Technical Publications Catalog

October 2008 – September 2009

Turner-Fairbank Highway Research Center
Research, Development and Technology

FHWA-HRT-10-018

U.S. Department of Transportation
Federal Highway Administration

Table of Contents

1 Introduction

The Federal Highway Administration's Turner-Fairbank Highway Research Center presents its fifth *Technical Publications Catalog*. This is a comprehensive listing of research documents published from October 2008 through September 2009, and includes fact sheets, flyers, product briefs, reports, summaries, and TechBriefs, available in print from the Federal Highway Administration Product Distribution Center and online at www.tfhrc.gov.

This catalog is a transportation research resource for engineers, transportation specialists, policymakers, information specialists, and other interested groups. Four preceding volumes cover earlier research publications:

- October 1998 – September 2003
- October 2003 – September 2006
- October 2006 – September 2007
- October 2007 – September 2008

Readers may access most publications online or order a copy from the source listed.

Direct questions or comments about this publication to Martha Soneira at martha.soneira@fhwa.dot.gov, or (202) 493-3468.

Michael Trentacoste
Associate Administrator
Research, Development, and Technology
Federal Highway Administration

2 Administration

Summaries

Turner-Fairbank Highway Research Center Brochure
FHWA-HRT-08-066

This brochure summarizes the history of Turner-Fairbank Highway Research Center, which began in 1938 through today. It also summarizes its three research and development offices—Infrastructure, Safety, and Operations—along with the Exploratory Advanced Research Program.
http://www.tfhrc.gov/about/brochure.htm

Exploratory Advanced Research Program Brochure
FHWA-HRT-09-025

The Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users authorized the Exploratory Advanced Research program has been established to conduct longer tern, higher risk research that will result in potentially dramatic / breakthroughs for improving the durability, efficiency, environmental impact, productivity, and safety of highway and intermodal transportation system. This brochure describes 15 projects that were awarded through two broad agency announcements. The awards represent an estimated Federal Highway Administration investment of over $13 million, spanning multiple years. With cost-share agreements in place for most projects, the total estimated budget for these projects is over $24 million.
Federal Highway Administration Research Library

Research Project Summary of Selected Items FY 2007-2008
FHWA-HRT-09-038

The tables found in this summary correspond to initiatives at Turner-Fairbank Highway Research Center. They provide representative examples of the Office of Research, Development, and Technology's activities in fiscal years 2007 and 2008 geared toward conducting research, deploying products and technologies, and providing communications and resource management support. Federal Highway Administration is publishing this information as part of its commitment to identify, develop, promote, and install new and proven technologies and innovative solutions to improve system performance. This report documents completed research.

Each table provides summary information on the individual research projects. For each project, information is included on its projected impact on Federal Highway Administration's strategic goals, the percentage of the work that has been accomplished, information about whether the project is on schedule and within budget,

its anticipated completion date or date when it was completed, and the availability of a resulting product. Contact information for more details on each project is also included.
http://www.tfhrc.gov/about/perfplan0708/01.htm

The Value of Research: Telling the R&T Story
FHWA-HRT-09-050

The Federal Highway Administration plays a leadership role in shaping and executing a national research and technology program. The agency also acts as a convener; collaborations with State, industry, and academic partners provide the foundation for conducting research and developing innovations that are essential, indispensable, and connected to the needs of transportation system users.

Federal Highway Administration's continuing commitment to highway research and the implementation of ground-breaking technology is changing the way roads, bridges, and other facilities are designed, built, and maintained across the country, ultimately improving the transportation system's safety, reliability, effectiveness, sustainability. This document highlights examples of valuable Federal Highway Administration research, translated into applications of ground-breaking technology that improve the transportation system's performance—in safety, reliability, effectiveness, and sustainability.
http://www.tfhrc.gov/about/09050/index.htm

3 Environment

None to report

4 Human Factors

None to report

5 Operations

Fact Sheets

Office of Operations Research and Development
FHWA-HRT-08-030

The Office of Operations Research and Development is making major contributions to help the Federal Highway Administration meet its mobility, safety, and security goals through completed or planned products and activities with the following strategies: (1) implementing an integrated intelligent transportation system infrastructure; (2)

developing and implementing technologies focusing on weather, security, and lifesaving; and (3) developing and implementing a reliable nationwide differential global positioning system.
http://www.tfhrc.gov/about/08030.htm

