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7. AUTHOR  Ching-Yao Chan		8. PERFORMING ORGANIZATION REPORT NO.  UCB-ITS-PRR-2012-02
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16. ABSTRACT

Toward the goal of reducing collisions while maintaining the integrity and sustainability of roadways, separate projects in both France and California in recent years have been developed to achieve the following objectives:

- Evaluating the effectiveness of roadway surface improvements, in terms of the reduction in collisions, thus allowing the selection of cost-effective countermeasures
- Understanding and modeling the deterioration of skid resistance over time, and allowing timely and effective measurement of roadway surface status;
- Exploring alternative collection method of monitoring skid resistance on roadway surface within the framework of cooperative infrastructure and vehicles;
- Developing real-time system of monitoring roadway surface conditions and offering alerts to drivers.

This project is aimed at leveraging and cross-fertilizing the developments in France and California with data and information exchange, lessons learned and a plan for the future. The proposed work is intended to promote the advancements of research ideas through the long-lasting and continuing cooperation between LCPC and PATH.

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*Monitoring and Improving Roadway Surface Conditions*  
*For Safe Driving Environment and Sustainable Infrastructure*

**- Project Report –**

**Contract 65A0342-Task Order 006**

**Prepared By:**

**Ching-Yao Chan**

**California PATH, University of California at Berkeley**

**June 2012**

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## EXECUTIVE SUMMARY

This report documents the research work conducted under the sponsorship of Caltrans, Contract 65A342-TO006. This project is sponsored by Caltrans under the CalFrance program, with a focus on monitoring roadway surface conditions for safety and sustainability. The project was initially proposed and approved in 2009 but was postponed due to some delays in budgetary and contractual processes. It was officially started in October 2011 and ended in March 2012. The project leads are Dr. Minh-Tan DO of IFSTTAR and Dr. Ching-Yao Chan of California PATH. This report documents the literature summary, idea exchange and potential future endeavors that are parts of the joint project.

The French Ministry of Transportation and Caltrans have had a long-lasting cooperation relationship for over ten years. Under the umbrella of this international collaboration, the two agencies have exchanged information and visits to explore innovative solutions and advanced ideas for improving the mobility and safety performance of transportation systems. Through the direct and close working arrangements with the two ministries, the researchers from IFSTTAR (formerly INRETS and LCPC) and California PATH at UC Berkeley have also engaged in a number of joint projects under the so-called CalFrance agreements, in which both agencies sponsored the respective research organizations to seek synergistic products based on individual research activities in France and US.

Toward the goal of reducing collisions while maintaining the integrity and sustainability of roadways, separate projects in both France and California in recent years have been developed to achieve the following objectives:

- Evaluating the effectiveness of roadway surface improvements, in terms of the reduction in collisions, thus allowing the selection of cost-effective countermeasures;
- Understanding and modeling the deterioration of skid resistance over time, and allowing timely and effective measurement of roadway surface status;
- Exploring alternative collection method of monitoring skid resistance on roadway surface within the framework of cooperative infrastructure and vehicles;
- Developing real-time system of monitoring roadway surface conditions and offering alerts to drivers.

The outcomes of such projects have generated or will produce useful tools, from the definition of conceptual framework to the implementation of real-world safety applications, to assist the decision-making process for pavement management as well as to offer safety improvements for the traveling public.

In recent and ongoing projects that have been conducted in California and France, significant insights are gained and feasible solutions to tackle the safety issues described above are being developed for monitoring the roadway surface conditions. This collaborative project is built upon the knowledge base gathered from relevant projects in France and California respectively, which will allow synergistic fusion of common ideas that are applicable for both sides. Yet, researchers can also learn from partners about the distinctive features and constraints that they have not encountered or conceived. Ultimately, the goal will be to create a mutually beneficial

research team that can seek support for future joint projects and deliver the benefits for safe driving environment and sustainable infrastructure.

Based on the information exchange and idea sharing that were carried out in the project, some selective topic areas have been identified to be the candidate areas where synergies in ongoing and future research activities can be best realized.

One such area is the development of real-time estimation of roadway surface parameters. The goal within this topic area is to develop methodologies to accurately and reliably estimate roadway conditions then utilize the acquired information to implement vehicle-based or infrastructure-based applications. These applications can provide safety and operation benefits by the implementation of on-board driver assistance and vehicle control functions as well as roadway operation, maintenance and safety management functions. A continuation of this research topic will be to investigate further in depth, through the exchange of information and methodologies between French and California researchers, to

- Provide an updated overview of all European and French research programs on the subject of cooperative vehicles and highways
- Explore up-to-date vehicle safety applications that may rely on similar sensor suites or vehicle platform
- Explore the technical and institutional issues in the future implementation of such concepts and the recommendations for governments and industries to enable expedient developments.

Another topic area is safety measures that can be implemented under foggy conditions, which presents a serious safety challenge. This is a particular concern for the central valley highways in California, such as Highway 99 where historically a number of chain crashes have occurred. A continuation of this research topic will be to investigate further in depth, through the exchange of information and methodologies between French and California researchers, to

- Provide an updated overview of all European and French research programs on the subject of roadway conditions and associated driver alert systems
- Explore up-to-date deployment that may rely on similar sensor inputs
- Explore the technical and institutional issues in the future implementation of such concepts and the recommendations for governments and industries to enable expedient developments.

## 1. Background

French Ministry of Transportation and Caltrans have had a long-lasting cooperation relationship for over ten years. Under the umbrella of this international collaboration, the two agencies have exchanged information and visits to explore innovative solutions and advanced ideas for improving the mobility and safety performance of transportation systems. Through the direct and close working arrangements with the two ministries, the researchers from IFSTTAR (formerly INRETS and LCPC) and California PATH at UC Berkeley have also engaged in a number of joint projects under the so-called CalFrance agreements, in which both agencies sponsored the respective research organizations to seek synergistic products based on individual research activities in France and US.

This project is sponsored by Caltrans in the latest round of CalFrance program, with a focus on monitoring roadway surface conditions for safety and sustainability. The project was started in October 2011 and ended in March 2012. The project leads are Dr. Minh-Tan DO of IFSTTAR and Dr. Ching-Yao Chan of California PATH. This report documents the literature summary, idea exchange and potential future endeavors that are parts of the joint project.

## 2. Motivation and Objectives

Toward the goal of reducing collisions while maintaining the integrity and sustainability of roadways, separate projects in both France and California in recent years have been developed to achieve the following objectives:

- Evaluating the effectiveness of roadway surface improvements, in terms of the reduction in collisions, thus allowing the selection of cost-effective countermeasures;
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The outcomes of such projects have generated or will produce useful tools, from the definition of conceptual framework to the implementation of real-world safety applications, to assist the decision-making process for pavement management as well as to offer safety improvements for the traveling public.

In recent and ongoing projects that are conducted in California and France, significant insights are gained and feasible solutions to tackle the safety issues described above are being developed for monitoring the roadway surface conditions. This collaborative project is built upon the knowledge base gathered from relevant projects in France and California respectively, which will allow synergistic fusion of common ideas that are applicable for both sides. Yet, researchers can also learn from partners about the distinctive features and constraints that they have not encountered or conceived. Ultimately, the goal will be to create a mutually beneficial research

team that can seek support for future joint projects and deliver the benefits for safe driving environment and sustainable infrastructure.

## **2.1. Research Needs and Objectives of Projects Conducted at California PATH**

Several relevant research projects were recently carried out in California and the research team sought to achieve the following main objectives:

- Identify and analyze before-and-after historical collision data at the operational test sites where new types of pavements have been installed in order to quantify the effectiveness of the safety performance of similar pavement improvements.
- Evaluate and analyze skid test results, from the test data inventory collected by Pavement Field Testing Branch (PFTB) at the Caltrans Sacramento Laboratory, to investigate and model the effects of environmental and traffic attributes on skid resistance, and furthermore to propose efficient data collection protocols.
- Explore innovative ways of monitoring and measuring roadway surface conditions with the concept of cooperative vehicles and infrastructure.

## **2.2. Research Needs and Objectives of Projects Conducted at LCPC, France**

In recent years, researches carried out at LCPC in the skid resistance area aimed at:

- getting a better understanding and modeling the tire/wet road friction and its evolution over time;
- developing tools to detect “black spots” on itineraries;
- informing drivers about road conditions, mainly under adverse weather conditions;
- proposing approaches to move towards a harmonization of skid resistance measurement methods.

## **2.3. Main objectives of Collaboration between LCPC and California PATH**

This project is aimed at leveraging and cross-fertilizing the developments in France and California with data and information exchange, lessons learned and a plan for the future. The proposed work is intended to promote the advancements of research ideas through the long-lasting and continuing cooperation between LCPC and PATH.

The project is intended to result in the proliferation and expansion of synergistic projects in France and California that have potentials to improve driving environment and sustainable infrastructure. The cooperation involves:

- Direct exchange between the French and California partnering researchers to identify common objectives and to set up the detailed program
- “State of the art” studies or scans of existing technologies and projects
- A common report, introducing recommendation and to the extent possible, identified commonalities for the next phases, will be developed and delivered.
- Leveraging knowledge base in ongoing respective studies toward the formation of partnerships for follow-up joint projects.

### 3. Research Plan and Tasks

The scientific and technical aspects that are explored in the project are centered on roadway surface monitoring and management, with emphases on two fronts: one on effectiveness of pavement countermeasures and the other on skid resistance monitoring and maintenance. Specific questions which we address in the project are aimed at leveraging, research and expertise of participants to understand and develop a unified and powerful concept of operations to the following set of problems:

- What is the specific problem to be solved with respect to roadway surface monitoring and maintenance?
- What relevant information needs to be captured to support the deployment of effective countermeasures?
- How do we measure the effectiveness of pavement improvement projects?
- How can the measures for safety performance of pavements be built into the pavement management system?
- How is the relevant information for monitoring roadway surface characteristics?
- What are the standards of characterizing roadway surface and how can they be homogenized among different regions or countries?
- How do the performing characteristics of roadway surface deteriorate over time?
- What primary factors are responsible for resulting in the variation of skid resistance on roadway surface?
- How can the monitoring of roadway surface be efficiently managed?

#### **Task 1: Information Exchange, Literature Review and Documentation of Knowledge Base**

The program began with a preliminary phase, devoted to identify common objectives and perform a literature review of “state of the art” in both France and Europe, and California and US. Identification of practices through a combined and pragmatic survey would include developments in Europe and the United States. The focus of the literature search is the scope of the proposed wet roadway surface and skid resistance issues.

#### **Task 2: Identification of System Performance Measures, Effective Solutions, and Implementation Guidelines**

The joint proposal aims at deriving from the knowledge base from both Europe and US to form a comprehensive set of performance measures and effective solutions. Note that distinctive features in the suggested solutions may exist due to the differences in societal background and governmental regulations. However, the practices adopted or developed in both sides can offer considerable insights on the common issues and challenges. This task consists of an important step to develop and document common methodologies and approach for implementation. It is in this task where the findings of leveraging projects in both France and California will be incorporated into a joint report.

### **Task 3: Refine and Verify Methodologies**

This task involves the usage of methodologies developed by both sides. Data are shared between the partners, and methods or approaches of analysis are mutually verified at either side. Through this cross evaluation, the methodologies can be evaluated and further refined.

### **Task 4: Development of Synergistic Work Plan for Potential Joint Projects**

The last task will be the exploration of common interest and the identification of research and deployment plans that are based on the proposed methodologies in France and California. A work plan will be developed based on the system to be proposed to potential funding agencies to support the deployment at selective test sites. Importantly, plans, methodologies used and lessons learned will be brought forward to have the concepts and tools as close to being deployable as possible.

### **Addendum Note on Tasks and Project Deliverables**

This project started in late 2011 with a significant delay on the Caltrans side, due to various budgetary and contractual issues, after the initial approval by the France and Caltrans reviewed process in 2009. Due to the delay, the French partners had to suspend their project. After the project was officially started in Caltrans, the French researchers had to re-establish the contract and to recruit new personnel to participate in the project. Furthermore, there had been plans in the original proposals for mutual visits and meetings to carry out the tasks. However, due to budgetary constraints on travel, those trips and meetings have been cancelled and the work plans changed. Even though the PATH researcher (Ching-Yao Chan) made a non-project sponsored trip to meet with French partners, the exchange has been limited.

