Research Digest

FORWARD ALL REQUESTS TO:
The University of Texas at Austin
Center for Transportation Research **LIBRARY**
3208 Red River • Suite 115 • Austin • Texas • 78705-2650
Phones: (512) 232-3126 and (512) 232-3138 • Fax: (512) 232-3088
Email: ctrlib@uts.cc.utexas.edu

In this Issue:
State DOT Reports

Table of Contents

Research Digest

Item 1

The Use of Recycled Concrete Aggregate in a Dense Graded Aggregate Base Course

NJ DOT

FHWA-NJ-2008-002 • 2008

The research project was broken up into 2 different parts. The first part involved evaluating the potential use of the Time Domain Reflectometry, TDR (ASTM D6780), as a non-nuclear means for determining the dry density and moisture content of granular base and subbase aggregates during quality control. The second part of the research study was to evaluate potential methods of increasing the permeability of recycled concrete aggregate (RCA), while attempting to maintain its structural integrity (i.e. – California Bearing Ratio, CBR).

The results of the laboratory testing showed that the best performing modification to the RCA was when blended with 50% DGA. This increased the permeability to levels considered average, while still providing excellent bearing strength. The attempts of using the NJDOT I-3 and poorly graded sand did not dramatically increase the permeability, while a decrease in bearing strength was still reported. Increasing the top size of the processed/screened RCA from 1.5 inches to 2.0 inches helped to increase the permeability, while achieving the same bearing strength properties (CBR).

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2008-002.pdf

Item 2

Manual of Guidelines for Inspection of ITS Equipment and Facilities

NJ DOT

FHWA-NJ-2008-006 • 2008

ITS acceptance and maintenance inspection manual is needed as a reference document to assist the Department's inspectors, ITS design and traffic operations and ITS maintenance personnel to ensure effective inspection and maintenance of ITS facilities. This manual should be a comprehensive reference document that has separate inspection (acceptance) and maintenance sections. Inspection (acceptance) section should definitely cover the following areas (but should not be limited to these only): Inspection of ITS equipments after the installation, acceptance testing, verifying that the corresponding ITS equipment and its elements have been manufactured and constructed in accordance to the quality requirements of the specifications/plans.

Maintenance sections will cover the following areas (but should not be limited to these only): Routine maintenance of various ITS equipment including, Maintenance schedules for ITS systems and devices, Troubleshooting, spare parts inventory, configuration management and disaster recovery, etc.

A wide variety of engineers including civil, mechanical, electrical, software and computer, and communication engineers, are required to design and construct ITS facilities. ITS device manufacturers, system vendors, suppliers, and contractors, etc., develop and provide drawings, guides, manuals, inspection procedures, maintenance procedures. Thus, there is a vast amount of knowledge that is needed to be extracted and then incorporated into a Manual of Guidelines for effective Inspection of ITS facilities by knowledgeable, experienced NJDOT personnel and well-trained inspectors and/or subcontractors. The major goal of this project is to provide these stakeholders with the tools necessary to effectively inspect and maintain New Jersey's ITS equipments.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2008-006.pdf

Item 3

Stability and Accuracy of HCM Level of Service in Darkness and Adverse Weather

NJ DOT

FHWA-NJ-2008-007 • 2008

The Highway Capacity Manual (HCM) uses average travel speed to assign Levels Of Service (LOS) to urban streets and arterials. However, the HCM procedure for estimating travel speeds has weaknesses, particularly in the determination of the Free-Flow Speed (FFS), by failing to account for the impact of weather conditions (e.g., rain, snow, ice, etc,) and light conditions (e.g., sunglare, darkness, etc.).

In this research, traffic data, under adverse weather, were collected and the impact of weather conditions to speed and density on selected New Jersey highways were investigated. Equations were developed to adjust the capacity estimation formula and figures suggested by HCM (2000) that can be used to accurately estimate travel times for buses and general traffic considering darkness and adverse weather.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2008-007.pdf

Item 4

Operational Improvements at Traffic Circles: Safety Analysis

NJ DOT

FHWA-NJ-2008-011 • 2008

The purpose of this study was to improve the safety and operation at three traffic circles in New Jersey. To do this, data were collected at the traffic circles to allow researchers to model the circles using the PARAMICS software simulation package. Once operational and safety factors were evaluated at the circles, alternatives for improvement were developed. The PARAMICS model was then utilized to evaluate the costs and benefits of each alternative. To augment the simulation work, empirical analysis was also performed using two model forms.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2008-011.pdf

Item 5

Operational Improvements at Traffic Circles

NJ DOT

FHWA-NJ-2008-012 • 2008

This study deals with the development of a credible and valid simulation model of the Collingwood, Brooklawn, and Asbury traffic circles in New Jersey. These simulation models are used to evaluate various geometric and operational improvement alternatives. An extensive review of the available simulation packages is presented. PARAMICS microscopic simulation software was selected due to its capability of modeling and simulating complex roadway structures and driver behavior. The simulation models of these circles were developed using PARAMICS. These models were validated and calibrated using the extensive field data collected as part of this project. The specifics of the collected data, and the extraction procedure are also explained in the report. The development of the simulation models and the validation and calibration steps are presented in detail.