Integrated Urban Systems Modeling
FHWA-HRT-09-042

Metropolitan planning agencies face increasingly complex issues in modeling interactions between the built environment and multimodal transportation systems. Although great strides have been made in simulating land use, travel demand, and traffic flow, gaining the ability to model urban systems across these phenomena would be a revolutionary advance. This challenge is the focus of “Modeling the Urban Continuum in an Integrated Framework: Location choice, Activity Travel Behavior and dynamic Traffic Patterns,” an Exploratory Advance Research (EAR) Program project launched by the Federal Highway Administration in 2008.
http://www.fhwa.dot.gov/advancedresearch/pubs/interurbsys.cfm

Next-Generation Smart Traffic Signals
FHWA-HRT-09-063

Can a self-calibrating signal control system lead to wider adoption of adaptive traffic control systems? The focus of “Next Generation of Smart Traffic Signals,” an Exploratory Advanced Research (EAR) Program project, is a system that –with little human intervention—continuously monitors, learns, predicts, and responds to traffic demands and conditions with optimal signal timing for prevailing conditions. Launched by the Federal Highway Administration in 2007, the study is being conducted by Arizona State University in Phoenix. This fact sheet discusses the promise of new technology, the challenges, and future efforts.
Federal Highway Administration Research Library

6 Pavements

Newsletter

LTPP Newsletter, Volume 5, Issue 1, Winter 2009
FHWA-HRT-09-034

The 88th Annual Transportation Research Board Meeting was held the second week in January. As in previous years, the Long-Term Pavement Performance program kicked off the week with the Long-Term Pavement Performance State Coordinators' Meeting. This 21st coordinators' meeting answered the question: "Where do we go from here with the Long-Term Pavement Performance program?" This article highlights some of the key information presented at the meeting.
http://www.fhwa.dot.gov/pavement/ltpp/news/09034.cfm

LTPP Newsletter, Spring 2009, Volume 5, Issue 2
FHWA-HRT-09-043

Long-Term Pavement Performance is moving forward with the collection of traffic data. While the Long-Term Pavement Performance program takes pride in the quantity and quality of the data available in the pavement performance database, there are some data that are lacking. Long-Term Pavement Performance has identified approximately 88 General and Specific Pavement Studies test sites where there is very little or no monitored traffic data. With the support and help from our State partners, Long-Term Pavement Performance is taking action to fill in this gap.
http://www.fhwa.dot.gov/pavement/ltpp/news.cfm

Technical Reports

Design and Evaluation of Jointed Plain Concrete Pavement with Fiber Reinforced Polymer Dowels
FHWA-HRT-06-106

This study evaluates fiber reinforced polymer (FRP) dowel bars as load transferring devices in jointed plain concrete pavement (JPCP) under HS25 static and fatigue loads and compares their response with JPCP consisting of steel dowels. Along with laboratory and field evaluations of JPCP with FRP and steel dowels, analytical modeling of dowel response was carried out in terms of maximum bending deflection, relative deflection (RD), and bearing stress of dowels. In addition, field rehabilitation of JPCP was carried out using FRP dowels to evaluate its long-term performance.

Laboratory tests included static and fatigue load application corresponding to HS25 load and 1.5 times HS25 load on concrete slabs (27.94- and 30.48-cm (11-and 12-inch) depth) with 3.81- and 2.54-cm (1.5- and 1.0-inch) steel and FRP dowels at different spacings (30.48 and 15.24 cm (12 and 6 inches)). Both 3.81- and 2.54-cm (1.5-and 1.0-inch)-diameter FRP dowels were installed in the field with 15.24-, 20.32-, 22.86-, and 30.48-cm (6-, 8-, 9-, and 12-inch) spacings. Load calibrated field tests were conducted on these pavements using a West Virginia Department of Transportation truck in 2002 and 2003. FRP dowel bars that were 1.5 inches in diameter were also used for pavement rehabilitation.

Field data collected through an automatic data acquisition system included strain and joint deflections, which were used for assessing joint load transfer efficiency (LTE), joint RD, and pavement performance. Theoretical calculations are provided through different examples for JPCP with FRP and steel dowels by varying dowel diameters, spacing, dowel material properties, joint width, and base material properties. This research showed that JPCP with FRP dowels provided very good LTE up to and beyond 90 percent, which exceeds the American Association of State Highway and Transportation Officials and American Concrete Pavement Association criteria. JPCP with FRP dowels also provide sufficient LTE after 5 million cycles of fatigue tests under HS25 loading.
Federal Highway Administration Research Library

LTPP Manual for Profile Measurements and Processing
FHWA-HRT-08-056

This manual describes operational procedures for measuring longitudinal pavement profiles for the Long-Term Pavement Performance Program using the International Cybernetics Corporation road profiler, Face Company Dipstick®, and the rod and level. It also contains procedures for measuring transverse profiles of the pavement using the Face Company Dipstick®. Procedures for calibration of equipment, data collection, record keeping, and maintenance of equipment for each of these profiling devices are described in this manual. This manual also describes procedures to be followed in the office when processing the profile data that were collected in the field as well as guidelines for performing inter-regional comparison tests among the Long-Term Pavement Performance profilers.
http://www.fhwa.dot.gov/pavement/ltpp/pubs/08056/index.cfm