Therefore, the report contents is somewhat lacking with inputs from the French collaborators, because they are still in the process of re-start the project. This report can be updated when more inputs are received from IFSTTAR.

## **4. Literature Review Summary**

The literature review was carried out with several topic areas of previous studies, including:

- Roadway surface modeling
- Surface treatment effectiveness
- Surface treatment before and after effects
- Roadway condition warning systems
- Driver warning
- Driver warning based on Vehicle-infrastructure cooperation

A summary of literature and state-of-the-art practices are given in the following sub-sections, while the full synopsis of each literature is given in the Appendix A.

## **4.1. Roadway Surface Modeling and Measurement**

Topics that were covered within the review are listed below. The years of publications are given in parenthesis after the subject title.

### **4.1.1 Tire/Road Estimation and Modeling**

- Application of Drag Coefficients to ABS Related Sideslip (2007)
- Environmental effects on Pacejka's scaling factors (2006)
- GPS Based Real-Time Tire-Road Friction Coefficient Identification (2004)
- Model-Based Road Friction Estimation (2004)
- An Optimal Pole-matching Observer Design for Estimating Tyre-road Friction Force (2010)
- Use of an Extended Kalman Filter as a Robust Tyre Force Estimator (2006)
- Vehicle and Road State Estimation Using Interacting Multiple Model Approach (2006)
- Estimation of Contact Forces and Road Profile Using High-Order Sliding Modes (2010)
- Online Estimation of Friction Coefficients of Winter Road Surfaces Using the Unscented Kalman Filter (2007)

### **4.1.2 Roadway Surface and Crash Safety**

- A probability-based approach for assessing the relationship between road crashes and road surface conditions (2007)
- A quantitative model of road-surface safety (2011)
- Relationship between Pavement Surface Characteristics and Crashes, Volume 1: Synthesis Report (2010)
- Modeling Asphalt Pavement Friction and Wet-Pavement Traffic Accidents for Two-Lane Rural Highways (2006)
- The effect of skid resistance and texture on crash risk (2005)
- Incorporating Road Safety into Pavement Management: Maximizing Surface Friction for Road Safety Improvements (2005)
- Investigation of Factors associated with Truck crashes in Nebraska (2010)
- A quantitative model of road-surface safety (2011)
- Relationship Between Highway Pavement Condition, Crash Frequency, and Crash Type (2009)
- Roadway Factors Associated with Motorcycle Crashes (2011)
- Influence of Roadway Surface Discontinuities on Safety: State of the Art Report (2009)
- Road Pavements Design and Traffic Safety - Evaluation of Relationships Between Accident Risk and Functional Properties of Road Pavements (2007)

### **4.1.3 Skid Resistance/Friction Measurement and Modeling**

- Harmonization of Texture and Skid-Resistance Measurements (2008)
- Polishing Mechanism and Its Numerical Modeling for Flexible Pavement (2010)
- A systems approach to the management of skid resistance deficiencies sites on a road network (2011)
- On the Study of Polishing of Road Surface under Traffic Load (2010)
- Relating Surface Texture of Rigid Pavement with Noise and Skid Resistance (2004)
- Sensitivity of in-service skid resistance performance of chipseal surfaces to aggregate and texture characteristics (2005)

- Skid resistance loss of plastic-grooved concrete roadways (2008)
- The Evaluation of the Evolution of Road Surface Friction: A Case Study in Naples' District (2004)
- Evaluation of Investigations into the Application of the IFI (International Friction Index) (2003)
- Evaluation of pavement temperature on skid frictional of asphalt concrete surface (2011)
- Precision Estimates of AASHTO T 242 (2009)
- Prediction of Road Surface Friction Coefficient Using Only Macro- AND Micro-texture Measurements (2005)
- Skid Resistance Prediction by Computer Simulation (2004)
- Skid Resistance - Measurement and Interpretation (2002)
- Evaluation of Traffic and Environment Effects on Skid Resistance and Safety Performance of Rubberized Open-grade Asphalt Concrete (2010)
- Development of a New Method for Optimizing the Skid Resistance and Compactability of Asphalt Pavements (2011)
- Review of High-Friction Surface Technologies -- Constructability and Field Performance (2010)
- Skid resistance performance profiles (2011)

#### **4.1.4 Roadway Surface Measurement and Hydroplaning**

- Analytical Modeling of Effects of Rib Tires on Hydroplaning (2008)
- Modeling and Analysis of Truck Hydroplaning on Highways (2008)
- Prediction of Wet-Pavement Skid Resistance and Hydroplaning Potential (2007)
- Wet-Pavement Hydroplaning Risk and Skid Resistance: Modeling (2007)
- Transverse Pavement Grooving against Hydroplaning. I: Simulation Model (2006)

#### **4.1.5 Other Roadway Measurement and Modeling Topics**

- 3D Visualization Model of Road Surface (2009)
- Comparison of Alternative Models for Road Surface Condition Classification (2010)
- Effects of Frequency of Pavement Condition Data Collection on Performance Prediction (2010)
- Probabilistic Models for Discriminating Road Surface Conditions based on Friction Measurements (2008)
- An Original Evaluation of the Wearing Course Macrotecture Evolution using the Abbot Curve (2009)
- Tyre and Road Surface Optimization for Skid Resistance and Further Effects (TYROSAFE) (2010)
- Monitoring and Improving Roadway Surface Conditions For Safe Driving Environment and Sustainable Infrastructure (this very project; research in progress)
- The future of skid resistance? (2011)
- TYROSAFE: tyre and road surface optimization for skid resistance and further effects (2011)
- Pavement Surface Condition/Performance Assessment: Reliability and Relevancy of Procedures and Technologies (2007)

## **4.2. Roadway Condition Detection and Warning**

Topics that were covered within the review are listed below. The years of publications are given in parenthesis after the subject title.

### **4.2.1 Road Conditions and Driver Alerts**

- Slippery when dry? Low dry friction and binder-rich road surfaces (2005)
- Experimental evaluation of fog warning system (2007)
- Pennsylvania Turnpike Commission (PTC) Fog Detection, Traveler Information and Dynamic Traffic Control System PTC Fog Warning System (FWS) (2007)
- I-68 FOG DETECTION SYSTEM PLANNING REPORT (2003)
- I-68 Reduced Visibility Fog Detection and Warning System: Evaluation Report (2006)
- Evaluation of Fog-Detection and Advisory-Speed System (2004)
- Active Warning Systems: Synthesis (2005)
- Effects of Road Surface Appearance and Low Friction Warning Systems on Driver Behavior and Confidence in the Warning System (2009)
- Vehicle Infrastructure Integration (VII) Based Road-Condition Warning System for Highway Collision Prevention (2009)
- Fog Detection for Interstates and State Highways (research in progress)
- A study of a safety support system that uses information from the road infrastructure in Human Factors in Driving and Telematics, and seating comfort (2004)

### **4.2.2 Roadway Surface Detection and Testing/Measurement**

- New System for Detecting Road Ice Formation (2011)
- Road Surface Condition Forecasting in France (2009)
- WARNING: Weather Ahead (2006)
- Enhancing Road Weather Information Through Vehicle Infrastructure Integration (2007)
- Expediting Vehicle Infrastructure Integration (EVII) : Where the Rubber Meets (and Talks to) the Road (2008)
- A New Paradigm in Observing the Near Surface and Pavement: Clarus and Vehicle Infrastructure Integration (2008)
- Latest Developments in Fixed and Mobile Road Weather Observing As They Relate to the CLARUS and Vehicle Infrastructure Integration (VII) Initiatives (2008)
- Opportunity to Leverage Vehicle Infrastructure Integration (VII) Data for Pavement Condition Monitoring (2008)
- Statewide Wireless Communications Project; Volume 3: Data Collection and Signal Processing for Improvement of Road Profiling and Proof of Concept of a Vehicle-Infrastructure Based Road Surface Monitoring Application (2008)
- Vehicle Infrastructure Integration Test Beds Planned for Detroit (2007)
- Weather Applications and Products Enabled Through Vehicle Infrastructure Integration (VII) Feasibility and Concept Development Study (2007)

### **4.2.3 Roadway Conditions and Maintenance**

- Evaluation of ODOT Roadway/Weather Sensor Systems for Snow & Ice Removal Operations - Part V: Vehicular Speed Associated with Winter Pavement Conditions (2006)

#### 4.2.4 Other Roadway Conditions Topics

- Monitoring and Improving Roadway Surface Conditions For Safe Driving Environment and Sustainable Infrastructure (this very project; research in progress)

### 4.3. Pavement Treatment

Topics that were covered within the review are listed below. The years of publications are given in parenthesis after the subject title.

#### 4.3.1 Pavement Treatments and Effects

- Relative Effectiveness of Grooves in Tire and Pavement for Reducing Vehicle Hydroplaning Risk (2010)
- Evaluating Improvement Measures for Wet-Weather Operational Safety (2007)
- The effectiveness of the application of high friction surfacing on crash reduction (2005)
- Centerline Rumble Strips Help Cars and Bicyclists (2005)
- Improving Safety as Part of a Pavement Preservation Program (2005)
- Transverse Rumble Strips (2007)
- Fog Seal Effectiveness for Bituminous Surface Treatments (2011)
- Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Preservation Tool: Phase 2 (research in progress)
- Pavement Surface Characteristics Concrete New Construction (MN Road Studies) (research in progress)
- Performance of Permeable Friction Course (PFC) Pavements Over Time (research in progress)
- Implementation of New OGFC Specifications (2008)
- An Onboard Virtual Rumble-Strip Based Operation for Road Departure Warning - FY11 NATSRL (research in progress)
- Effectiveness of Rumble Stripes on Roadway Safety in Mississippi (research in progress)
- Promoting Center Line Rumble Strips to Increase Rural, Two-Lane Highway Safety (research in progress)
- Safety Improvement from Edge Lines of Rural Two-Lane Highway (research in progress)
- Does friction and color equal safety? (2005)
- The influence of road surface condition on traffic safety and ride comfort (2004)
- Economic appraisal and optimization process in road safety projects (2010)
- Using high friction surface treatments to reduce traffic accidents (2004)
- Innovative surfacing treatments delivering safer roads (2011)
- Synthesis of Current Practice on the Design, Construction, and Maintenance of Porous Friction Courses (2006)
- Synthesis of Current Research on Permeable Friction Courses: Performance, Design, Construction, and Maintenance (2010)
- Surface Treatments in Asphalt Pavements - A Systems View (2006)

#### 4.3.2 Before-After Effects

- Evaluation of the Safe Lane™ Overlay System for Crash Reduction on Bridge Deck Surfaces (2010)
- Safety Performance of Experimental Pavement Types in California Using Before-and-After Comparisons (2010)

- The early life skid resistance of road surfaces (2008)
- Evaluation of Innovative Safety Treatments. Volume 3: A Study of the Effectiveness of Tiderip High Friction Surface Treatment (2008)
- Accidents par pert adherence : Relation adherence-security router et analyses resalable a intervention (2005)
- Skid Accident Reduction Program (SKARP): Targeted Crash Reductions (2003)
- Safety Effect of Preventive Maintenance: A Case Study of Micro surfacing (2008)
- Evaluation of Concrete Pavement Texturing Practice in Minnesota Using the Wet Weather Accident Evaluation Criterion (2008)
- Evaluation of Rubberized Open Graded Asphalt Concrete (OGAC) for Counteracting Wet Pavement Collisions (2007)
- Road Safety Effects of Porous Asphalt: A systematic Review of Evaluation Studies (2005)

## **5. Review of Performance Measures, Design and Implementation Guidelines**

This section contains a summary of review on performance measures, design and implementation guidelines that are related to roadway monitoring and associated implementation of safety systems. The sub-categories of reviews include:

- Performance Measures for Safety Systems
- Design Guidelines for Safety Systems
- Implementation and Evaluation of Safety Systems

A summary of literature and state-of-the-art practices are given in the following sub-sections, while the full synopsis of each literature is given in the Appendix B.