The study observed that the efficiency of these traffic circles is directly related to the gap acceptance/rejection of vehicles at yield-controlled or stop-controlled intersections, and the interarrival time of vehicles at the approaches. Therefore, at each selected location, gap acceptance/rejection models are developed based on the extracted data. The Application Programming Interface (API) of PARAMICS is used to incorporate site specific gap acceptance/rejection models. Also, to model realistic interarrival times at the approaches, the traffic signals at the vicinity of the circles are modeled using actual signal timing parameters.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2008-012.pdf

Item 6

Implementation of Weigh-in-Motion (WIM) Systems

NJ DOT

FHWA-NJ-2009-001 • 2009

This research finished the development and implementation of a novel and durable, higher voltage, and lower temperature dependant weigh-in-motion (WIM) sensor that was begun under an earlier research project. These better sensors will require fewer lane closings and replacements than the existing sensors. They will also aid the Departments of Transportation to better identify those vehicles, which use the nations major highways, that do not comply with the current weight restrictions that are placed on larger vehicles. The primary focus of the research was to create a full scale WIM sensor that is less temperature dependent and more durable than traditional WIM sensors. Traditionally, the data collected from the sensor may be utilized in two ways. The first is by using static vehicle effects on the sensor, which corresponds to the weight of the vehicle, this data can be used for enforcement of the vehicle legal weight limits. The second is by using the dynamic loading of the sensor, which relates to the actual loading that the roadway is experiencing, this data will be useful to engineers who must design the roadway as well as plan for repair schedules. However, there is a growing trend to broaden the use of WIM data and use the data to its fullest extent. Instead of just using WIM data to screen commercial vehicles or for pavement design; there is a new recognition that good data can be useful for bridge structural analysis, safety analysis, traffic control and operations, freight management and operations, facility planning and programming, and standards and policy enforcement as per the recent report “Effective Use of Weigh-in-Motion Data, the Netherlands Case Study” FHWA October 2007. In lieu of this development, the need for better sensors to provide good data is more important today than ever before.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2009-001.pdf

Item 7

Design and Evaluation of Effective Crosswalk Illumination

NJ DOT

FHWA-NJ-2009-003 • 2009

Pedestrian-related crashes are a common cause of roadway fatalities, and reduced visibility at night is a probable contributor to pedestrian injuries and death. The purpose of the present study was to systematically evaluate different approaches to lighting at pedestrian crosswalks to improve pedestrian visibility and detection. The project team conducted a series of photometrically accurate lighting simulations in order to assess the visual conditions resulting from different lighting configurations, and assessed the economics (initial cost, and electricity and maintenance costs) of each system evaluated. Finally, the most promising lighting configuration was field tested during a one-night demonstration at an intersection in New Jersey. The results of visual performance and economic evaluations converged in that they suggested that a bollard-based fluorescent lighting system mounted at the ends of a crosswalk and oriented to provide vertical illumination on pedestrians in the crosswalk could be a feasible approach with reduced costs to improving pedestrian visibility. The results of the field demonstration also confirmed that the bollard- based solution was practical. Improvements of the approach such as use of louvers for glare control and coordinating light output level with the timing of pedestrian signals to provide an alerting signal are also provided.

Full-text PDF of this report is available for free download from
http://www.utrc2.org/research/assets/152/FHWA-NJ-2009-0031.pdf

Item 8

Development of FWD Procedures Manual

NJ DOT

FHWA-NJ-2009-005 • 2009

In this project, the state-of-practice in FWD testing and analysis procedures were examined by looking at the standard protocols of a number of other highway agencies. The specific needs of NJDOT were also examined and a protocol was developed that encompassed current standard practice in a way most suited to NJDOT operations. This report documents the development of the FWD Procedures Manual required by NJDOT.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2009-005.pdf

Item 9

2009 NJDOT FWD Procedures Manual

NJ DOT

FHWA-NJ-2009-006 • 2009

This NJDOT FWD procedures manual is based on a modified LTPP FWD Procedures Manual. A falling weight deflectometer (FWD) is a device designed to simulate deflection of a pavement surface caused by a fast-moving truck. The FWD generates a load pulse by dropping a weight onto the pavement surface. This load pulse is transmitted to the pavement through a 300 (mm) 11.8 inch diameter circular load plate. The load pulse generated by the FWD momentarily deforms the pavement under the load plate into a dish or bowl shape (Figure 1). Envisioned from a side view, the shape of the deformed pavement surface is a deflection basin. Based on the force imparted to the pavement and the shape of the deflection basin, it is possible to estimate the stiffness of the pavement by using various computational methods. If the thickness of the individual layers is also known, the stiffness of those layers can also be calculated.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2009-006.pdf