Long-Term Pavement Performance Computer Parameter: Frost Penetration
FHWA-HRT-08-057

As the pavement design process moves toward mechanistic-empirical techniques, knowledge of seasonal changes in pavement structural characteristics becomes critical. Specifically, frost penetration information is necessary for determining the effect of freeze and thaw on pavement structural responses. This report describes a methodology for determining frost penetration in unbound pavement layers and subgrade soil using temperature, electrical resistivity, and moisture data collected for instrumented Long-Term Pavement Performance Seasonal Monitoring Program (SMP) sites. The report also contains a summary of Long-Term Pavement Performance frost depth estimates and a detailed description of the Long-Term Pavement Performance computer parameter tables containing frost penetration information for 41 Long-Term Pavement Performance SMP sites. The frost penetration analysis methodology and the accompanying E-FROST program is used in-situ soil temperature as a primary source of data to predict frost depth in unbound pavement layers. In addition to temperature data, electrical resistivity and moisture data were used as supplemental data sources for the analysis when temperatures were close to the freezing isotherm. The Enhanced Integrated Climatic Model was used to fill intermediate gaps in the measures soil temperature data.
http://www.fhwa.dot.gov/pavement/ltpp/pubs/08057/

Long-Term Pavement Performance Compliance with Department of Transportation Information Dissemination Quality Guidelines
FHWA-HRT-08-065

This document provides information on the compliance of the Long-Term Pavement Performance program with the guidelines the U.S. Department of Transportation issued Information Dissemination Quality Guidelines. These guidelines were developed in response to requirements of Section 515 of the Treasury and General Government Appropriations Act for fiscal year 2001. The purpose of the guidelines is to ensure and maximize the quality, utility, objectivity, and integrity of information that is disseminated

by the Federal Government. This document discusses the activities performed under the Long-Term Pavement Performance program, and it also addresses the policies and procedures established by these guidelines.
http://www.fhwa.dot.gov/pavement/ltpp/pubs/08065/index.cfm

7 Safety

Fact Sheets

Office of Safety Research and Development
FHWA-HRT-08-025

The Federal Highway Administration Office of Safety Research and Development is helping to reduce highway crashes and related fatalities and injuries by developing and implementing safety innovations through a program of nationally coordinated research and technology. The selections from this broad research portfolio are highlighted in this publication. They are the following: Roadway Departure, Intersections, Pedestrian, Speed Management, Safety Management, and Advanced Research.
http://www.tfhrc.gov/safety/pubs/08025/index.htm

Two Low-Cost Safety Concepts for Two-Way Stop-Controlled, Rural Intersections on High-Speed Two-Lane, Two-Way Roadways
FHWA-HRT-08-063

The Federal Highway Administration Office of Safety has identified intersections as one of its safety focus areas. As part of the Federal Highway Administration efforts to reduce intersection crashes and the related injuries and fatalities, two concepts have been identified: (1) rumble strips on outside shoulders and in a painted yellow median island on major road approaches and (2) channelizing separator islands on side road approaches with supplemental STOP signs. Specifically, the strategies are low-cost countermeasures for intersections at two-lane, two way roadways with two-way STOP-control.

The lane narrowing concept (concept 1) features the introduction of rumble strips on the outside shoulders and in a painted yellow median island on the major road approaches (figures 1 and 2).The objective of this first concept is to induce drivers on major roads to reduce approach speeds at intersections by effectively reducing the lane width. The minor road splitter island concept (concept 2) features channelizing separator islands on the side road approaches on which supplemental STOP signs are installed (figures 3 and 4). The objective of the second concept is to provide redundancy of the STOP sign and increase driver-compliance with the STOP sign. A third concept includes the combination of concepts 1 and 2 (figure 5). The concepts have greater potential for effectiveness on intersections of high-speed roadways. However, they can also be applied to intersections with lower posted speed limits. With the cooperation of several transportation agencies, these two strategies were deployed at a limited number of sites

in the United States. This paper documents an evaluation of the operational and safety effectiveness of these strategies.
http://www.tfhrc.gov/safety/pubs/08063/index.htm

The Exploratory Advanced Research Program Fact Sheet: Seeing in the Dark Improving Understanding of Driver Visibility Requirements at Night
FHWA-HRT-09-024

What visual cues aid drivers the most as they drive at night? Advancing knowledge and understanding of how drivers acquire and act on visual information while driving at night is the goal of "Increased Understanding of Driver Visibility Requirements," an Exploratory Advanced Research (EAR) Program project launched by the Federal Highway Administration in 2008.

