



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

Phone: (512) 232-3126 and (512) 232-3138

Fax: (512) 232-3088

Email: ctrlib@uts.cc.utexas.edu



Research Digest

Item 1

Implementation of Self-Consolidating Concrete for Prestressed Concrete Girders

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NC DOT)

FHWA/NC/2006-30 • 2005

This report documents the first experience of using self-consolidating concrete for prestressed concrete bridge girders in North Carolina. Under construction in eastern North Carolina was a multi-span bridge which used one hundred thirty AASHTO Type III girders, each 54.8 ft (16.7 m) long. To demonstrate the full-scale field production of self-consolidating concrete, and for comparative purposes, three girders from one production line of five girders were selected for the experimentation. Two of the girders were cast with self-consolidating concrete and one with normal concrete as control.

The plastic and hardened properties of both the self-consolidating concrete and the normal concrete were monitored and measured. The plastic properties of self-consolidating concrete included unit weight, air content, slump flow, visual stability index (VSI), and passing ability measured by J-ring and L-box. Hardened properties of the two concretes included temperature development during curing, compressive strength, elastic modulus, and flexural tensile strength, creep, and shrinkage. The prestressing force was monitored by load cells. The transfer lengths of prestressing strands were determined by embedded strain gauges, and from the measured strand end-slips. Finally, the three girders were tested in flexure up to the design service load to determine and compare their load-deformation characteristics. Based on the satisfactory results on this study, the two prestressed SCC girders were installed in the bridge for service as other normal concrete girders.

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

<http://www.lib.ncsu.edu/theses/available/etd-12132004-202907/unrestricted/etd.pdf>



Research Digest

Item 2

High-Performance Continuously Reinforced Concrete Pavements in Richmond and Lynchburg, Virginia *FEDERAL HIGHWAY ADMINISTRATION (FHWA); VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)*

FHWA/VTRC 08-R4 • 2007

This study evaluated the properties of two high performance concrete (HPC) paving projects in Virginia. These continuously reinforced concrete pavements were placed on State Route 288 near Richmond and on the U.S. 29 Madison Heights Bypass in Lynchburg; a minimum flexural strength of 650 psi at 28 days was required for each. In an attempt to control cracking, reduced shrinkage was sought through the use of large maximum size well-graded aggregates and proper curing.

The results showed that satisfactory strengths can be obtained at 28 days. Concretes with the lowest water content had the lowest shrinkage, as expected. For desired performance, good construction practices including a level base, correct steel placement, proper consolidation, timely texturing, and effective curing are required. Although pavement designs are based on flexural strength, compressive strength tests are more convenient and less variable than are flexural strength tests. Therefore, a correlation was established between flexural and compressive strength, and acceptance of the pavements was based on compressive strength.

The findings of the study led to the following recommendations with regard to the concrete used in HPC paving projects:

- Consider specifying strength at ages above 28 days to encourage the use of a higher percentage of pozzolanic material.
- Specify the use of large maximum size aggregate in combination with well-graded aggregate to reduce water content and minimize segregation.
- Use trial batches to determine the minimum cementitious materials content that provides acceptable strength and workability.
- Use actual elastic modulus values to check and adjust the design of the pavement.
- Use a test section before the start of the paving operation to determine if any changes to the equipment and placement procedures are needed.
- Use compressive strength for the acceptance of a project after a correlation with flexural strength is established.
- Permit maturity testing to estimate the strength of concrete in the pavement for opening to traffic based on concrete curing time and temperature.

If as little as a 10 percent increase in service life were achieved by using HPC, the savings would be in the millions of dollars over the life of the pavement. With proper selection of the aggregates, a reduction in the cementitious material content of 50 lb/yd³ is possible and would translate to a savings of about \$400,000 dollars for the two projects investigated in this study. The reduction in time for opening to traffic of new or reconstructed pavements through strength estimation by the maturity method and the use of appropriate earlier strength mixtures can lead to road user cost savings close to \$0.5 million per year.

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

http://www.virginia.gov/vtrc/main/online_reports/pdf/08-r4.pdf



Research Digest

Item 3

Post-Tensioning the Inverted-T Bridge System for Improved Durability and Increased Span-to-Depth Ratio

KANSAS DEPARTMENT OF TRANSPORTATION (KS DOT)

K-TRAN: KSU-03-5 • 2007

Possibly the most pressing need in highway construction today is the repair or replacement of existing bridges. Due to increased needs and growing traffic, in addition to aging and extensive use, more than 2000 bridges in Kansas alone need to be replaced during the next decade. The majority of these bridges has spans of 100 ft or less, and has relatively shallow profiles. It is becoming increasingly important to implement a standard method for replacement in which the process is expedited and accomplished in cost-effective manner.