### **5.1. Performance Measures for Safety Systems**

Topics that were covered within the review are listed below. The years of publications are given in parenthesis after the subject title.

#### **5.1.1 Overall Traffic Safety Performance Measures**

- Development of Outcomes Based National Road and Rail Safety Performance Measures (2011, Italy)
- Benchmarking Road Safety: Lessons to Learn from a Data Envelopment Analysis (2009, Europe - Belgium)
- Comparative Performance Measurement: Safety (2009, US - AASHTO)
- National Traffic Safety Index (2009, TRB - South Korea)
- Measuring Performance Among State DOTs, Sharing Best Practices -- Safety (2009, US - FHWA, AASHTO, NCHRP)
- Traffic Safety Performance Measures for States and Federal Agencies (2008, US - NHTSA)
- Traffic Safety: Improved Reporting and Performance Measures Would Enhance Evaluation of High-Visibility Campaigns (2008, US - GAO)
- Sunflower Next: Towards A Composite Road Safety Performance Index (2008, Israel)
- Examination of Macro-Level Annual Safety Performance Measures for Virginia (2008, US - Virginia)

- Use and Misuse of Motor-Vehicle Crash Death Rates in Assessing Highway-Safety Performance (2006, US - IIHS)

### **5.1.2 Traffic Safety Data, Methodologies and Performance Measures**

- Model Performance Measures for State Traffic Records Systems (2011, US - NHTSA)
- Traffic Safety Data: State Data System Quality Varies and Limited Resources and Coordination Can Inhibit Further Progress (2010, US - GAO)
- Safety Data, Analysis, and Modeling (2008, US - TRB)
- Quantified Road Safety Target and Road Fatality Reduction (2006, Hong Kong)
- Working Group on Achieving Ambitious Road Safety Targets: Country Reports on Road Safety Performance (2006, France)
- Halving Roadway Fatalities: A Case Study from Victoria, Australia, 1989-2004 (2006, US FHWA - Australia)
- Road Infrastructure Safety Assessment (2006, Australia – New Zealand)
- Identifying and Quantifying Operational and Safety Performance Measures for Access Management: Micro-Simulation Results (2005, US – FHWA, Texas)

### **5.1.4 Pavement Related Studies**

- Performance Assessment Methodology for Sustainable Pavement Marking Safety (2009, US - TRB)
- Analyzing Road Pavement Skid Resistance (2005, ITE – New Zealand)

### **5.1.4 Operation Performance and Planning**

- Measuring Performance Among State DOTs, Sharing Best Practices--Operations Performance Using Incident Response Time (2010, US - FHWA, AASHTO, NCHRP)
- Performance Measurement for Highway Winter Maintenance Operations (2009, US - Iowa)
- Evaluating the Effectiveness of State Department of Transportation Investment Decisions: Linking Performance Measures to Resource Allocation (2006, US)

### **5.1.5 Safety Culture**

- Road Safety Culture Development for Substantial Road Trauma Reduction: Can the Experience of the State of Victoria, Australia, be applied to Achieve Road Safety Improvement in North America? (2007, US - AAA)
- Improving Traffic Safety Culture in the United States - The Journey Forward (207, US - AAA)

## **5.2. Design Guidelines for Safety Systems**

Topics that were covered within the review are listed below. The years of publications are given in parenthesis after the subject title.

### **5.2.1 Roadway Design for Safety**

- Highway Geometric Design from the Perspective of Recent Safety Developments (2011, Greece)
- Country Report – the Netherlands (2010, Netherlands)
- Roadway Safety Design Workbook (2009, US - FHWA, Texas)
- Roadway Safety Design Synthesis (2005, US - FHWA, Texas)

- Role and Application of Accident Modification Factors in the Highway Design Process (2005, US – FHWA, Texas)

### 5.2.2 Evaluation Procedures and Tools

- Development of Safety Performance Monitoring Procedures (2010, US – FHWA)
- Calibration Factors Handbook: Safety Prediction Models Calibrated with Texas Highway System Data (2008, US – FHWA, Texas)
- Development of Tools for Evaluating the Safety Implications of Highway Design Decisions (2007, US – FHWA)
- A New Procedure for Evaluating Traffic Safety on Two-Lane Rural Roads (2003, France)

### 5.2.3 Practices and Case Studies

- Operations and Safety of Super 2 Corridors with Higher Volumes (2011, US –FHWA, Texas)
- Synthesis of Information Related to Highway Problems. Topic 41-01. Geometric Design Practices for Resurfacing, Restoration, and Rehabilitation (2009, US - FHWA, AASHTO, NCHRP)
- Optimizing Design of Highway Horizontal Alignments: New Substantive Safety Approach (2008, Canada)
- Advance Warning Flashers: Guidelines for Application and Installation (2005, Canada)
- Development of Guidelines for In-Roadway Warning Lights (2004, US FHWA - Virginia)
- Design Guidelines for Safety of In-Vehicle Information Systems (2002, UK)

### 5.2.4 Human Factors

- Integrating Safety and Human Factor Issues into Road Geometric Design Guidelines (2010, US TRB – Greece)
- Crash Warning System Interfaces: Human Factors Insights and Lessons Learned (2007, US - NHTSA)
- Driver Perception of Roadway, Traffic and Environment: A Basic Human Factor to be Considered in Road Design Standards (2004, Europe)
- Integrating Human Factor Evaluation in the Design Process of Roads - A Way to Improve Safety Standards for Rural Roads (2004, Europe)
- Integrating Human Factor Evaluation in the Design Process of Roads - A Way to Improve Safety Standards for Rural Roads (2003, Europe)

### 5.2.5 Pavement Related

- Guide for Pavement Friction (2009, US – NCHRP)
- Guide for Pavement Friction (2008, US – AASHTO)
- Evaluation of Pavement Friction Characteristics (2000, US – NCHRP)

## 5.3. Implementation and Evaluation of Safety Systems

Topics that were covered within the review are listed below. The years of publications are given in parenthesis after the subject title.

### 5.3.1 Evaluation of In-Vehicle Safety Systems

- Cost Benefit Evaluation of Advanced Primary Safety Systems: Final Report (2011, UK)
- Study on Lane Departure Warning and Lane Change Assistant Systems (2008, UK)

### 5.3.2 Evaluation of Roadway Safety Systems

- Safety Effectiveness of Actuated Advance Warning Systems (2011, US - Nebraska)
- An Examination of the Rural Intersection Collision Avoidance System (2009, US - Wisconsin)
- Implementation of Advance Warning of End of Green System (AWECS): Implementation Report (2008, US – FHWA, Texas)
- Enhanced Field Observation of Traffic Patterns for Intersection Collision Warning Systems (2008, US - California)
- Enhancements to the Advance Warning of End of Green System (AWECS) (2006, US - Texas)
- Improved Risk Management of Potential Roadside Slip Sites: Development and Implementation of a Roadside Slope Hazard Warning System (2006, Australia)
- Improved Grade Crossing Safety with In-Pavement Warning Lights (2005, US - California)
- Advance Warning of Stopped Traffic on Freeways: Field Studies of Congestion Warning Signs (2005, US - Texas)
- Methods and Metrics for Evaluation of an Automated Real-Time Driver Warning System (2005, US - California)

### 5.3.3 Driver Interface

- Crash Warning Interface Metrics Task 3: Report Appendices (2011, US - NHTSA)
- Crash Warning Interface Metrics Task 3 Report: Empirical Studies of Effects of DVI Variability (2011, US - NHTSA)

### 5.3.4 Impacts of Safety Warning Systems

- Forecasting and Evaluation of Traffic Safety Impacts: Driving Assistance Systems Against Road Infrastructure Measures (2007, Sweden)
- Accident Reduction Potential of Advanced Adverse Weather Warning Systems (2007, France)
- Active Warning Systems: Synthesis (2005, US)

## 6. Topics of Potential Joint Projects with Synergies in Research Background

Based on information exchange between the research partnering organizations, selective topics have been identified as the potential areas where future collaboration can be pursued. This section documents the discussions including the topics of:

- Cooperative Systems of Roadway Condition Monitoring
- Implementation of Safety Alerts for Adverse Roadway Conditions
- Frontiers of Next-Generation Roadway Management

### 6.1 Cooperative Systems of Roadway Condition Monitoring

A meeting was held between Renault, IFSTTAR and PATH in March 2012 to discuss potential cooperation on research areas. This section provides a description of the meetings and highlights the points of deliberation.

### 6.1.1 Meeting Participants

**Date:** March 7, 2012

**Place:** Techno Centre Renault, Guyancourt cedex, France

**Participants:**

- Renault: Christian CHABANON, Roland DARGAUD, Javier IBANEZ-GUZMAN
- IFSTTAR: Minh-Tan DO
- UC Berkeley PATH: Ching-Yao CHAN

**Re:** Potential Research Collaboration

### 6.1.2 Meeting Background

All participants and their associated research partners have experience and interests in exploring the advancements of real-time estimation of roadway surface parameters. The goal is to develop methodologies to accurately and reliably estimate roadway conditions then utilize the acquired information to implement vehicle-based or infrastructure-based applications. These applications can provide safety and operation benefits by the implementation of on-board driver assistance and vehicle control functions as well as roadway operation, maintenance and safety management functions.

The potential collaborative partnership will bring together capabilities and expertise that are synergistic and supplementary to one another.

- **Renault:**
  - Wide range of previous and current corporate internal and supported external research activities
  - Expertise as one of the world-wide major automakers
  - Provision of test vehicle instrumentation and maintenance
  - Provision of resource and funding support
- **IFSTTAR:**
  - Recognized institutional expertise in measurements and data collection on roadway surface conditions and pavement skid resistance
  - Provision of test equipment of gaining ground-truth data, as well as possession of existing database for various surface and roadways
  - Current ongoing collaboration with Renault
  - Previous and current ongoing collaboration project with UCB-PATH
  - Previous working experience with tire manufacturers
- **UCB-PATH:**
  - Recognized institutional reputation as being a research pioneer in intelligent transportation systems, with a strong emphasis of using technologies for Connected Vehicles applications

- Previous research experience in the subject matter of smart tires by Professor Francesco Borrelli from the Mechanical Engineering Department of UC Berkeley (UCB-ME) under collaboration with Perrelli
- Previous research experience in the subject matter of roadway surface estimation by Professor Kang Li of National Taiwan University (NTU), a former postdoctoral scholar at PATH, with the use of onboard sensing devices
- Previous experience in implementing remote data collection, monitoring, and data server management
- Current ongoing collaboration with Renault
- Previous and current ongoing collaboration project with IFSTTAR
- Previous and current collaboration with Industrial Technology Research Institute (ITRI) for DSRC/Cellular communication for V2V and V2I applications
- Working experience with multiple automakers and public agencies

### 6.1.2 Research Scope and Goals

The research scope can be set up in multiple stages with prospective goals as follows:

- **Near-Term:**
  - Conducting tests and collecting data on controlled facilities
  - Validating and comparing methodologies
  - Establishing instrumented vehicles and test platform
- **Medium-Term:**
  - Conducting tests and collecting data on real world roadways
  - Substantiating test results with existing database and supplementing with additional data collection from vehicles and roadways if necessary
  - Adjust algorithms and methodologies if necessary
  - Refine and standardize probe vehicle test package
- **Long-Term:**
  - Implementing wireless communication backhaul system and data storage server
  - Conduct multiple-vehicle real-world data collection to establish a live database from roadway network
  - Develop strategies for commercialization of envisioned applications

### 6.1.3 Basic Framework of Collaboration:

To effectively and practically offer vehicle instrumentation and testing support, it is suggested that the testing activities be carried out in France, primarily carried out by Renault and IFSTTAR with support from UCB-PATH. With this arrangement, the potential partners will offer the following research contributions:

- **Renault:**
  - Test vehicle and necessary instrumentation and maintenance support
  - Data collection and analysis
  - In-house expert support
- **IFSTTAR:**

- Test facility and test equipment
- Data collection and analysis
- In-house algorithms and methodologies
- In-house expert support
- Partnership with
  - CETE
- **UCB-PATH:**
  - Support for large-scale remote data collection
  - Data analysis
  - Algorithms and methodologies developed by Prof. Francesco Borreli (UCB-ME)
  - Algorithms and methodologies developed by Prof. Kang Li (NTU)
  - Smart tires developed by Perreli
  - Additional partnerships with
    - Caltrans (California DOT) for additional research project in California
    - ITRI with support for wireless communication aspects

#### **6.1.4 Follow-up Action Items:**

After the meeting, a few follow-up steps were suggested and agreed upon by the participants. The partners are now exploring venues and mechanisms to facilitate the cooperative efforts.