Item 10

Safety Comparison of Roadway Design Elements on Urban Collectors with Access

NJ DOT

FHWA-NJ-2009-008 • 2009

The main goal of this study identified by NJDOT can be defined as “the quantification of the effects of management treatments on roadway operations and safety on urban collectors with access”. Since urban collector road runs through highly diversified areas, various factors have to be considered when before-and-after comparisons of improvements in terms of safety are conducted in this study. For 25-40 mph urban collectors with access, these are:

1. Increase in lane widths (10' or 11' to 12'),
2. Construction of 4,6,8, or 10 foot shoulders,
3. Removal of trees in median and border areas,
4. Installation of guide rails, and vertical & horizontal geometry changes to improve sight distances.

Before and after analysis for these countermeasures was conducted via several approaches, including naïve approach, analysis via control groups, analysis via Empirical Bayes approach, and analysis via Full Bayes approach. After conducting before-and-after analysis, Crash Reduction Factors (CRF) were estimated for each countermeasure. The individual CRF values and their relative order among different countermeasures are similar to the values in the literature. In particular, improvements in vertical and horizontal alignment results in highest reduction in the accident rate, followed by adding shoulders, median barrier installation, lane width increase, and guide rail installation.

Full-text PDF of this report is available for free download from
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2009-008.pdf

Item 11

Field Testing of the Wolf Creek Curved Girder Bridge - Part I: Vibration Tests

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 09-CR13 • 2009

The Wolf Creek Bridge is a curved, multi-girder three span steel composite bridge located south of Narrows, Virginia, that was completed in 2006. A finite element model of the bridge revealed that pier flexibility may be important in modeling the bridge. In addition, questions have been raised as to the effectiveness of the C15x33 diaphragms in providing lateral transfer of loads between members.

This study was conducted as Phase I of a project for which the overall goal was to use field testing to obtain a better understanding of the behavior of multi-span curved girder bridges. An array of vertically oriented accelerometers was located along the inner and outer edges of the bridge, along with radially oriented accelerometers along the outer edge, a tangentially oriented accelerometer on the outer edge, and an additional vertical accelerometer placed in the middle of the center span. Dynamic response data were collected under a variety of excitations, including sinusoidal forcing induced by an electro-dynamic shaker, impulse loadings at various locations, and several different vehicular loads.

Implications of this study could have a significant effect on future health monitoring applications as they pertain to both c curved girder bridges correctly. Thus, it will be important to perform subsequent numerical research studies to develop models that will result in more precise predictions and to use these and other methods being developed in any health monitoring applications.

Full-text PDF of this report is available for free download from
http://www.virginiadot.org/vtrc/main/online_reports/pdf/09-cr13.pdf

Item 12

Field Testing of the Wolf Creek Curved Girder Bridge - Part II: Strain Measurements

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 09-CR14 • 2009

The Wolf Creek Bridge is a curved, multi-girder three span steel composite bridge located south of Narrows, Virginia, that was completed in 2006. A finite element (FE) model of the bridge revealed that pier flexibility may be important in modeling the bridge. In addition, questions have been raised as to the effectiveness of the C15x33 diaphragms in providing lateral transfer of loads between members.

This study was conducted as Phase II of a project for which the overall goal was to use field testing to obtain a better understanding of the behavior of multi-span curved girder bridges. The Phase I study was published separately (Turnage and Baber, 2009). During Phase II, an array of 49 strain gages was installed on the superstructure of the bridge: 34 gages were installed on the four girders at the mid-point of the center span, and 15 gages were installed on the three diaphragm members located closest to mid-span. The bridge was then subjected to static and dynamic applications of a loaded dump truck for which the axle loads were quite close to those of an HS-20 truck. The static strains were measured when the truck was located at 19 different locations on the inner and outer lanes. The dynamic strains were measured under the truck crossing the bridge at normal traffic speed for the structure.

The static loading was then replicated on the FE model. The measured static strains were compared with the strains computed from the FE model. Both measured and computed strains on the girders were used to estimate distribution factors, which were compared to evaluate the effectiveness of moment transfer between girders. The measured static and dynamic strains were also compared to estimate dynamic amplification factors. Finally, measured and computed diaphragm strains were compared to evaluate the FE model's diaphragm girder approximation.