Requirements for design and construction of concrete bridges have drastically changed during recent years. A main change in design is live-load requirements.

Nebraska inverted-T bridge system has gained increasing popularity for its lower weight compared to I-girder bridges. However, there are some limiting issues when using IT system in replacing existing CIP bridges.

Implementation of a post-tensioned IT system, which is the focus of this research, is believed to be one excellent solution for the IT deficiencies. Post-tensioning is added by placing a draped, post-tensioning duct in the stems of the IT members. Post-tensioning will lead to a higher span-to-depth ratio than IT system, and will reduce the potential transverse cracks in the (CIP) deck. Finally, the undesired cambers of pretensioned beams will be reduced, because fewer initial prestressing will be needed.

This study was intended to explore the behavior of the PT-IT system, identify major parameters that control and limit the design of this system, and investigate different construction scenarios. This was achieved by conducting an extensive parametric study. For that purpose, PT-IT analysis program was developed and written using C++ programming language. The program was used to analyze various post-tensioning procedures for the post-tensioned inverted-T system. A Visual Basic friendly interface was provided to simplify the data input process.

The findings of this research included recommendation of construction scenario for PT-IT system, as well as examining different methods for estimating time-dependent restraining moments. Effect of different concrete strengths on the behavior of PT-IT system was also determined. Most importantly, the effect of timing on different construction stages was also evaluated and determined.

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

<http://krex.k-state.edu/dspace/bitstream/2097/240/1/RimNaya12006.pdf>



Research Digest

Item 4

2007 Austin-Area Transportation Databook

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT)

MS-8088 • 2007

The Texas Department of Transportation (TxDOT), Austin District, presents this databook as a tool for local and regional elected officials, professional engineers and planners, interested citizens, and policy stakeholders alike. The purpose of this document is to provide information to assist in the development and assessment of transportation infrastructure, services, and policies within the Central Texas area. The databook is just one tool in providing information for decision-making that helps develop plans and projects for the region to move people and goods safely and efficiently through our communities.

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

http://www.transportationdatabook.org/austin/docs/2007_austin_area_transportation_databook.pdf

Item 5

Bridge Deck Corner Cracking on Skewed Structures

MICHIGAN DEPARTMENT OF TRANSPORTATION (MI DOT)

RC-1490 • 2007

This study had a focus on corner cracking in concrete decks of skew highway bridges. A survey of state transportation agencies in the U.S. was conducted on this subject. It found that deck corner cracking in skew bridges is commonly observed. Deck inspection for bridges in Michigan was also performed in this study. Cracking intensity in these decks was viewed as an effect of several possible causal factors, which was collected from 40 bridge decks, including 20 straight and 20 skewed structures. Analysis of the inspection results indicates no clearly agreeable causal relations. Two skew decks were instrumented using temperature and strain sensors for the concrete and the ambient environment. Concrete deck's temperature and strain response was collected to thermal-, shrinkage-, and truck-wheel-loads. Test results and thereby calibrated finite element analysis results show that the main cause of skew deck corner cracking is cement concrete's thermal and shrinkage load. Based on current Michigan practice of skew deck design and construction, additional reinforcement in the corner areas is therefore recommended to reduce concrete stresses. Further research is also recommended to develop solutions using optimal combinations of ingredients in concrete and to minimize the constraint between the deck and the supporting superstructure.

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

http://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC1490_210204_7.pdf



Research Digest

Item 6

Evaluation of the Dynamic Late Lane Merge System at Freeway Construction Work Zones: Final Report
MICHIGAN DEPARTMENT OF TRANSPORTATION (MI DOT)
RC-1500 • 2007

In normal work zones with lane closures, drivers do not merge at any one definite point, thus causing sudden interruption in traffic flow and sometimes higher delay. The dynamic late lane merge system (DLLMS) was used to identify a definite merge point, improve the flow of the congested freeway work zones and reduce queue lengths in the freeway travel lanes. During the 2006 construction season, the DLLMS was implemented on three freeway segments in southern Michigan. Each work zone segment involved a lane closure from two to one lane. Based on the travel time characteristics, queue, merge locations, and throughput, the effectiveness of the DLLMS was evaluated by the Wayne State University Transportation Research Group. Before period data was not available, so a conventional work zone merge system located on EB I-94 was used as a control site for the WB I-94 test site. Since the two I-69 test sites are approximately 150 miles away from the EB I-94 control site, the I-94 control site could not be used as a control for the I-69 sites. When comparing the I-94 control and test sites, the presence of the DLLMS improved the flow of traffic and increased the percentage of merging vehicles that merged at the taper.