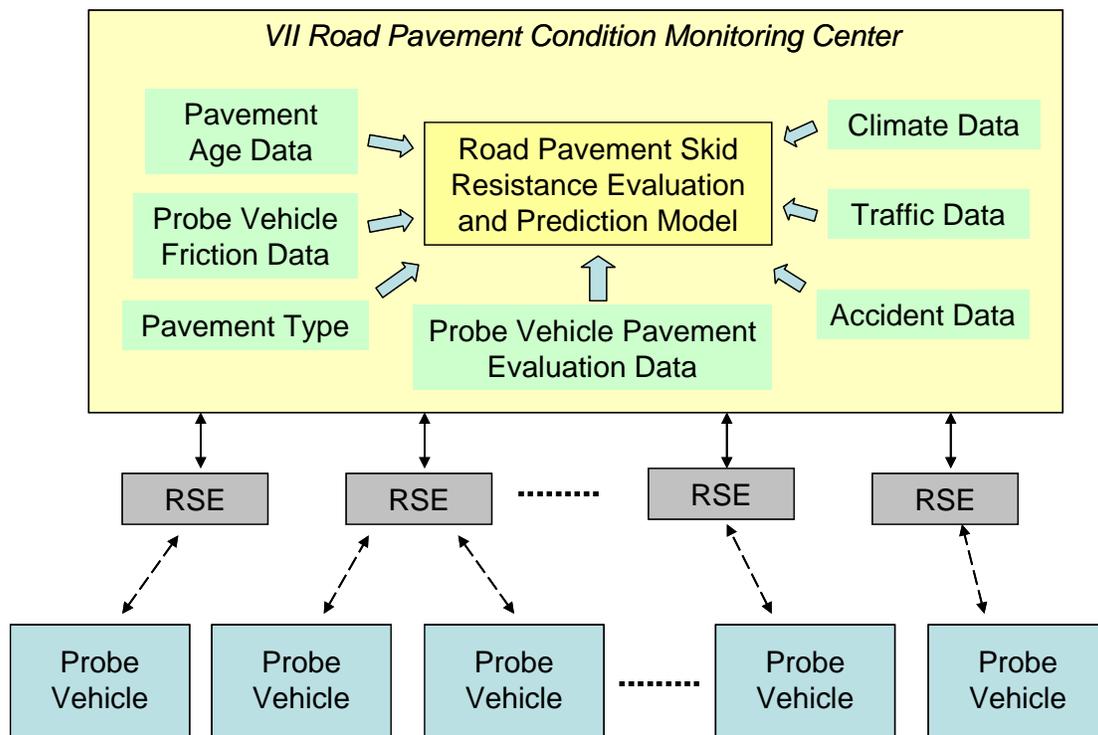
- Strategize the collaboration framework
- Explore additional research topics and opportunities for collaboration
- Revise research collaboration and work plan outline
- Hold conference with all parties to discuss logistics and issues for establishing research partnership

#### **6.1.5 Further Description of Envisioned Systems**

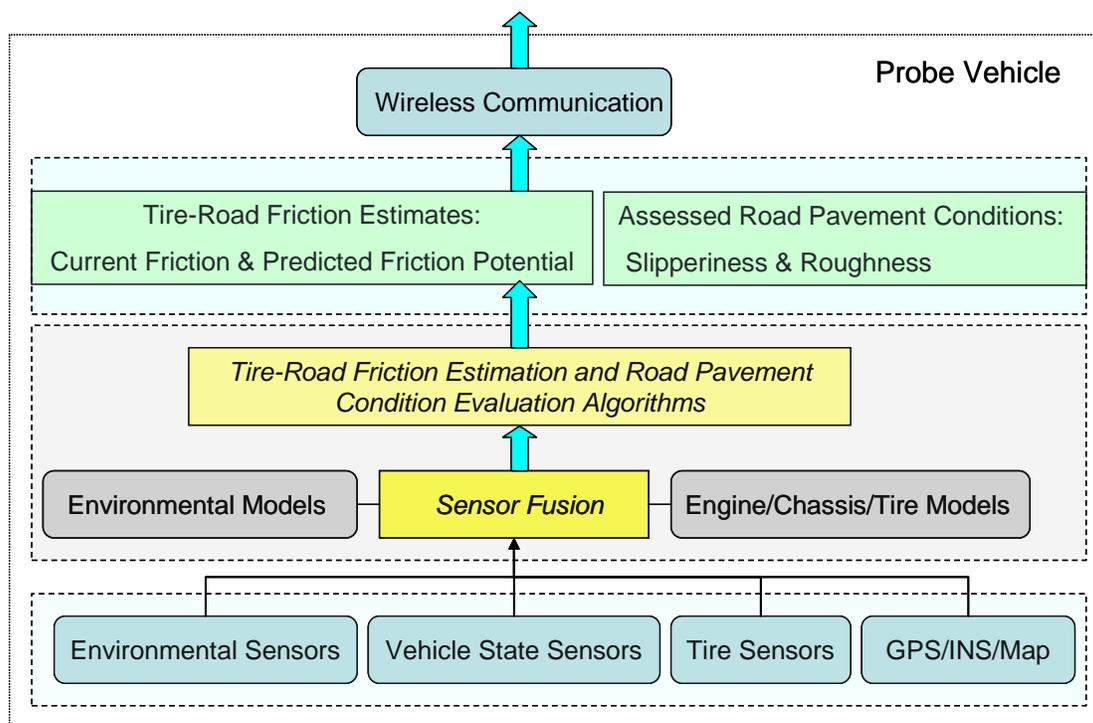
As revealed in previous research, existing tire friction estimation approaches using on-board sensors cannot guarantee precise determination of tire-road friction potential and road pavement condition under all driving or road conditions. In light of the increasing popularity of wireless communication devices and positioning system, such as GPS navigation, on modern vehicles, a cooperative estimation approach can be developed by employing a group of probe vehicles performing friction estimation and pavement condition evaluation thus becomes an attractive solution. Based on this approach, the average tire-road friction data from a group of probe vehicles can imply the road pavement slipperiness or the “available” friction for normal tires to a certain level of accuracy. Also, the actual friction potential can be well approximated by the friction estimates obtained by probe vehicles under high-friction demand scenarios, such as emergent braking or high-G maneuvering/acceleration, without skid resistance tests performed by an instrumented vehicle. Thus, systematically collecting pavement condition information can be very useful and applied to the preventive or cooperative safety applications, such as low-friction warning and cooperative adaptive cruise control (CACC).

Figure 1 depicts the concept of group-enabled pavement condition monitoring through cooperative vehicles and infrastructure. At the roadway management agency, the road pavement condition monitoring system is operated and maintained based on the previously developed pavement condition evaluation and prediction model. This model takes into account all relevant pavement data, traffic information, climate data, and real-time road condition evaluation data provided by probe vehicles, such that the model parameters can be calibrated using up-to-date data. The prediction for pavement skid resistance by this model can therefore be improved and validated by probe vehicles' estimates or measurements.

However, the determination of precise tire-road friction potential relying on one type of friction estimator and sensor can still be difficult for each probe vehicle unless the tire skid occurs. This is mainly due to the complex tire-road friction dynamics, which is affected not only by tire/pavement property but also environmental factors. Therefore, we consider an intelligent *sensor clustering* approach by fusing a set of vehicle-state, tire, and environmental sensors in the hope of providing sufficient information for the on-board tire-road friction estimation and pavement condition evaluation algorithm.



**Figure 1 Group-enabled road pavement condition monitoring through Cooperative Vehicles and Infrastructure**



**Figure 2 On-board tire-road friction estimation and pavement condition evaluation by sensor clustering**

As illustrated in Figure 2, the probe vehicle employs above three types of sensors for friction estimation and pavement condition evaluation based on the environmental and vehicle/tire models. Also, the GPS/INS/Map integrated localization system<sup>1 2</sup> provides the reliable positioning information on the map, such that the parameters of environmental models, such as pavement status, e.g., paved versus unpaved, and road type, etc. can be extracted from the on-board digital map database. Moreover, the assessed friction/pavement condition data must be associated with the map or GPS position data in order to describe the location of road surface condition information to be transmitted to a nearby RSE or vehicles.

Field tests conducted in previous research showed that this system was able to achieve the desired pavement evaluation objectives with sufficient excitation inputs, i.e., traction or braking force. Yet, medium to large friction demands as necessary conditions for good estimation results are only available in partial travel time for each vehicle. The effectiveness of this road condition monitoring system would be limited if it is used in a stand-alone manner on each vehicle. Therefore, the cooperative estimation approach appears to be a promising countermeasure to deal with the lack of excitation problem. Namely, by deploying a large number of probe vehicles on

<sup>1</sup> Kang Li, Han-Shue Tan, and J. K. Hedrick, "An Enhanced GPS-Based Vehicle Positioning System through Sensor Fusion of Digital Map Data", *Proceedings of the International Symposium on Advanced Vehicle Control*, Kobe, Japan, Oct. 6-9, 2008.

<sup>2</sup> Kang Li, Han-Shue Tan, and J. Karl Hedrick, "Map-Aided GPS/INS Localization Using a Low-Order Constrained Unscented Kalman Filter", *48th IEEE Conference on Decision and Control and 28th Chinese Control Conference*, Shanghai, China, December 16-18, 2009.

roads, the accurate road surface condition estimates can cover most of the road surfaces in the road network.

### 6.1.6 CalFrance Collaboration Perspectives

A continuation of this research topic will be to investigate further in depth, through the exchange of information and methodologies between French and California researchers, to

- Provide an updated overview of all European and French research programs on the subject of cooperative vehicles and highways
- Explore up-to-date vehicle safety applications that may rely on similar sensor suites or vehicle platform
- Explore the technical and institutional issues in the future implementation of such concepts and the recommendations for governments and industries to enable expedient developments.

## 6.2 Fog Condition Detection and Warning

A meeting was held between researchers from IFSTTAR and PATH in March 2012 to discuss potential cooperation on research areas. This section provides a description of the meetings and highlights the points of deliberation. The presentation provided by IFSSTAR in the meeting are attached in Appendix C.

### 6.2.1 Meeting Participants

**Date:** March 5, 2012

**Place:** IFSTTAR Office, Paris, France

**Participants:**

- IFSTTAR: Eric DUMONT, Nicolas HAITIERE, Jean-Michel AUBERLET, Sylvie PROESCHEL
- UC Berkeley PATH: Ching-Yao CHAN

**Re:** Potential Research Collaboration

### 6.2.2 Background

Traffic movements under foggy conditions present a serious safety challenge, which is equally true for many regions. This is a particular concern for the central valley highways in California, such as Highway 99 where historically a number of chain crashes have occurred. It was brought to the attention of California researchers in previous interactions with IFSTTAR that there have been also significant research efforts in France to address a similarly serious problem.

According to a review by IFSTAR, it was reported that fog related traffic fatalities reached 700 in US and 100 in France annually. Fog is also prevalent issue at airports, where instruments are also deployed to measure visibility. IFSTTAR is exploring the use of existing low-cost CCTV cameras through the implementation of improved vision detection software to overcome the problem. Comparably, the costs of CCTV cameras, typically at several hundred dollars are much less inexpensive than the instruments used at airports, which usually cost more than ten thousand dollars. Over the years, IFSTTAR started research in 2001 in this area by investigating the use of in-vehicle cameras to measure visibility, and in 2006 by roadside cameras. In the

years of 2006-2010, the IFSTTAR team is part of the European consortium to develop safety systems and this very research topic was a focus of their efforts.