This fact sheet addresses the following: (1) Determining the quantity and quality of visual information needed, (2) Developing a revolutionary design tool, (3) Progress, and (4) Future efforts.
http://www.fhwa.dot.gov/advancedresearch/pubs/seedarkear.cfm

The Exploratory Advanced Research Program Fact Sheet: Increasing Highway Throughput Communications and Control Technologies to Improve Traffic Flow
FHWA-HRT-09-037

How can the new capabilities of intelligent vehicles and highway infrastructure be used to reduce congestion and effectively increase highway capacity? This question is the focus of "Development and Evaluation of Selected Mobility Applications for VII," an Exploratory Advanced Research (EAR) Program project launched by the Federal Highway Administration in 2007. Researchers at the Partners for Advanced Transit and Highways (PATH) program of the University of California, Berkeley, are conducting the 3-year project in cooperation with Caltrans.

This fact sheet includes material on: (1) using the potential of intelligent infrastructure effectively, (2) Managing traffic flow and density, (3) Taking control for greater efficiency, (4) Maneuvering three-truck platoons, and (5) Future efforts.
http://www.fhwa.dot.gov/advancedresearch/pubs/inchwyfact.cfm

Flyer

SafetyAnalyst Brochure
FHWA-HRT-09-023

This brochure describes the state-of-the-art analytical tools for use in the decisionmaking process to help highway agencies identify and mange a system wide program of site-specific improvements to cost-effectively enhance highway safety. This brochure includes an overview of SafetyAnalyst, its scope, toolkit components, its benefits, development activities and participants.
http://www.tfhrc.gov/safety/pubs/09023/index.htm

Summary

Two Low-Cost Safety Concepts for Two-Way Stop-Controlled, Rural Intersections on High-Speed Two-Lane, Two-Way Roadways

FHWA-HRT-08-063

As part of the Federal Highway Administration efforts to reduce intersection crashes and the related injuries and fatalities, two concepts have been identified: (1) rumble strips on outside shoulders and in a painted yellow median island on major road approaches and (2) channelizing separator islands on side road approaches with supplemental STOP signs. Specifically, the strategies are low-cost countermeasures for intersections at two-lane, two way roadways with two-way STOP-control.
http://www.tfhrc.gov/safety/pubs/08063/index.htm

TechBriefs

Traffic Calming on Main Roads Through Rural Communities

FHWA-HRT-08-067

This TechBrief summarizes an evaluation of the effects on speed of low-cost, traffic-calming treatments on main rural highways passing through small, rural communities in Iowa. The full report, *Appropriate Traffic Calming Techniques for Small Iowa Communities* (TR-523), is available on Iowa State University's Web site at: http://www.ctre.iastate.edu/research/detail.cfm?projectID=-226410767.
http://www.tfhrc.gov/safety/pubs/08067/index.htm

Summary: Evaluation of Sign and Marking Alternatives for Displaced Left-Turn Lane Intersections

FHWA-HRT-08-071

This document describes research conducted by the Federal Highway Administration to support guidance on the signing and marking of displaced left-turn lane intersections (DLT)—also known as continuous flow intersections (CFI).
http://www.tfhrc.gov/safety/pubs/08071/index.htm

Safety Evaluation of Advance Street Name Signs

FHWA-HRT-09-030

This document is a technical summary of the Federal Highway Administration report, *Surrogate Safety Assessment Model and Validation: Final Report*, FHWA-HRT-09-029.
http://www.tfhrc.gov/safety/pubs/09030/index.htm

Safety Evaluation of Lane and Shoulder Width Combinations on Rural, Two-Lane, Undivided Roads
FHWA-HRT-09-032

This document is a technical summary of the Federal Highway Administration report Safety Evaluation of Lane and Shoulder Width Combinations on Rural, Two-Lane, Undivided Roads (FHWA-HRT-09-031), which will be available online at http://www.tfhrc.gov/safety.
http://www.tfhrc.gov/safety/pubs/09032/index.htm

Safety Evaluation of Offset Improvements for Left-Turn Lanes
FHWA-HRT-09-036

This document is a technical summary of the Federal Highway Administration report, *Safety Evaluation of Offset Improvements for Left-Turn Lanes* (FHWA-HRT-09-035), which will be available online at http://www.tfhrc.gov/safety.
http://www.tfhrc.gov/safety/pubs/09036/index.htm