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

http://www.michigan.gov/documents/mdot/MDOT_Research_Report_RC1500_Part1_209842_7.pdf



Research Digest

Item 7

Preparing to Use Vehicle Infrastructure Integration in Transportation Operations: Phase I

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 08-CR1 • 2007

The close integration of vehicles and the infrastructure in the surface transportation system has been envisioned for years, but recent advances in wireless communications has made such integration feasible. Given this feasibility, a coalition of the public and private sectors is currently exploring the national deployment of vehicle infrastructure integration (VII), based on the relatively new Dedicated Short Range Communications (DSRC) standard. The Virginia Department of Transportation (VDOT) is a member of this coalition, known as the National VII Coalition.

Most of the effort at the national level is focused on technology aspects and study of safety benefits. In order to best inform design, deployment and operations decisions, it is also necessary to fully evaluate potential VII-enabled operations applications. This research effort focused on the development of a simulation environment to model VII and associated operations applications. This model was then used to begin to explore implications of VII design decisions on the potential for VII to support traffic operations.

A major contribution of this research was the development of a high resolution VII/traffic simulation environment. This environment uses AIMSUN for traffic simulation, integrated with custom code that emulates VII functionality. Using this model, VII roadside units (RSUs) were “placed” based on guidance from VII architecture and the extent of VII coverage was determined. A prototype traffic monitoring application was developed and evaluated for various penetration rates of VII equipped vehicles on an urban traffic network in the Tysons Corner area.

The results of this study identify the important factors that influence the benefits that VII can provide for traffic monitoring. It was found from this study that based on current guidance in the VII Architecture, roughly 55% of the sections in the network would be within the direct range of an RSU. The accuracy and coverage analysis of the network illustrated that, based on the current VII architecture, around 60% of the network could be “covered” at low penetration rates. The error range for mean speed estimation was in range of 2.5 to 4 mph, even at very low VII penetration rates.

Based on these findings, it is clear that potential benefits of VII are significant. However, given the sensitivity of the benefits to RSU deployment (which will require substantial investments in terms of installation and maintenance), the costs of VII will also be significant. As more information about the final national VII design becomes available, the simulation environment developed in this research can be used to conduct detailed benefit/cost analyses. Finally, the findings of this research support the need for VDOT to remain actively involved in VII development efforts and to expand VII research and evaluation efforts in the areas of operations applications.

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

http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-cr1.pdf



Research Digest

Item 8

Development of a Safety Evaluation Procedure for Identifying High-Risk Signalized Intersections in the Virginia Department of Transportation's Northern Virginia District

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 08-R1 • 2007

This research was undertaken to develop an evaluation procedure to identify high-risk four-legged signalized intersections in VDOT's Northern Virginia district by traffic movements and times of day. By using the developed procedure, traffic engineers are expected to be able to identify signalized intersections where the traffic crash occurrences under different traffic conditions for different times of day are more frequent than would normally be expected.

Using generalized linear models such as negative binomial models, one safety performance function was estimated for each of nine crash population reference groups formed by three traffic crash patterns (crash patterns 1, 4, and 6) and four times of day (A.M. peak, mid day, P.M. peak, and evening off peak). Crash pattern 1 is a same-direction crash (rear-end, sideswipe or angle crash) that occurs after exiting the intersection; crash pattern 4 is a right-angle crash between two adjacent straight-through vehicle movements in the intersection; and crash pattern 6 is an angle or head-on or opposite sideswipe crash between a straight-through vehicle movement and an opposing left-turn vehicle movement in the intersection.