The IFSTTAR team has developed a methodology to link the meteorological visibility to the sum of gradients taken on the Lambertian surfaces<sup>3</sup>. They have shown that this estimator is robust to illumination variations on experimental data.<sup>4,5</sup> Their method is easily deployable using the camera network already installed alongside highways and therefore of high impact to traffic safety at marginal cost. The output of their system can also feed into weather forecasting systems and can inform drivers with speed limits under low visibility conditions.

The California Department of Transportation (Caltrans) has implemented a fog detection and warning system on Highway 99 near Fresno.<sup>6,7</sup> The entire central valley region is susceptible to Tule fog, which can reduce visibility tremendously, sometimes to near zero. This area has experienced numerous multiple vehicle crashes because of the fog, most recently in 2007, when a 108 car pile-up caused two deaths and nearly 40 injuries, and closed the highway for more than twelve hours. The fog detection system uses speed and visibility detectors to assess road conditions, traffic management software to process data and control the field devices, and changeable message signs to provide information to the traveling public.

### 6.2.3 Research Scope and Goals

As can be seen in the descriptions above, there are synergies in the fog-detection and warning systems that both regions are pursuing. The research scope can be approached in multiple stages with prospective goals as follows:

- **Near-Term:**
  - IFSTTAR desires to expand their development work into field tests and is interested in seeking a deployment site in California. This will provide further validation and enhancements to the technology advantages. The primary goal will be to identify a site suitable for field testing. This conceivably can be on selective highways in District 6.
  - Caltrans and California PATH are interested in exploring low-cost technology as alternatives of foggy conditions to enable highway operation and safety systems
- **Medium-Term and Longer Term:**
  - Establish a pilot collaboration program where a number of cameras, preferably existent, can be adapted to exercise the detection system and constitute a network of detection stations.
  - Learn further from field deployment in France and California
  - Refine and standardize detection station package
  - Develop strategies for expanded commercialization of envisioned systems

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<sup>3</sup> [http://en.wikipedia.org/wiki/Lambertian\\_reflectance](http://en.wikipedia.org/wiki/Lambertian_reflectance)

<sup>4</sup> Babari, R., Hautière, N., Dumont, E., Brémond, R. and Papanoditis, N, *A Model-Driven approach to estimate atmospheric visibility with ordinary cameras*, In **Atmospheric Environment**, 45 (30): 5316-5324, 2011.

<sup>5</sup> Babari, R., Hautière, N., Dumont, E., Papanoditis, N. and Misener, J, *Visibility Monitoring using Conventional Roadside Cameras – Emerging Applications*, In **Transportation Research Part C**, 22: 17-28, 2012.

<sup>6</sup> Case Study, *Fresno Fog Detection and Warning System*.

<sup>7</sup> White paper by ICX Technologies and Caltrans District 6, *Caltrans Fog Detection and Warning System*.

#### **6.2.4 CalFrance Collaboration Perspectives**

A continuation of this research topic will be to investigate further in depth, through the exchange of information and methodologies between French and California researchers, to

- Provide an updated overview of all European and French research programs on the subject of roadway conditions and associated driver alert systems
- Explore up-to-date deployment that may rely on similar sensor inputs
- Explore the technical and institutional issues in the future implementation of such concepts and the recommendations for governments and industries to enable expedient developments.

#### **6.2.5 Follow-up Action Items:**

After the meeting, a few follow-up steps were suggested and agreed upon by the participants. The partners are now exploring venues and mechanisms to facilitate the cooperative efforts.

- Communicate to Caltrans, particularly D6, to explore potential interests of establishing a pilot project
- Explore and search in the TRB data base to check whether there is some on-going research or if questions have been expressed on this topic, and to see whether it would be possible to submit a NCHRP project on that topic in the future.

## **Appendices**

### **A1. Roadway Surface Modeling & Measurement**

### **A2. Roadway Condition Detection & Warning**

### **A3. Pavement Treatment & Effects**

### **B1. Safety Performance Measures**

### **B2. Safety Systems Design Guidelines**

### **B3. Warning System Implementation**

## **Modeling: Surface course/ Skid resistance/ Surface friction/ Tire-pavement friction**

**Title:** 3D Visualization Model of Road Surface

**Accession Number:** 01343159

**Record Type:** Component

**Language:** English

**Abstract:** The purpose of this paper is to introduce a new method for 3D visualization modeling of road surface. The modeling data are intensive transects of 3D data, which are collected by multifunction road monitoring vehicle. The first step is to establish a method used for dealing with the massive data, converting the data into the needed format for directly using of modeling. Based on further development of the existing road design software, a road surface terrain model is made, realizing the road surface 3D visualization. This model can provide 3D digital information of the road surface, information of the catchment area and scale calculation of its area. It can also provide complete, objective, and accurate 3D digital information for the road surface distortion distress identification, the road surface condition evaluation, road surface science maintenance management, road safety and so on.

**Supplemental Notes:** Abstract reprinted with permission of Taylor & Francis.

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**Media Type:** Web

**Pagination:** pp 435-442

**Authors:** Li, Xiao-min  
Harbin Institute of Technology

Ma, Song-lin  
Harbin Institute of Technology

Hou, Xiang-shen  
[houXiangshen@sina.com](mailto:houXiangshen@sina.com)  
Harbin Institute of Technology

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P.O. Box 447  
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**Editors:** Erol Tutumluer  
[tutumlue@uiuc.edu](mailto:tutumlue@uiuc.edu)  
University of Illinois, Urbana-Champaign  
I L Al-Qadi  
University of Illinois, Urbana-Champaign

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**Conference:** Bearing Capacity of Roads, Railways and Airfields. 8th International Conference (BCR2A'09)  
Location: Champaign IL  
Date: 20090629 - 20090702  
Sponsors: University of Illinois, Urbana-Champaign

**Index Terms:** Advanced technology; Blanket course; Data acquisition; Data collection; Digital simulation; Highway safety; Road conditions; Road safety; Road surfaces; Structural models; Surface course (Pavements); Technological innovations; Terrain evaluation; Three dimensional data; Three dimensional model; Visualisation; Visualization

**Subject Areas:** Data and Information Technology; Highways; Pavements; I23: Properties of Road Surfaces; I61: Equipment and Maintenance Methods; I85: Safety Devices used in Transport Infrastructure

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**Title:** **Comparison of Alternative Models for Road Surface Condition Classification**

**Accession Number:** 01151178

**Record Type:** Component

**Language:** English

**Order URL:** <http://pubsindex.trb.org/orderform.html>

**Source Data:** Transportation Research Board Annual Meeting 2010 Paper #10-2789

**Abstract:** Roadside reporting by road maintenance staff is the major approach for real time monitoring of road surface conditions during and after winter snowstorms, especially in North America. Latest sensor and information technologies, such as road weather information system (RWIS) and web cams have afforded new opportunities for improved road condition monitoring. Continuous friction measurement is another method for road surface condition monitoring and winter road maintenance performance measurement, which can reveal road contaminant (snow/ice) information with much larger continuous spatial coverage than RWIS and web cams. Friction measurement is also considered more objective than human reporting. In this research, with the help of a classification tree, several nested logistic regression models based on continuous friction measurement were developed for automatic classification of multiple winter road surface conditions. New variables from probability density pattern, like variance and skewness, and from spectral density pattern of continuous friction measurement were included in the classification models in addition to mean friction level. As these new variables can reflect spatial distribution patterns of snow cover along the maintenance route, including them into the classifier can improve the power of the models. The performance of the nested logit models were partially compared to the naive Bayesian classifier which was solely based on mean friction.

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**Pagination:** 18p

**Authors:** Feng, Feng  
[f3feng@uwaterloo.ca](mailto:f3feng@uwaterloo.ca)  
University of Waterloo, Canada

Fu, Liping  
[lfu@uwaterloo.ca](mailto:lfu@uwaterloo.ca)  
University of Waterloo

Perchanok, Max S  
[Max.Perchanok@ontario.ca](mailto:Max.Perchanok@ontario.ca)  
Ontario Ministry of Transportation

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**Index Terms:** Adverse conditions; Cameras; Friction; Real time information; Road weather information systems; RWIS; Surface condition; Surface properties; Surface texture; Texture; Weather conditions; Winter maintenance

**Subject Areas:** Highways; Maintenance and Preservation; I62: Winter Maintenance

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**Title:** **Effect of Frequency of Pavement Condition Data Collection on Performance Prediction**

**Accession Number:** 01150981

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2153-08>

**Abstract:** Monitoring pavement surface conditions over time is essential for pavement management and performance models. Time series distress data can be used to determine the remaining service life at the project level, which can then be used for all projects to assess the overall health of the pavement network. Observed field performance is also crucial for calibrating performance prediction models for

pavement design purposes. Therefore, highway agencies collect pavement condition data to accomplish both policy and engineering objectives. However, differences exist among agencies between the monitoring frequency used for pavement surface distress (imaging) and that used for sensor-measured features. These differences pertain primarily to the relative difficulties in collecting and processing imaging data. Many agencies collect sensor data more frequently than images. Most highway agencies monitor pavement condition at 1-, 2-, or 3-year frequencies. Discrepancies between performance model predictions and observed field performance are conventionally attributed solely to errors in predicted pavement distresses. In fact, inherent uncertainty may also be present in measured pavement distresses due to spatial variability, sampling, and measurement errors. The frequency of distress data collection adds further uncertainty in performance prediction. This paper explores the effect of pavement condition monitoring frequency on pavement performance prediction. Analyses of observed pavement performance show that condition data collection frequency can significantly affect performance prediction. Therefore, more frequent data collection for image-based methods can reduce the associated risk in performance prediction and thus be more effective for better decision making for pavement management.

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Phone: 517-432-7798  
Fax: 517-432-1827  
[syedwaqa@egr.msu.edu](mailto:syedwaqa@egr.msu.edu)  
Michigan State University, East Lansing

Baladi, Gilbert Y  
[baladi@egr.msu.edu](mailto:baladi@egr.msu.edu)  
Michigan State University, East Lansing

Chatti, Karim  
[chatti@egr.msu.edu](mailto:chatti@egr.msu.edu)  
Michigan State University, East Lansing

Dean, Christopher M  
Michigan State University, East Lansing

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ISSN: 0361-1981

**Index Terms:** Condition surveys; Data acquisition; Data collection; Mathematical models; Monitoring frequency; Pavement distress; Pavement management; Pavement management systems; Pavement performance; Performance monitoring; Performance prediction models; Primary detectors; Sensors; Video imaging detectors; Wide area detector systems

**Subject Areas:** Design; Highways; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces

---

**Title:** **Harmonization of Texture and Skid-Resistance Measurements**

**Accession Number:** 01115772

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://www.dot.state.fl.us/research-ce...eted\\_Proj/Summary\\_SMO/FDOT\\_bdh23\\_rpt.pdf](http://www.dot.state.fl.us/research-ce...eted_Proj/Summary_SMO/FDOT_bdh23_rpt.pdf)

**Abstract:** Due to safety concerns associated with friction testing on both high and low-speed facilities, testing at variable speeds has been previously

investigated by the Florida Department of Transportation (FDOT). The American Society for Testing and Materials (ASTM) has endorsed this concept with the publication of a standard method for the calculation of the International Friction Index (IFI) as described in ASTM E 1960. Previous research conducted the FDOT and the principal investigator has demonstrated that a 64 kHz non-contact, laser measurement system can provide a repeatable and accurate measure of pavement macro-texture in terms of Mean Profile Depth (MPD) at highway operating speeds. With a repeatable measure of MPD and wet friction, IFI may be approximated in general accordance with ASTM E 1960. This report summarizes the results of an effort to “harmonize” such texture and skid-resistance measurements in Florida. The results of this effort confirm that the Circular Track Meter (CTM) is highly correlated with the 64 kHz speed laser texture measuring device. The Dynamic Friction Tests (DFT) was also found to provide a reasonable correlation with the FDOT full-scale, locked-wheel friction test units. However, the speed gradient (slope) obtained from DFT test data was not found to be well correlated with pavement texture (MPD). Since this correlation is fundamental to the implementation of IFI, as described in ASTM E 1960, it is concluded that IFI cannot be implemented in Florida at this time without significant reservations. A practical methodology for measuring pavement friction and texture at variable highway speeds with the FDOT locked-wheel friction test unit and the ribbed tire is presented. Since the results of the ribbed test are known to be significantly influenced by pavement micro-texture, and MPD is a direct measure of pavement macro-texture, and the complementary MPD data together may be readily employed to characterize frictional properties in Florida roadways.