Safety Evaluation of Improved Curve Delineation
FHWA-HRT-09-046

This document is a technical summary of the Federal Highway Administration report, *Safety Evaluation of Improved Curve Delineation* (FHWA-HRT-09-045). The Federal Highway Administration organized 26 States to participate in the Federal Highway Administration Low Cost Safety Improvements Pooled Fund Study as part of its strategic highway safety plan support effort. The purpose of the pooled fund study is to estimate the safety effectiveness for several of the unproven low-cost safety strategies identified in the *National Cooperative Highway Research Program (NCHRP) Report 500 Series.* One of the strategies chosen to be evaluated for this study is improved curve delineation. This strategy is intended to reduce the frequency of curve-related crashes by providing more conspicuous signing and lane markings. The safety effectiveness of this strategy has not been thoroughly documented, and this study is an attempt to provide a crash-based evaluation through scientifically rigorous procedures.
http://www.tfhrc.gov/safety/pubs/09046/index.htm

Technical Reports

Test Track and Driving Simulator Evaluations of Warnings to Prevent Right-Angle Crashes at Signalized Intersections
FHWA-HRT-08-070

Two experiments (simulator and test track) were conducted to validate the concept of a system designed to warn potential victims of a likely red-light violator. The warning system uses sensors to detect vehicles that are unlikely to stop at red traffic signals and uses signs and flashing lights to warn drivers who might collide with a violator. Several human factors issues need to be addressed before such a system could be deployed. The experiments for this study addressed one of these issues—whether, if warned, a

sufficient number of drivers would respond in a way that would allow them to avoid a right-angle collision. The results suggest that in the case where no other vehicles precede or follow, a majority of drivers who receive a conspicuous warning will act by braking sharply. Driver responses in both tests were similar. The test track results support the continued use of driving simulators in development of the system. Further research is required to assess responses to warnings given to drivers within a stream of traffic.
http://www.tfhrc.gov/safety/pubs/08070/index.htm

The Effects of Commercial Electronic Variable Message Signs (CEVMS) on Driver Attention and Distraction: An Update
FHWA-HRT-09-018

The present report reviews research concerning the possible effects of commercial electronic variable message signs (CEVMS) used for outdoor advertising on driver safety. Such CEVMS displays are alternatively known as electronic billboards and digital billboards. The report consists of an update of earlier published work, a review of applicable research methods and techniques, recommendations for future research, and an extensive bibliography. The literature review update covers recent post-hoc crash studies, field investigations, laboratory investigations, previous literature reviews, and reviews of practice.

The present report also examines the key factors or independent variables that might affect a driver's response to CEVMS, as well as the key measures or dependent variables which may serve as indicators of driver safety, especially those that might reflect attention or distraction. These key factors and measures were selected, combined, and integrated into a set of alternative research strategies. Based on these strategies, as well as on the review of the literature, a proposed three stage program of research has been developed to address the problem.

The present report also addresses CEVMS programmatic and research study approaches. In terms of an initial research study, three candidate methodologies are discussed and compared. These are: (1) an on-road instrumented vehicle study, (2) a naturalistic driving study, and (3) an unobtrusive observation study. An analysis of the relative advantages and disadvantages of each study approach indicated that the on-road instrumented vehicle approach was the best choice for answering the research question at the first stage.
http://www.fhwa.dot.gov/realestate/cevms.htm

Safety Evaluation of Advance Street Name Signs
FHWA-HRT-09-029

The Federal Highway Administration organized a pooled fund study of 26 States to evaluate low-cost safety strategies as part of its strategic highway safety effort. The objective of the pooled fund study was to estimate the safety effectiveness for several of the unproven, low-cost safety strategies identified in the *NCHRP 500 Series* reports through scientifically rigorous crash-based studies. One of the strategies chosen to be

evaluated for this study was advance street name signs at signalized intersections. This strategy is intended to reduce the frequency of older driver crashes and crashes related to way-finding (i.e., rear-end and sideswipe crashes) at signalized intersections.