The procedure developed in this study is based on the empirical Bayes (EB) method. Additional data do not need to be collected in order to use the EB procedure because all the data required for applying the EB procedure should be obtainable from VDOT's crash database and from Synchro input data that are already available to traffic engineers for traffic signal phase plans. Thus, the EB procedure is cost-effective and readily applicable. For easy application of the EB procedure, an EB spreadsheet was developed using Microsoft Excel, and a users' guide was prepared. These are available from the author upon request.

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

http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-r1.pdf



Research Digest

Item 9

Material Investigation of the Full-Depth, Precast Concrete Deck Panels of the Old Woodrow Wilson Bridge

FEDERAL HIGHWAY ADMINISTRATION (FHWA); VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 08-R2 • 2007

The Woodrow Wilson Memorial Bridge crossing the Potomac River near Washington, D.C., was replaced after more than 45 years of service. Researchers examined the full-depth, precast lightweight concrete deck panels that were installed on this structure in 1983. This report covers the visual survey and concrete material tests from this investigation.

The concrete deck appeared to be in good condition overall, with no discernible cracks or signs of impending spalls on the top surface, except for a few signs of distress evidenced by asphalt patches. From below the deck, there were some indications of efflorescence and some panel joints exhibited rust staining, efflorescence, and small pop-out spalls. Closure pours for the expansion joints had more severe corrosion and efflorescence. Steel bearing plates and hold-down rods used for panel-to-deck connections were generally in good condition, although there were the occasional elements that rated poorly.

The concrete sampled from the lightweight precast deck panels had an average compressive strength of 7.01 ksi (48.3 MPa), which represented little increase over the average 28-day strength. The average elastic modulus was 2,960 ksi (20.4 GPa), which is on the low end for typical modern concrete mixtures. The average splitting tensile strength was within a typical strength range at 535 psi (3.67 MPa). The average equilibrium unit weight of the plain concrete was 116.5 lb/ft³ (1866 kg/m³). The concrete was sound with no evidence of cracking or other deleterious reactions. The results of absorption, permeability, and chloride tests indicated a material matrix with the capability of absorbing moisture and other contaminants. An epoxy concrete surface layer, an asphaltic concrete wearing surface, and cover depths greater than 2 in seemed to have limited harmful chloride exposure to the reinforcing steel, which appeared to be in good condition.

The full-depth, precast lightweight concrete panels appeared to have performed well, with few maintenance issues observed. Reports of similar, more recent, projects have noted additional direct costs associated with precast deck systems on the order of \$26 to \$30 per square foot. However, anecdotal information from those projects, as well as an analysis of the construction alternatives presented herein, demonstrates that use of precast deck systems for deck replacement of existing bridges can shorten construction time by several weeks or months and induce far less disruption to travel than the conventional cast-in-place alternative, resulting in a dramatic reduction in user costs. When total life-cycle costs, including those associated with road user costs, construction time, construction safety, and maintenance, are taken into account full-depth precast concrete deck panels are the more economical alternative.

The costs and benefits assessment demonstrated a clear advantage to using precast bridge deck technology for select deck rehabilitation projects. However, the nature of the estimates and the infrequency with which this sort of repair is implemented make it unreasonable to attribute a direct value in annual savings.

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

http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-r2.pdf



Research Digest

Item 10

Preliminary Field Investigation of Intelligent Compaction of Hot-Mix Asphalt

VIRGINIA TRANSPORTATION RESEARCH COUNCIL (VTRC)

VTRC 08-R7 • 2007

Attention is being directed toward intelligent compaction (IC) of pavement layers, which uses rollers especially manufactured to determine the degree of compaction and regulate the compactive effort required to produce a pavement layer with the optimum density. An IC roller should also have the capability to record a mix characteristic that can be correlated with the density of the final product. In this study, a small field investigation was conducted to determine if the stiffness measured by a particular IC roller correlated with the density of the thin surface layer of asphalt being compacted, thereby leading to a possible future end-result acceptance tool. The roller patterns were also used to determine whether the IC roller was more efficient than a conventional vibratory roller, i.e., whether fewer roller passes were required than with a conventional roller.

The following were concluded from the results of the study:

The IC roller was not more efficient than the conventional vibratory roller. The IC roller may not have been able to capitalize on its “intelligent” features to provide more compactive effort when needed because of the thinness and fineness of the mat being placed in this study. A thicker, coarser mat such as that obtained with stone matrix asphalt might have produced different results.