**TRIS Files:** TRIS

**Contract Numbers:** BDH-23

**Media Type:** Print

**Pagination:** 181p

**Authors:** Jackson, N Mike  
Phone: 904-620-1847  
Fax: 904-620-1391  
[njackson@unf.edu](mailto:njackson@unf.edu)  
University of North Florida, Jacksonville

**Features:** Appendices (11) ; Figures; Photos; References (40) ; Tables

**Corporate Authors:** University of North Florida, Jacksonville  
College of Computing, Engineering and Construction  
1 UNF Drive

Jacksonville, FL 32224-2645 USA

Florida Department of Transportation  
605 Suwannee Street  
Tallahassee, FL 32399-0450 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20080930

**Edition:** Final Report

**Index Terms:** Blanket course; Circular track meter; Florida; International Friction Index; Mean profile depth; Pavement design; Road surfaces; Skid resistance; Speed gradient model; Surface course (Pavements); Variable speed control

**Subject Areas:** Highways; History; Pavements; I22: Design of Pavements, Railways and Guideways

---

**Title:** **Polishing Mechanism and Its Numerical Modeling for Flexible Pavement**

**Accession Number:** 01152110

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.ijprt.org.tw/files/sample/V3N1%286%29.pdf>

**Abstract:** Pavement polishing is a distress type exhibited with asphalt pavement and is caused by repeated sliding contact wear on the pavement wear course. In this paper, pavement polishing mechanisms are first discussed. Next, a finite element procedure to predict pavement polishing is developed. A modified Archard's wear law is used to calculate geometric change based on contact pressure and relative slip between 2 bodies. The material loss due to polishing is realized through the geometric change. The thickness loss is also used together with deformation to calculate the polishing configuration due to surface ablation. The polished configuration will be adaptively remeshed for the next simulation time step. Thus, mechanical behavior due to pavement polishing can be reasonably captured. Representative simulations are provided to demonstrate the effectiveness of the proposed pavement polishing model, which include parametric study on

material hardness and wheel slip rate. Further developments on pavement polishing modeling are also discussed.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 43-50

**Authors:** Xia, Kaiming  
[kaiming.xia@gmail.com](mailto:kaiming.xia@gmail.com)  
Colorado School of Mines

Wang, Linbing  
Phone: 540-231-5262  
Fax: 540-231-7532  
[wangl@vt.edu](mailto:wangl@vt.edu)  
Virginia Polytechnic Institute and State University, Blacksburg

**Features:** Figures; Photos; References (7) ; Tables (1)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/19966814>

**Publication Date:** 20100100

**Serial:** International Journal of Pavement Research and Technology  
Volume: 3  
Issue Number: 1  
Publisher: Chinese Society of Pavement Engineering  
ISSN: 1996-6814  
EISSN: 1997-1400

**Index Terms:** Asphalt pavements; Finite element analysis; Finite element method; Flexible pavements; Mathematical models; Pavement distress; Wearing course (Pavements)

**Subject Areas:** Highways; Pavements; I22: Design of Pavements, Railways and Guideways

---

**Title:** Probabilistic Models for Discriminating Road Surface Conditions based on Friction Measurements

**Accession Number:** 01129937

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.library.mto.gov.on.ca/webop...422e-800e-a53392110279&AttachmentIndex=0>

**Abstract:** This study examines the feasibility of using of friction measurements to ascertain the condition of a highway pavement, specifically whether it is covered with snow or not. The utilization of both disaggregate and aggregate logit models is discussed, as an alternative to the threshold based approach that is commonly used. The models are described in detail and are evaluated in this report.

**TRIS Files:** TAC, TRIS

**Media Type:** Web

**Pagination:** 47p

**Authors:** Fu, Liping  
Phone: 519-888-4567  
Fax: 519-888-4349  
[lfu@uwaterloo.ca](mailto:lfu@uwaterloo.ca)  
University of Waterloo

Feng, Feng  
Phone: 519-888-4567  
[f3feng@uwaterloo.ca](mailto:f3feng@uwaterloo.ca)  
University of Waterloo

**Features:** Appendices (9) ; Figures; References; Tables

**Corporate Authors:** Ontario Ministry of Transportation  
301 St. Paul Street  
St. Catharines, Ontario L2R 7R4 Canada

**Publication Date:** 20080800

**Index Terms:** Blanket course; Friction; Logit models; Logits; Probabilistic models; Road conditions; Road surfaces; Snow and ice control; Surface course (Pavements); Winter maintenance

**Subject Areas:** Highways; Maintenance and Preservation

---

**Title:** **A probability-based approach for assessing the relationship between road crashes and road surface conditions**

**Accession Number:** 01095163

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E216132

**Abstract:** Establishing a risk-based approach for managing road skid resistance

**TRIS Files:** ITRD

**Pagination:** 8P

**Authors:** PIYAPATROOMI, N  
Queensland University of Technology  
WELIGAMAGE, J  
Queensland. Department of Main Roads  
BUNKER, J  
Queensland University of Technology

**Publication Date:** 20071000

**Serial:** AUSTRALASIAN ROAD SAFETY RESEARCH POLICING  
EDUCATION CONFERENCE, 2007, MELBOURNE, VICTORIA,  
AUSTRALIA  
Publisher: THE MEETING PLANNERS

**Index Terms:** Accident; Conference; Conferences; Congresses; Highway accidents;  
Public safety; Risk assessment; Risk assessment; Safety; Safety; Safety  
measures; Skid resistance; Skidding resistance; Symposia; Traffic  
accidents; Vulnerability assessment

**Subject Areas:** Safety and Human Factors; I82: Accidents and Transport Infrastructure

---

**Title:** **A quantitative model of road-surface safety**

**Accession Number:** 01344032

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.saferroads.org.uk/2011papers.asp>

**Source Agency:** ARRB Group Limited  
500 Burwood Highway

Vermont South, Victoria 3133

- Abstract:** Safe operation of vehicles is affected by natural factors, human factors, and traffic loads. A reduction in the quality of the road surface leads to a decrease in the safe following distance and stability on curves and causes accidents such as rear-end collisions and skids. In addition to the surfacing type, road alignment, and operating speed, traffic safety is also related to the pavement roughness, texture, and skid resistance as well as other road surface conditions. Eight road surface skid-resistance evaluation parameters, including the maximum longitudinal and transverse friction coefficients, the allowable longitudinal friction coefficient  $f_{TA}$ , the allowable transverse friction coefficient  $f_{SA}$ , the expected longitudinal friction coefficient  $f_{TR}$ , the expected transverse friction coefficient  $f_{SR}$ , and the longitudinal and transverse critical values of road surface safety condition, were used to establish a quantitative model of road-surface safety. A case study and road-surface model showed that the critical values of road surface safety condition of test sections of a road in China was 13.2, indicating that the minimum technical standard for the friction coefficient of bituminous penetration-type pavement is lower in China than in other countries and is one of the critical factors in skidding accidents.
- Supplemental Notes:** Need to request password to view papers online
- TRIS Files:** ITRD, ARRB
- Pagination:** 13p
- Authors:** Hu, J  
Beijing University of Technology
- Monograph Title:** 3rd International Road Surface Friction Conference, Gold Coast, Queensland, 15-18 May 2011
- Monograph Accession Number:** 01344041
- Publication Date:** 20110500
- Conference:** International Surface Friction Conference, 3rd, 2011  
Location: Gold Coast Queensland, Australia  
Date: 20110515 - 20110518
- Index Terms:** Behavior; Behaviour; Case study; China; Design standards; Driver behaviour; Drivers; Harmonisation; Harmonization; Highway safety; Human behavior; Motor vehicle operators; Public safety; Road networks; Road safety; Safe systems (road users); Safe systems (roads); Safety; Safety measures; Skidding resistance; Standardisation; Standardization; Uniformity; Vehicle spacing

**Subject Areas:** Safety and Human Factors; I23: Properties of Road Surfaces

---

**Title:** **Relationship between Pavement Surface Characteristics and Crashes, Volume 1: Synthesis Report**

**Accession Number:** 01333785

**Record Type:** Monograph

**Language:** English

**Abstract:** There is a lack of comprehensive documentation (from the U.S. and abroad) on the effect that pavement surface characteristics (PSC) (i.e., texture, friction, and roughness) can have in reducing the unacceptable number of fatalities and serious injuries on U.S. highways. Moreover, while various studies have attempted to establish clear relationships between friction and other surface characteristics and crashes, tort liability concerns have greatly limited the collection and distribution of data and analysis results, particularly in the U.S. This document is part of a three-volume report investigating the relationship between PSCs and crashes and examining the legal issues surrounding the collection and retention of surface characteristics data by highway agencies. In this volume, the contribution of pavement friction and texture on the reduction of vehicle crashes is examined, both in general and for specific roadway locations, such as curves, intersections, and work zones. The synthesis draws upon important information and findings contained in hundreds of literary documents compiled for the study. The synthesis is intended to provide pavement, materials, and safety engineers at the federal, state, and local levels with the information necessary to effect crash-reducing improvements in pavement surface conditions. This is the first volume of a three-volume report. The other volumes in the series are: Volume 2 - Annotated Bibliography; Volume 3 - Executive Report on Legal Issues Associated with Surface Characteristics.

**TRIS Files:** TRIS

**Contract Numbers:** DTFH61-07-D-00028

**Media Type:** Print

**Pagination:** 138p

**Authors:** Larson, R M  
Applied Pavement Technology, Incorporated  
Smith, K L

Applied Pavement Technology, Incorporated

**Features:** Appendices (1) ; Figures (24) ; References; Tables (18)

**Corporate Authors:** Applied Pavement Technology, Incorporated  
115 W. Main Street  
Suite 400  
Urbana, IL 61801 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20101000

**Edition:** Final Report

**Period Covered:** October 2009 to October 2010

**Index Terms:** Blanket course; Friction; Highway accidents; Highway factors in accidents; Highway safety; Legal aspects; Legal factors; Road safety; Road surfaces; Roughness; Skid resistance; Surface course (Pavements); Surface properties; Surface roughness; Surface texture; Texture; Tort liability; Traffic accidents; Unevenness

**Subject Areas:** Highways; Safety and Human Factors; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

---

**Title:** **A systems approach to the management of skid resistance deficiencies sites on a road network**

**Accession Number:** 01344023

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.saferroads.org.uk/2011papers.asp>

**Source Agency:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Abstract:** This paper describes a systematic approach to the assessment and treatment of sites with insufficient skid resistance as part of a performance specified maintenance contract (PSMC). Typically, the inspection of skid deficient sites is undertaken by experienced roading engineers, who decide what type of action is needed to address skid resistance deficiencies on the network. However, this approach, based on site inspections alone, can lead to significant oversights and errors in the assignment of treatments to skid deficient sites. To address this problem, Transfield Services NZ Ltd developed a systematic approach which synthesises historic skid resistance trends, accident data and pre-scheduled works. Using this integrated approach in conjunction with site inspections, the road inspector can make a more informed and holistic assessment of the site deterioration trends, likelihood of accidents and cost of intervention. The approach outlined in this paper has been implemented on several road networks with significant gains in inspection process efficiency and consistency of assigned interventions. The paper outlines the background to the methodology, putting specific emphasis on the PSMC context and the need for innovation. The key motivators behind the system are described and a detailed description of the methodology, with example applications is presented.