Geometric, traffic, and crash data were obtained at signalized intersections for 82 sites in Arizona, 65 sites in Massachusetts, and 46 sites in Wisconsin. To account for potential selection bias and regression-to-the-mean, an Empirical Bayes before-after analysis was conducted to determine the safety effectiveness of installing advance street name signs. Based on the aggregate analysis, sideswipe crashes were the only crash type that changed significantly, which was a 27-percent reduction in Massachusetts and a 10-percent reduction for the three States combined. While results showed an insignificant reduction for total crashes in Massachusetts and Wisconsin, there was an insignificant increase in total crashes in Arizona. For the three States combined, there was a statistically insignificant reduction in total crashes (1.6 percent). The disaggregate analysis indicated that advance street name signs may be more effective on the major road at three-legged intersections as well as those locations with a relatively large average annual daily traffic (AADT) or a large expected number of crashes. Also, additional signs (i.e., two or more per approach) were shown to be more effective than just one advance sign. Based on conservative cost estimates, a reduction of just 0.01 crashes per intersection-year would achieve a 2:1 benefit-cost ratio. Given the very low cost of this strategy and the potential to enhance way-finding, the use of advance street name signs is justified, particularly at three-legged intersections and locations with a relatively large AADT or a large expected number of crashes.
http://www.tfhrc.gov/safety/pubs/09029/index.htm

Safety Evaluation of Flashing Beacons at STOP-Controlled Intersections
FHWA-HRT-09-031

The Federal Highway Administration organized a pooled fund study of 26 States to evaluate low-cost safety strategies as part of its strategic highway safety effort. The goal of this study is to evaluate the safety effectiveness of various lane-shoulder width configurations for fixed total paved widths as a countermeasure for roadway departure crashes. Where possible, crash modification factors (CMF) are provided for specific lane-shoulder configurations. The cost of this treatment is essentially zero because it involves only the location of pavement markings. A matched case-control analysis was applied to geometric, traffic, and crash data for road segments in Pennsylvania and Washington.

In general, wider pavement widths 9.75-10.97 m (32-36 ft) are associated with fewer crashes than narrower paved widths 7.92-9.14 m (26-30 ft). For specific lane-shoulder configurations, there is a general safety benefit associated with wider lanes and narrower shoulders for a fixed pavement width. For 7.92- to 9.75-m (26- to 32-ft) total paved widths, a 3.66-m (12-ft) lane provides the optimal safety benefit; the CMF ranges from 0.94 to 0.97, indicating a 3-6 percent crash reduction for 3.66-m (12-ft) lanes compared with 3.05-m (10-ft) lanes. For a 10.36-m (34-ft) total paved width, 3.35-m (11-ft) lanes provide the optimal safety benefit; CMF was 0.78 compared with the 3.05-m (10-ft) baseline. For a 10.97-m (36-ft) total paved width, both 3.35-m and 3.66-m (11-ft

and 12-ft) lanes provide the optimal safety benefit; CMF was 0.95 compared with the 3.05-m (10-ft) baseline. Based on the estimated safety effectiveness of this strategy, specific lane-shoulder configurations have the potential to reduce crashes cost effectively on rural, two-lane, undivided roads. However, limited sample sizes make it difficult to identify statistically significant differences between certain lane-shoulder configurations within a total paved width.
http://www.tfhrc.gov/safety/pubs/09031/index.htm

Safety Evaluation of Offset Improvements for Left-Turn Lanes
FHWA-HRT-09-035

The Federal Highway Administration organized a pooled fund study of 26 States to evaluate low-cost safety strategies as part of its strategic highway safety effort. One of the strategies chosen to be evaluated for this study was offset improvements for left-turn lanes. This strategy is intended to reduce the frequency of crashes by providing better visibility for drivers that are turning left. The safety effectiveness of this strategy has not been thoroughly documented, and this study is an attempt to provide an evaluation through scientifically rigorous procedures.

Geometric, traffic, and crash data were obtained for 92 installations in Nebraska, 13 in Florida, 12 in Wisconsin, and for a number of untreated reference sites in each State. To account for potential selection bias and regression-to-the-mean, an Empirical Bayes (EB) before-after analysis was conducted to determine the safety effectiveness of improving the offset for left-turn lanes. There was a large difference in observed effects among the three States, which may be explained, in part, by the wide variation in offset improvements. Florida and Nebraska employed pavement marking adjustments or minor construction to improve the offset. While the offset was improved at each site, most improvements did not result in a positive offset. Wisconsin reconfigured left-turn lanes through major construction projects, resulting in significant positive offsets. Results in Florida and Nebraska showed little or no effect on total crashes. Wisconsin showed significant reductions in all crash types investigated-total (34 percent), injury (36 percent), left-turn (38 percent), and rear-end (32 percent).

A disaggregate analysis was conducted for Nebraska, the only State with enough installations to disaggregate the results. The analysis revealed that the percent reduction in crashes increased as the expected number of crashes increased. An economic analysis was conducted to identify the level of expected crashes that would yield a crash benefit to justify the construction cost. Based on this analysis, offset improvement through reconstruction is cost-effective at intersections with at least nine expected crashes per year and where left-turn lanes are justified by traffic volume warrants.
http://www.tfhrc.gov/safety/pubs/09035/index.htm

8 Structures

Brochure

Long-Term Bridge Performance
FHWA-HRT-09-033

In April 2008, Federal Highway Administration's Office of Infrastructure Research and Development launched the Long-Term Bridge Performance (LTBP) program, a flagship research project with the objective of collecting scientific-quality data on the Nation's highway bridges. Federal Highway Administration envisions the LTBP as a 20-year or longer examination of highway bridges to improve knowledge of bridge performance and ultimately promote the safety, mobility, longevity, and reliability of the country's highway transportation assets. This brochure details the program's objectives and methodologies.