The correlation between IC stiffness measurements and pavement density was poor. Three possible reasons for the lack of correlation were the effect of the decreasing temperature of the mat on stiffness, the variation in stiffness of the underlying layers, and the use of an incorrect roller “hammer” setting.

As noted in the previous conclusions, proper project selection and conduct of IC experiments are important. A new construction project would eliminate the possibility of the underlying structure influencing compaction or stiffness readings, and the presence of knowledgeable equipment personnel on the project would ensure proper operation of the equipment.

The IC method of compaction is not ready for use in asphalt construction at this time.

Although the results of this project were not encouraging with regard to the potential use of IC rollers in asphalt construction, they should not discourage additional studies and should aid in the planning of an imminent national pooled fund study.

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

http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-r7.pdf



Research Digest

Item 11

Performance Analysis and Forecasting for WSDOT Highway Projects

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WS DOT)

WA-RD 675.1 • 2007

Improving the way that WSDOT performs business is an important objective to pursue. The objectives of this research were to develop tools that will monitor the contractor's performance during construction in order to detect any unsatisfactory progress, and to develop tools that will improve the time and cost prediction of highway projects in order to reduce time and cost overruns.

To achieve the first objective, the research surveyed other state DOTs about how they measure and evaluate work progress and contractor performance. The survey showed that a formal progress measurement and performance evaluation process is lacking in many states, and that there is an apparent lack of progress charts for measuring contractor performance.

By using WSDOT historical project data on actual payment estimates and the elapsed working days of each estimate in each project, the current research developed minimum performance bounds and average performance bounds for a set of successfully completed projects using regression analysis. Performance bounds were developed for all projects and for clusters of projects grouped in categories based on quantities of asphalt concrete pavement/hot mix asphalt (ACP/HMA), contract value, project duration, and project miles.

Time and cost prediction models were developed through the application of general multiple regression analysis, ridge regression analysis, and nonlinear partial least-square regression analysis on WSDOT historical project data. The models were developed on the basis of a number of major variables in pavement projects, including project duration (working days), final contract value (paid-to-contractor dollars), ACP/HMA quantity (tons), grading (tons, cy), surfacing (ton), and the number of project highway miles.

Full-text PDF of this report is available for free download from
<http://www.wsdot.wa.gov/research/reports/fullreports/675.1.pdf>



Research Digest

Item 12

Program Scoping / State of Practice for Washington State

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WS DOT)

WA-RD 680.1 • 2007

The overall goal of this research project was to investigate ways to accurately scope projects with an efficient process in a timely manner to align with the critical path development for programming and the legislative cycle. The need for improved cost estimation is an acknowledged essential element in the scoping of a project. Past experiences throughout the world reveal how common and problematic these underestimations of cost and schedules, especially for mega-projects, have become. The accompanying public distrust, lack of confidence in project implementers, and lack of interest in increased funding have generated a great deal of literature, studies, website activity and media attention.

In this research effort, much of the many volumes of material on the subject of scoping and cost escalation were reviewed. Selected findings from selected differing sources formed the core of the review of literature section. These findings were then augmented by a broad survey and review of the activities and efforts of various states, usually by the Departments of Transportation in those states. Those discussions and analyses of those activities allow specific findings and recommendations to be determined.

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

<http://www.wsdot.wa.gov/research/reports/fullreports/680.1.pdf>

Please fold along dotted line.

From:

Name: _____
District: _____
Division: _____
Building: _____ Floor: ____ Room: ____
Other agency: _____
Agency address: _____

Please report address corrections to:
ctrlib@uts.cc.utexas.edu



To:
Research Digest

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH
ATTN: LIBRARY
3208 RED RIVER, SUITE 115
AUSTIN, TX 78705-2650



Research Digest

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

January Issue 08-01

Please check the box for the item(s) you want to borrow.

- 1 FHWA/NC/2006-30
- 2 FHWA/VTRC 08-R4
- 3 K-TRAN: KSU-03-5
- 4 MS-8088
- 5 RC-1490
- 6 RC-1500
- 7 VTRC 08-CR1
- 8 VTRC 08-R1
- 9 VTRC 08-R2
- 10 VTRC 08-R7
- 11 WA-RD 675.1
- 12 WA-RD 680.1

These items are available on a **two-week** loan basis.

Please fill out form completely and use other side of this page to mail in order. Thank you.

NAME _____

D/D/O _____

MAILING
ADDRESS _____

EMAIL _____