**Supplemental Notes:** Need to request password to view papers online

**TRIS Files:** ITRD, ARRB

**Pagination:** 11p

**Authors:** Foster, G  
Transfield Services NZ  
Parsons, R  
Transfield Services NZ  
Jooste, F  
Juno Services

**Monograph Title:** 3rd International Road Surface Friction Conference, Gold Coast, Queensland, 15-18 May 2011

**Monograph Accession Number:** 01344041

**Publication Date:** 20110500

**Conference:** International Surface Friction Conference, 3rd, 2011  
Location: Gold Coast Queensland, Australia  
Date: 20110515 - 20110518

**Index Terms:** Contracts; Highway maintenance; Maintenance; Maintenance and repair; Maintenance planning; New Zealand; Performance; Planning; Road design and asset management; Road maintenance; Road networks; Roadwork; Site investigation; Skidding resistance

**Subject Areas:** Maintenance and Preservation; Planning and Forecasting; I10: Economics and Administration; I23: Properties of Road Surfaces; I60: Maintenance

---

**Title:** Analytical Modeling of Effects of Rib Tires on Hydroplaning

**Accession Number:** 01090313

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2068-12>

**Abstract:** Hydroplaning is known to be a major cause of wet-weather road accidents. The risk of hydroplaning in wet-weather driving is a function of the depth of surface water, pavement texture properties, and tire characteristics. With the aim to improve and ensure wet-weather driving safety, extensive experimental studies have been conducted by researchers to understand how tire characteristics (in particular, tire tread depth), would affect vehicle hydroplaning risk. Rib tires have been commonly used for such experiments. Relationships derived experimentally by past researchers are available to estimate the effect of rib-tire tread depth on hydroplaning risk. However, such statistical relationships have limitations in their application range and transferability. They also do not provide detailed insights into the mechanism of hydroplaning. These limitations can be overcome through development of a theoretically derived analytical model. This paper presents an analytical simulation study that is based on the theory of hydrodynamics. The method of modeling using finite element techniques is described. Measured data from past experimental studies are used to validate the simulation model. The simulation model is applied to analyze the effect of tire tread depth on hydroplaning for different surface water depths. The effect of tire inflation pressure on the hydroplaning risk of rib tires is also examined. In addition, the effect of different rib tire designs in relation to the number of grooves is studied. This study demonstrates that the proposed model can be a useful analytical tool for evaluating the hydroplaning risk of wet-weather driving.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 109-118

**Authors:** Fwa, T F  
Phone: 65-6516-2276  
Fax: 65-6779-1635  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)  
National University of Singapore

Kumar, Santosh S  
[g0601001@nus.edu.sg](mailto:g0601001@nus.edu.sg)  
National University of Singapore

Ong, Ghim Ping  
Phone: 765-494-2255  
Fax: 765-496-7996  
[ongr@purdue.edu](mailto:ongr@purdue.edu)  
Purdue University

Huang, C J H  
National University of Singapore

**Features:** Figures (8) ; References (21) ; Tables (3)

**Monograph Title:** Pavement Monitoring, Evaluation, and Data Storage; Strength and Deformation Characteristics; and Surface Properties–Vehicle Interaction 2008

**Monograph Accession Number:** 01117265

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://trb.org/news/blurb\\_detail.asp?id=9888](http://trb.org/news/blurb_detail.asp?id=9888)

Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780309113403>

**ISBN:** 9780309113403

**Publication Date:** 20080000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2068  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Blanket course; Finite element analysis; Finite element method; Highway accidents; Hydrodynamics; Hydroplaning; Mathematical models; Road surfaces; Rolling contact; Surface course (Pavements); Surface properties; Surface texture; Texture; Tire pavement interface; Tire treads; Traffic accidents; Tread depth; Treads; Water depth; Wet weather; Wheel rail interaction

**Subject Areas:** Highways; Pavements; I23: Properties of Road Surfaces

---

**Title:** **Modeling and Analysis of Truck Hydroplaning on Highways**

**Accession Number:** 01090299

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2068-11>

**Abstract:** The widely adopted NASA hydroplaning equation has been able to predict closely the hydroplaning speed of passenger cars on a wet pavement. However, field observations and experimental studies have found that the equation cannot explain the hydroplaning behaviors of trucks. According to the NASA equation, trucks hydroplane only at a speed much higher than the normal range of travel speeds on highways. However, this conclusion is not supported by real-world experience and field tests. In addition, field observations and experimental studies have found that lightly loaded trucks are more prone to hydroplaning than heavily loaded ones. This phenomenon cannot be explained by the NASA equation, which states that, regardless of the magnitude of wheel load, hydroplaning speed is the same if tire inflation pressure remains unchanged. To the authors' knowledge, no studies have demonstrated theoretically or analytically why trucks behave differently from passenger cars in their hydroplaning behaviors. Using the technique of three-dimensional finite element modeling, this paper analyzes the problem of truck hydroplaning with an analytical simulation model based on hydrodynamics theory. The formulation of the model is described, and the computed results are validated against past experimental studies. The effects of tire inflation pressure, footprint aspect ratio, and truck wheel load on truck hydroplaning speed are also examined to help explain the different hydroplaning behaviors of trucks and passenger cars.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 99-108

**Authors:** Ong, Ghim Ping  
Phone: 765-494-2255  
Fax: 765-496-7996  
[ongr@purdue.edu](mailto:ongr@purdue.edu)  
Purdue University

Fwa, T F  
Phone: 65-6516-2276  
Fax: 65-6779-1635  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)  
National University of Singapore

**Features:** Figures (9) ; References (23) ; Tables (2)

**Monograph Title:** Pavement Monitoring, Evaluation, and Data Storage; Strength and Deformation Characteristics; and Surface Properties—Vehicle Interaction 2008

**Monograph Accession Number:** 01117265

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://trb.org/news/blurb\\_detail.asp?id=9888](http://trb.org/news/blurb_detail.asp?id=9888)

Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780309113403>

**ISBN:** 9780309113403

**Publication Date:** 20080000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2068  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Aspect ratio; Blanket course; Cargo vehicles; Design of experiments; Experimentation; Experiments; Finite element analysis; Finite element method; Heavy goods vehicles; Hydrodynamics; Hydroplaning; Lorries; Mathematical models; Operating speed; Road freight vehicles; Road surfaces; Rolling contact; Software validation; Surface course (Pavements); Tire pavement interface; Tire pressure; Trucks; Validation; Wet weather; Wheel loads; Wheel rail interaction

**Subject Areas:** Design; Highways; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces

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**Title:** **Modeling Asphalt Pavement Friction and Wet-Pavement Traffic Accidents for Two-Lane Rural Highways**

**Accession Number:** 01054614

**Record Type:** Component

**Language:** English

**Abstract:** Skid Number (SN) data and accident history were obtained for about five hundred rural two-lane highway sections, selected randomly from the United States. The total traffic accidents involved over a three year period were about thirty-six thousand with 20% occurring on wet-pavements. Lack of skid resistance is believed to have contributed to a portion of those vehicle accidents. The contents of both skid number and accident files were studied. The related parameters in the skid file were selected including SN and a group of accident parameters defined. The skid and accident files were merged to develop trends and models relating wet-pavement accidents to SN. Negative correlation exists between SN sub C (skid number corrected for temperature) and A sub WMY (wet-pavement accidents per mile per year) indicating that higher levels of skid resistance lead to lower potential for wet-pavement accidents. Models relating A sub WMY with SN sub c were developed using possible combinations of transformations on both the dependent variable (A sub WMY) and the independent variable (SN sub C). The developed models were found statistically significant but with relatively low coefficient of determination indicating that variables other than SN should be included in the models. Quantifying such relationship makes it possible to develop programs that allow the identification and review of "high risk" sections with inadequate skid resistance or with high potential for wet-pavement accidents.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 175-187

**Authors:** Murad, Maher M  
Phone: 814-269-7219  
Fax: 814-269-7245  
[murad@pitt.edu](mailto:murad@pitt.edu)  
University of Pittsburgh, Johnstown

**Features:** Figures (3) ; References (21) ; Tables (4)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/16762797>

**Publication Date:** 20060100

**Serial:** International Journal of Pavements  
Volume: 5  
Issue Number: 1-2-3  
Publisher: University of Mississippi, University  
ISSN: 1676-2797

**Index Terms:** Asphalt pavements; Friction; Highway accidents; Rural highways; Skid number; Skid resistance; Traffic accidents; Traffic models; Two lane highways; Two lane roads; Wet pavements

**Subject Areas:** Design; Highways; Operations and Traffic Management; Pavements; Safety and Human Factors; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

---

**Title:** **On the Study of Polishing of Road Surface under Traffic Load**

**Accession Number:** 01150769

**Record Type:** Component

**Language:** English

**Record URL:** [http://dx.doi.org/10.1061/\(ASCE\)0733-947X\(2010\)136:1\(45\)](http://dx.doi.org/10.1061/(ASCE)0733-947X(2010)136:1(45))

**Abstract:** This study presents both a laboratory test and a model for simulating the polishing phenomenon of road surfaces when subjected to traffic. In laboratory tests a machine called “Wehner-Schulze machine” is used which performs polishing and friction measurements on road specimens. The tests are done inside the laboratory and try to reproduce the variation of road friction when it is subjected to traffic. On the other hand, the presented model shows the possibility of computing the Wehner-Schulz polishing effect on the microtexture. The model itself uses an approach which mixes the calculation of contact parameters and some characteristic of the used aggregates. The here used aggregate characteristic is the capability to resist wear and is measured by another world wide used device different then the Wehner-Schulz machine. The model remains to be improved because of some assumptions, but this approach provides encouraging results regarding the ability to predict the evolution of road microtexture due to the polishing effect of traffic.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 45-51

**Authors:** Kane, Malal  
[malal.kane@lcpc.fr](mailto:malal.kane@lcpc.fr)  
Laboratoire Central des Ponts et Chaussées

Do, Minh Tan  
Phone: 332 40 84 59 35  
Fax: 332 40 84 57 08  
[minh.tan-do@lcpc.fr](mailto:minh.tan-do@lcpc.fr)  
Laboratoire Central des Ponts et Chaussées, France

Piau, Jean Michel  
[jean.michel.piau@lcpc.fr](mailto:jean.michel.piau@lcpc.fr)  
Laboratoire Central des Ponts et Chaussées

**Features:** Figures (14) ; References; Tables (3)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/oclc/8674831>

**Publication Date:** 20100100

**Serial:** Journal of Transportation Engineering  
Volume: 136  
Issue Number: 1  
Publisher: American Society of Civil Engineers  
ISSN: 0733-947X  
OCLC: 8674831  
Serial URL: <http://ascelibrary.aip.org/teo>

**Index Terms:** Blanket course; Computer simulation; Laboratory tests; Mathematical models; Microtexture; Polishing (Aggregates); Road surfaces; Simulation; Skid resistance; Surface course (Pavements); Traffic loads

**Subject Areas:** Highways; Pavements; I23: Properties of Road Surfaces

---

**Title:** Prediction of Wet-Pavement Skid Resistance and Hydroplaning Potential

**Accession Number:** 01044017

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2005-17>

**Abstract:** The current means of predicting the skid resistance of a wet pavement and the speed at which hydroplaning would occur are based on empirical models or relationships derived from experimental studies. These models and relationships are applicable only for the conditions specified, and extrapolations beyond the applicability range of parameters (e.g., vehicle speed, tire load, tire inflation pressure, water film thickness, and type of tire and pavement surface) are not advisable. Such restrictions could be overcome by developing an analytical model based on theoretical considerations. An analytical model also would provide a more in-depth understanding of the relative influence of different parameters. A three-dimensional finite element model is presented to predict wet-pavement skid resistance and hydroplaning speeds (i.e., wheel speed at which hydroplaning occurs) under different magnitudes of passenger-car wheel load, tire inflation pressure, water film thickness, and vehicle speed. The analysis shows that hydroplaning speed increases (i.e., hydroplaning risk decreases) with wheel load and tire inflation pressure but decreases with the depth of water film thickness. The skid resistance measured in terms of skid number decreases as the sliding-wheel speed or the water film thickness increases but increases with the magnitude of the wheel load and is affected marginally by the tire inflation pressure. Within the normal passenger-car operation range of each of the parameters, the hydroplaning speed is affected most by tire inflation pressure followed by water film thickness and is least influenced by the wheel load; the skid resistance is most influenced by sliding-wheel speed followed by water film thickness and wheel load and is least affected by the tire inflation pressure.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 160-171