The LTBP program aims to compile a comprehensive database of quantitative information from a representative sample of bridges nationwide, looking at critical bridge elements and the factors that affect their performance—age, material, design, condition, use, and environment. By taking a holistic approach and analyzing the physical and functional variables that affect bridge performance, the program will provide a more detailed and timely picture of bridge health and better tools for bridge management.

Printed copies of the brochure are available from Federal Highway Administration's Office of Infrastructure Research and Development by phone at 202-493-3024, fax at 202-493-3442, or e-mail Monique Smith at monique.smith@dot.gov.

Fact Sheets

Chemistry Research Facility Fact Sheet
FHWA-HRT-08-059

The Turner-Fairbank Highway Research Center Chemistry Research Facility (CRF) conducts fundamental studies of highway materials from a chemical point of view. Investigations into the chemical mechanisms involved in well-known distress modes in concrete and asphalt pavements helps to generate new testing methods and foster the development of new materials. CRF validates Federal Highway Administration sponsored off-site research, offers unbiased support for State agencies and industry partners, and assists with the forensic evaluation of pavement failures.

This fact sheet describes the major components of CRF, its recent accomplishments, current research and partnerships.
http://www.tfhrc.gov/about/08059.htm

Office of Infrastructure Research and Development
FHWA-HRT-08-069

This fact sheet describes the mission of the Office of Infrastructure research and development. Its goals include: (1) research and development strategies, (2) long-term infrastructure performance, (3) durable infrastructure systems, (3) accelerated highway construction, (4) environmentally-sensitive highway infrastructure, (5) comprehensive and integrated infrastructure asset management, (6) collaboration with other Federal Highway Administration offices and with the broader community, and (7) the benefits derived through the pursuit of these strategies.
http://www.tfhrc.gov/infrastructure/pubs/08069.htm

The Exploratory Advanced Research Program Fact Sheet: Real-Time Measurement of Soil Stiffness During Static Compaction
FHWA-HRT-09-047

This fact sheet is about exploratory advanced research, the next generation of transportation solutions. Topics covered in this document are: (1) new approach to intelligent compaction, (2) measuring pad contact force and soil deflection, (3) continuous, comprehensive, accurate data for operators and inspectors, and (4) future efforts.
http://www.fhwa.dot.gov/advancedresearch/pubs/soilcompact.cfm

Crack-Resistant Concrete
FHWA-HRT-09-065

Although much progress has been made in reducing concrete's propensity to crack, the goal remains elusive. A novel approach to this problem is the focus of "High-Performance Stress-Relaxing Cementitious Composites for Crack-Free Pavements and Transportation Structures," an Exploratory Advanced Research Program project launched by the Federal Highway Administration in 2009 and conducted at Texas A&M University's Texas Transportation Institute.
Federal Highway Administration Research Library

TechBrief

High-Performance Materials for Substructures, Foundations, and Earth Retaining Systems Workshop
FHWA-HRT-08-058

High-performance materials (HPM) are being applied to many areas of highway construction and maintenance. These materials range from engineered concrete and composite materials to specialty steels and recycled materials. Currently, most applications of these materials are in pavements and bridge superstructures. With the constant pressure on our stakeholders to manage the existing highway infrastructure with tighter budgets, higher costs, and continuing environmental concerns, the

extended use of HPMs to other elements of the highway system, specifically substructures, foundations, and retaining structures, warrants investigation.

To facilitate discussion on the above, a workshop was held at the Turner-Fairbank Highway Research Center on August 28-29, 2006. This tech brief is a summary of the workshop proceedings.
http://www.fhwa.dot.gov/bridge/pubs/08058/index.cfm

Technical Reports

Long-Term Pavement Performance program Manual for Profile Measurements and Processing