Full-text PDF of this report is available for free download from
http://www.virginiadot.org/vtrc/main/online_reports/pdf/09-cr14.pdf

Item 13

Investigation of Solutions to Recurring Congestion on Freeways

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 09-R10 • 2009

Persistent daily congestion, which has been increasing in recent years, is commonly experienced for several hours or more during the morning and evening on Virginia's urban freeways. Many of these roadways are at or near capacity, which causes severe delays and backups. One solution to reducing recurring congestion is to add capacity by building more lanes; however, this is usually the last resort as it is an expensive and time-consuming approach. Another strategy proposed to combat recurring congestion is to manage the current freeways so that they operate more efficiently. Reducing congestion through better managed freeways has numerous documented benefits, including reducing travel times, smoothing the traffic flow, increasing average fuel economy, shortening the rush hour period and reducing vehicle queuing.

The highway operational strategies implemented to reduce recurring congestion have shown promising results abroad where there is an extensive use of active traffic management systems. To prove the effectiveness of a better managed freeway in mitigating recurring congestion, this study tested the effectiveness of an active traffic management system on a simulated model of I-66 and I-95 in Northern Virginia. Hard shoulders, variable speed limits, and ramp metering are several active traffic management systems simulated in this study. The simulation model was based on the geometric characteristics, ramp volumes, vehicle flows, and speeds of actual recorded conditions. Compared with the simulated control conditions, the results of the study indicated improvements in average fuel economy, travel delay, delay of the onset of congestion, and reduction of queues. The two active traffic management systems, i.e., variable speed limits and hard shoulders, showed the highest potential for reducing recurring congestion and should be considered as potential countermeasures in congested corridors.

Although the capital costs of implementing these strategies would be high, the return on investment in the first year of operations is estimated at $500,000, with the potential to grow to as much as $8 million annually in subsequent years.

Full-text PDF of this report is available for free download from
http://www.virginiadot.org/vtrc/main/online_reports/pdf/09-r10.pdf

Item 14

Evaluation of Retroreflective Material on Stop Sign Posts in Virginia

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 09-R23 • 2009

The purpose of this study was to evaluate the effectiveness of retroreflective material on stop sign posts in Virginia with respect to visibility and driver compliance at the stop sign. The investigation included a review of the feasibility, costs, and benefits of this application. In addition, a review of practices by other localities and DOTs was performed and field studies were conducted to examine visibility and driver compliance.

Full-text PDF of this report is available for free download from
http://www.virginiadot.org/vtrc/main/online_reports/pdf/09-r23.pdf

Item 15

Synthesis of Benefits and Costs of Alternative Lane Marking Strategies

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 09-R24 • 2009

The Virginia Department of Transportation (VDOT) currently uses snowplowable raised pavement markers (SRPMs) to supplement longitudinal pavement markings on some facilities. SRPMs are much more visible than traditional longitudinal markings under wet, nighttime conditions. SRPMs have been reported to dislodge from pavement, however, which has raised the question as to whether alternative marking materials might be able to replace SRPMs.

The purpose of this study was to investigate the visibility performance of longitudinal pavement marking materials currently on the market. The specific objectives of this study were (1) to determine whether or not new pavement marking materials could be used in place of SRPMs; (2) if SRPMs were to be used, to develop guidelines for their installation and maintenance; and (3) to determine the costs and benefits of using SRPMs to the maximum extent possible. No new data on the visibility or durability of pavement marking materials were collected for this study. The study primarily synthesized existing research on the characteristics of different marking materials and then applied information derived from the synthesis to Virginia-specific data to estimate the impacts of using different materials. National practices for installing, inspecting, and maintaining SRPMs were also reviewed.

The results of the literature review indicated that SRPMs remain the only marking system that provides sufficient nighttime preview time at high speeds, especially under wet conditions. Further, SRPMs can improve safety in certain situations, but they can also degrade safety in other situations since drivers may travel at higher speeds when the distance they can see down the road at night increases.

Proposed guidelines for the installation and maintenance of SRPMs were developed. They recommend that SRPMs be installed on all limited access freeways, on all two-lane roads with an average daily traffic volume above 15,000 vehicles per day, and on all roads with a posted speed limit of 60 mph or greater. Several other situations where SRPMs might be installed based on engineering judgment were also identified. A proposed maintenance schedule that requires inspections every 2 to 3 years was also developed.

A conservative economic analysis indicated that the benefits of installing and maintaining SRPMs using the guidelines developed in this study outweighed the costs by more than 80 to 1, based purely on potential safety improvements on road geometries where SRPMs have been shown to improve safety. Further, VDOT can realize cost savings by discontinuing SRPM usage on low-volume facilities and by revising particular SRPM standards

Full-text PDF of this report is available for free download from
http://www.virginiadot.org/vtrc/main/online_reports/pdf/09-r24.pdf