Stresses in the GFRP reinforcing bars were much less than the design allowable stress and did not change significantly after 1 year of service. The strain gauges, vibrating wire gauges, and thermocouples in the bridge deck were monitored for approximately 1 year using a permanent data acquisition system. Daily, monthly, and long-term fluctuations in temperature and stresses were examined. The vibrating wire gauges were more reliable than the electrical resistance strain gauges, and the main influence on strain changes was temperature fluctuation. A cost/benefit analysis of using GFRP bars indicates their high initial costs are justified when compared to the costs of a concrete overlay.

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Item 18

Characterization of the Punching Shear Capacity of Thin Ultra-High Performance Concrete Slabs

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 05-CR26 • 2005

Ultra-high performance concrete (UHPC) is a relatively new type of concrete that exhibits mechanical properties that are far superior to those of conventional concrete and in some cases rival those of steel. The main characteristics that distinguish UHPC from conventional reinforced concrete are its very high compressive strength (20 to 33 ksi), the addition of steel fibers which enables tension to be carried across open cracks without conventional reinforcing steel, and a very high resistance to corrosion and degradation. The mechanical properties of UHPC allow for smaller, thinner sections as compared to conventional reinforced concrete sections. However, as it is a new material, the use of UHPC has been limited to a few structural applications due primarily to the high cost of the material and the lack of established design guidelines. In previous research, a material model based on physical tests was used in conjunction with finite element models to develop an optimized cross-section for a prestressed UHPC girder for bridge applications. The cross-section is a double-tee with bulbs at the bottoms of the webs to accommodate the prestressing strands. As it is envisioned in bridge applications, the double-tees will be placed directly adjacent to one another, and the top flange will act as the riding surface after a thin asphalt overlay is placed. Based on the longitudinal compressive stresses, the top flange of the girder can be quite thin. However, there exists the possibility that a punching shear failure could occur from the application of a point load such as a wheel patch load if the flange is made too thin. The research reported herein was initiated to characterize the punching shear capacity of thin UHPC plates and to develop recommendations on the minimum top flange thickness for the optimized double-tee. Twelve small slabs (45 in x 45 in) were tested to failure to characterize the punching shear strength of UHPC. The variables considered were the slab thickness (2, 2.5, and 3 in) and loading plate dimensions (from 1 in x 1 in to 3 in x 3 in). The results of the testing were compared to several existing models for punching shear. The two equations that predicted strengths most reliably were the current ACI punching shear equation and a modified bolt pull-out equation. After evaluation of the test results, the minimum slab thickness required to prevent a punching shear failure in the top flange due to an 8 in x 20 in wheel patch was determined to be 1 in. Three larger slabs were also tested. These slabs had the same clear span length as the top flange of the optimized double-tee and were loaded with a wheel patch load. The slabs were all approximately 3 in thick and all failed in flexure rather than punching shear. It was concluded that the casting method has a strong influence on the orientation of the steel fibers, which in turn influences the flexural strength in orthogonal directions in the slab. The top flange thickness will be governed by transverse bending rather than punching shear, and the 3 in slabs were not able to support the full wheel load plus impact and load factor. The results of this research help in the continued optimization of a UHPC shape for use in highway bridges. If material use in the girder is minimized, UHPC bridges can become economically competitive with HPC bridges, but offer the benefits of more rapid construction and better durability.

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Item 19

A Tale of Three Regions: Influence of Highway Investments on Population and Traffic Growth in Virginia

VIRGINIA TRANSPOTATION RESEARCH COUNCIL
VTRC 05-R23 • 2005

To what extent may highway investments shape population growth and land development? To answer this question, three decades of data were examined in the Virginia locations of Fairfax County, Spotsylvania County, and Newport News. In each location, a highway investment (or deliberate decision not to make such an investment) was proposed by some as an instrument for increasing, shaping, or decreasing population or development growth. The case study approach was used, considering Fairfax County's decision not to build Monticello and other freeways proposed in 1960s comprehensive plans, Spotsylvania's efforts to manage Route 3 traffic congestion, and Newport News' desire for the construction of I-664. By comparing what planners intended these transportation decisions to accomplish with what transpired, the adequacy of using highway investments to manage influence growth may be assessed. The results suggest that in many ways, transportation investments are a blunt policy instrument. They can and do affect short-term travel and longer term location choices, but it is difficult to use investments to manage growth precisely. In fact, in none of the three case studies were all planners' intentions realized: when planned roads were not built in order to stop growth, growth continued, and when roads were built to encourage development or redevelopment in a specific location, growth occurred elsewhere. Yet, the three case studies suggest several findings that, if applied to planning practice, can yield future plans that are more realistic: (1) view transportation improvements in a supply/demand context; (2) quantify expected impacts where possible; (3) give transportation plans a realistic implementation mechanism; and (4) present forecasts as ranges rather than point values. Although these practices may be "common sense," their explicit consideration may facilitate planning efforts in the short run. However, an unintended consequence of reviewing the case study histories is that they strongly suggest Virginia counties have limited options for managing growth. To some extent, counties can influence the specific location of growth and what type is attracted—but the case studies leave the impression that if the market is there to support growth, eventually it will come. Within Virginia's current legal environment, counties have limited options for how they can accommodate this growth.

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Item 20

Texture, Ride Quality, And The Uniformity Of Hot-Mix Asphalt Pavements

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 05-R34 • 2005

Two years ago, the author completed a study with researchers at Virginia Tech that was designed to develop a tool to measure and control segregation of hot-mix asphalt pavements. This earlier work focused on the application of high-speed texture measurements and ultimately proposed an approach that would discourage segregation by establishing limits on allowable fluctuation of pavement macrotexture. Rather than emphasize segregation detection and measurement, the proposed special provision promoted new-surface uniformity. The activities discussed in this report represent the next step in the process of understanding the relationship between the uniformity and surface characteristics of hot-mix asphalt. The study documents the typical "texture profile" for Virginia's most common surface mixes. It revisits the texture-fluctuation provision proposed in the earlier project and delves into an expanded use of elevation profiles for promoting uniformity. Although the major findings and conclusions from this work do not specifically support a texture-based "segregation specification," the study does advocate continued dedication to material and construction uniformity. Alternatives to a texture-based specification include quality measures that recognize variability of traditional quality characteristics (such as percent defective and percent within limits specifications) and a new approach to reporting and using ride quality data, i.e., "roughness profiles." Whether specifically required or used voluntarily to comply with provisions that have stringent variability components (e.g., ride, texture, density), a properly functioning and operated material transfer vehicle is a proven contributor to good hot-mix uniformity. If the vehicle (at $900/mile) eliminates an estimated $3,000 per lane-mile loss in service life due to low-level segregation, the benefit-to-cost ratio is greater than 3.

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