FHWA-HRT-08-056

This manual describes operational procedures for measuring longitudinal pavement profiles for the Long-Term Pavement Performance Program using the International Cybernetics Corporation road profiler, Face Company Dipstick, and the rod and level. It also contains procedures for measuring transverse profiles of the pavement using the Face Company and the rod and level. It also contains procedures for measuring transverse profiles of the pavement using the Face Company Dipstick. Procedures for calibration of equipment, data collection, record keeping, and maintenance of equipment for each of these profiling devices are described in this manual. This manual also describes procedures to be followed in the office when processing the profile data that were collected in the field as well as guidelines for performing inter-regional comparison tests among the Long-Term Pavement Performance profilers.
http://www.fhwa.dot.gov/pavement/ltpp/pubs/08056/index.cfm

Corrosion Resistant Alloys for Reinforced Concrete

FHWA-HRT-09-020

Deterioration of concrete bridges because of reinforcing steel corrosion has been recognized for 4-plus decades as a major technical and economic challenge for the United States. As an option for addressing this problem, renewed interest has focused on corrosion resistant reinforcements, stainless steels in particular. The present research study was performed jointly by Atlantic University and the Florida Department of Transportation to evaluate reinforcements of this type. These included solid stainless steels 3Cr12 (UNS-S41003), 2101LDX (ASTM A955-98), 2304 (UNS-S31803), 2205 (UNS 31803), two 316L (UNS S31603) alloys, two 316 stainless steel clad black bar products, and ASTM A1035 commonly known as MMFX 2. Black bar (ASTM A615) reinforcement provided a baseline for comparison purposes. Results from short-term tests and preliminary results from long-term exposure of reinforced concrete slabs were presented in the first interim report for this project.

This second interim report provides longer-term data and analyses of chloride exposures that involved four different types of reinforced concrete specimens, two of which were intended to simulate northern bridge decks exposed to deicing salts and the remaining two to marine substructure elements. Three different concrete mix designs

were employed, and specimen types included combinations with a (1) simulated concrete crack, (2) bent top bar, (3) corrosion resistant upper bar(s) and black steel lower bars, and (4) intentional clad defects such that the carbon steel substrate was exposed. Cyclic wet-dry ponding with a sodium chloride (NaCl) solution was employed in the case of specimens intended to simulate northern bridge decks, and continuous partial submergence in either a NaCl solution or at a coastal marine site in Florida was used for specimens intended to represent a coastal bridge substructure. The exposures were for periods in excess of 4 years. The candidate alloys were ranked according to performance, and an analysis is reported that projects performance in actual concrete structures.
http://www.tfhrc.gov/structur/pubs/09020/index.htm

Hydrodynamic Forces on Inundated Bridge Decks
FHWA-HRT-09-028

The hydrodynamic forces experienced by an inundated bridge deck have great importance in the design of bridges. Specifically, the drag force, lift force, and the moment acting on the bridge deck under various levels of inundation and a range of flow conditions influence the design and construction of the bridge. This report explores the forces acting on bridges in two ways. First, through physical experimentation on scaled-down bridge deck models tested in a flume and then with computational fluid dynamics (CFD) simulation models. Three bridge deck prototypes were used for the experimentation: a typical six-girder highway bridge deck, a three-girder deck, and a streamlined deck designed to better withstand the hydraulic forces. The forces (expressed as nondimensional force coefficients) on each of the bridge deck shapes were measured in the laboratory with an ultra-precise force balance under a range of inundation scenarios (including partial inundation) and at four different velocities characterized by Froude numbers in the range of 0.16 to 0.32.

CFD modeling was performed using both the Fluent® and STAR-CD® software packages. The CFD models were calibrated to the flow conditions of the six-girder bridge, and these same conditions were used for the other two bridge shapes. A range of model options were tested including two-dimensional versus three-dimensional models, different mesh resolutions, boundary conditions, and turbulence models; their effect on the accuracy of results and processing efficiency were noted.

Fitting equations were generated to create an envelope around the experimental data and create design charts for each of the bridge types and force coefficients.

Finally, the CFD models, though they can match some of the general behavior of experimental models in terms of the relationship between inundation ratio and force measured at the bridge, do not yet faithfully reproduce the critical values of the hydraulic forces and show very little response to velocity. The CFD simulations seem promising as a method to test bridge designs, but more research is needed before complex

designs can be tested wholly in the CFD realm. However, the design charts from the experimental results should be a valuable tool for the bridge designer in a wide range of design applications.
http://www.tfhrc.gov/structur/pubs/09028/index.htm

LTPP Beyond FY 2009: What Needs to be Done?
FHWA-HRT-09-052

This report summarizes the current status of the Long-Term Pavement Performance program and its major activities—data collection, data storage, data analysis, and product development. It describes the work that will be needed beyond 2009 to realize the full potential of the world's most comprehensive pavement performance database and the benefits that will be accrued by capitalizing on the investment that has been made.
http://www.fhwa.dot.gov/pavement/ltpp/pubs/09052/index.cfm