**Authors:** Ong, Ghim Ping  
Phone: 765-494-2255  
Fax: 765-496-7996  
[ongr@purdue.edu](mailto:ongr@purdue.edu)  
Purdue University

Fwa, T F  
Phone: 65-6516-2276  
Fax: 65-6779-1635  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)

National University of Singapore

- Features:** Figures (6) ; References (20) ; Tables (5)
- Monograph Title:** Pavement Rehabilitation, Strength and Deformation Characteristics, and Surface Properties–Vehicle Interaction 2007
- Monograph Accession Number:** 01082341
- Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://www.trb.org/news/blurb\\_detail.asp?id=8516](http://www.trb.org/news/blurb_detail.asp?id=8516)
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Order URL: <http://worldcat.org/isbn/9780309104319>
- ISBN:** 9780309104319
- Publication Date:** 20070000
- Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2005  
Publisher: Transportation Research Board  
ISSN: 0361-1981
- Index Terms:** Blanket course; Finite element analysis; Finite element method; Hydroplaning; Mathematical models; Mathematical prediction; Pavement performance; Road surfaces; Rolling contact; Skid resistance; Speed; Surface course (Pavements); Tire pavement interface; Tire pressure; Tire treads; Treads; Wet pavements; Wet weather; Wheel loads; Wheel rail interaction
- Subject Areas:** Data and Information Technology; Design; Highways; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces
- 

**Title:** **RELATING SURFACE TEXTURE OF RIGID PAVEMENT WITH NOISE AND SKID RESISTANCE**

**Accession Number:** 00974243

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://ntl.bts.gov/lib/24000/24600/24638/index.html>

**Abstract:** Although pavements are initially designed to be durable for specified traffic loads, they must also satisfy other functional characteristics, primarily safety, smoothness and comfort (noise generation). Frequently, there are necessary trade-offs for the surface texture of pavements to "improve" certain of these pavement functional characteristics. This study assessed the influence of the depth, width, and shape of transverse tining of portland cement concrete (PCC) pavements on generation of tire/pavement interaction noise. The study also considered various other common PCC pavement surface textures - Astroturf, trowel, and broom finishes - and their influence on noise generation. And lastly the study assessed the influence of pavement texture profile on noise and skid resistance (safety). A mathematical model was developed to determine the stress distribution between the concrete pavement and the tire. The stress distribution was transformed to a power density spectrum to represent the input to the noise generation as the tire rolls over the surface. Noise modeling based on the stress distribution was performed for a set of surfaces and tine geometrics. Full scale testing of a tire on a concrete surface through the use of the SQDH Tire/Pavement Test Apparatus (TPTA) was performed to obtain the noise generated over various concrete surfaces. A laser profilometer was used to obtain the X, Y profile of different textured surfaces. This profile was used as an input for the stress model and used to obtain a transfer function for the noise model. An empirical transfer function was generated to link the computer modeling of the stress with the noise measured from the TPTA testing. Friction testing was performed on the different surfaces and was related to texture depth obtained from the laser profilometer. From the model and testing on the TPTA, the shape of the tine edge did not significantly change the overall noise level or the shape of the spectrum generation. However, the influence of the width of the tine was significant - reducing tine width resulted in a reduction of the overall sound level. Further study is needed to develop pavement surface textures that can provide desirable levels of safety and reduction in noise levels.

**Supplemental Notes:** Additional sponsors: Ford Motor Company; Goodyear Tire and Rubber Company; Continental General Tire, Inc.; Hankook Tire Company; Michelin Americas Research and Development Corporation. This research was supported by a grant from the U.S. Department of Transportation, University Transportation Centers Program.

**TRIS Files:** UTC, NTL, TRIS

**Report Numbers:** SQDH 2004-1,  
Final Report,  
HL 2004-1

**Pagination:** 175 p.

**OCLC:** 55130009

**Authors:** Olek, J  
Weiss, W J  
Garcia-Villarreal, R

**Features:** Appendices (3) ; Figures; References; Tables

**Corporate Authors:** Purdue University  
School of Civil Engineering, 550 Stadium Mall Drive  
West Lafayette, IN 47907 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

Find a library where document is available  
Order URL: <http://worldcat.org/oclc/55130009>

**Publication Date:** 20040100

**Index Terms:** Antiskid treatment; Concrete pavements; Friction tests; Highway noise; Laser profilometer; Mathematical models; Motor vehicle noise; Noise parameters; Pavement grooving; Rigid pavements; Rolling contact; Skid resistance; Sound level; Surface properties; Surface texture; Surface texture tests; Texture; Tines; Tining (Pavements); Tire pavement interface; Traffic noise; Transfer functions; Transverse grooving; Wheel rail interaction

**Subject Areas:** Design; Highways; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces

---

**Title:** **Sensitivity of in-service skid resistance performance of chipseal surfaces to aggregate and texture characteristics**

**Accession Number:** 01026763

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E212905

**Abstract:** A statistical modelling study was undertaken to identify critical aggregate properties from the perspective of in-service skid resistance performance of chipseal surfaces. Emphasis was placed on straight and level road sections to minimise confounding effects brought about by braking, cornering, and traction manoeuvres. The principal finding was that the critical determinants of in-service skid resistance performance of chipseal surfaces were cumulative heavy commercial vehicle (HCV) passes and the mean spacing between tips of aggregates. However, significant inter-relationships between aggregate microtexture and macrotexture were also identified, which require additional investigation given their implication to current seal design practice. The preliminary indications are that the selection of rounded alluvial aggregates for skid resistant surfaces should be predicated on PSV as is current practice whereas selection of angular/sharp-edged hard rock aggregates should be predicated on size (the smaller the better) and ability to withstand tip and edge wear caused by HCV traffic. (a) For the covering entry of this conference, please see ITRD abstract no. E212865.

**TRIS Files:** ITRD

**Pagination:** 23P (SESSION 8)

**Authors:** Cenek, P D  
Opus International Consultants Limited  
JAMIESON, N J  
Opus International Consultants Limited

**Monograph Title:** International Surface Friction Conference: roads and runways: improving safety through assessment and design, 1-4 May 2005, Christchurch, New Zealand

**Monograph Accession Number:** 01026723

**Publication Date:** 20050500

**Serial:** INTERNATIONAL SURFACE FRICTION CONFERENCE, 2005, CHRISTCHURCH, NEW ZEALAND  
Publisher: TRANSIT NEW ZEALAND

**Index Terms:** Aggregate; Aggregates; Angularity; Angularity; Building materials; Chippings; Chippings; Coefficient; Coefficients; Conference; Conferences; Congresses; Construction materials; Engineering properties; Material (constr); Mathematical model; Mathematical models; Polishing; Polishing (Aggregates); Properties; Properties of

materials; Seal coats; Skid resistance; Skidding resistance; Surface; Surface dressing; Surface dressing; Surface finish; Surface properties; Surface texture; Surface texture; Surfaces; Symposia; Texture; Waterproofing course

**Subject Areas:** Geotechnology; Highways; Materials; Pavements; I23: Properties of Road Surfaces; I36: Aggregates

---

**Title:** Skid resistance loss of plastic-grooved concrete roadways

**Accession Number:** 01102780

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E138033

**Abstract:** An adequate level of skid resistance should be maintained during the entire service life of a roadway to provide safe driving conditions. To plan the appropriate timing of surface restoration, it is necessary to predict the change in skid resistance with time. However, no reliable method to predict the change in skid resistance has been suggested yet. In this study, a method to predict the rate of skid resistance loss for a plastic-grooved concrete roadway is suggested. Accelerated road-surface wearing tests were conducted to investigate the general pattern in the rate of skid resistance loss with the repetition of wheel pass. The relationship between skid resistance and the number of wheel passes is nonlinear and can be expressed linearly using a log-log scale. The rates of skid resistance loss to number of wheel passes of plastic-grooved concrete roadway differ section by section. The difference may be caused by the traffic mixture and climatic conditions of each section. Based on the analysis of the multi-year measurements of skid resistance and the potentially related factors obtained from 13 long-term roadway performance sections, a reliable equation to predict the rate of skid resistance loss for a particular plastic-grooved concrete roadway section is suggested. (A)

**TRIS Files:** ITRD

**Pagination:** 65-70

**Authors:** LEE, S W

KANGNUNG NATIONAL UNIVERSITY, REPUBLIC OF KOREA  
CHON, B -  
KANGNUNG NATIONAL UNIVERSITY, REPUBLIC OF KOREA

**Publication Date:** 20080500

**Serial:** TRANSPORT (PROCEEDINGS OF THE ICE)  
Volume: 161  
Issue Number: TR2

**Index Terms:** Concrete; Concrete; Distribution; Distribution (gen); Forecast; Forecasting; Highway; Highways; Maintenance; Maintenance; Maintenance and repair; Mathematical model; Mathematical models; Physical distribution; Projections; Public safety; Safety; Safety; Safety measures; Scenarios; Skid resistance; Skidding resistance; Traffic; Traffic; Traffic management (Physical distribution); Wear; Wear; Weather; Weather

**Subject Areas:** Freight Transportation; Maintenance and Preservation; Operations and Traffic Management; Pavements; Safety and Human Factors; I20: Design and Planning of Transport Infrastructure; I23: Properties of Road Surfaces

---

**Title:** **The effect of skid resistance and texture on crash risk**

**Accession Number:** 01026756

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E212898

**Abstract:** This paper presents the results of a first attempt to combine detailed information on road geometry (horizontal curvature, gradient and cross-fall), road surface condition (roughness, rut depth, texture depth and skid resistance), carriageway characteristics (region, urban/rural environment, and traffic flow) and crashes. Four subsets of road crashes were investigated: all reported injury and fatal crashes; selected injury and fatal crashes covering loss of control events; reported injury and fatal crashes occurring in wet conditions; and selected injury and fatal crashes occurring in wet conditions. One and two-way tables and

Poisson regression modelling were employed to identify critical variables and the form of their relationship with crash risk. Particular emphasis was placed on quantifying the effect of skid resistance and texture depth on crash risk. (a) For the covering entry of this conference, please see ITRD abstract no. E212865.

**TRIS Files:** ITRD

**Pagination:** 17P (SESSION 6)

**Authors:** DAVIES, R B  
Statistics Research Associates

Cenek, P D  
Opus International Consultants Limited

Henderson, R J  
Opus International Consultants Limited

**Monograph Title:** International Surface Friction Conference: roads and runways: improving safety through assessment and design, 1-4 May 2005, Christchurch, New Zealand

**Monograph Accession Number:** 01026723

**Publication Date:** 20050500

**Serial:** INTERNATIONAL SURFACE FRICTION CONFERENCE, 2005, CHRISTCHURCH, NEW ZEALAND  
Publisher: TRANSIT NEW ZEALAND

**Index Terms:** Accident; Accidents; Cause; Causes; Conference; Conferences; Congresses; Engineering properties; Geometric design; Layout; Mathematical model; Mathematical models; Networks; Properties; Properties of materials; Public safety; Risk assessment; Risk assessment; Road network; Road networks; Roads; Safety; Safety; Safety measures; Skid resistance; Skidding resistance; Surface; Surface properties; Surface texture; Surface texture; Surfaces; Symposia; Texture; Vulnerability assessment

**Subject Areas:** Highways; Materials; Pavements; Safety and Human Factors; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

---

**Title:** **THE EVALUATION OF THE EVOLUTION OF ROAD SURFACE FRICTION: A CASE STUDY IN NAPLES' DISTRICT**

**Accession Number:** 00980905  
**Record Type:** Component  
**Language:** English  
**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** IRRD E121588

**Abstract:** Road surface friction, such as all pavement surface characteristics, undergoes to a degradation through time. The prediction of friction progression with time represents a key topic in pavement maintenance since it is important for road managers to know where and when the maintenance intervention is needed in order to restore a satisfactory friction level and, as a result, to guarantee an adequate road safety. For these reasons, it is necessary to quantify how road friction decreases with the increase of time and in which manner it is affected by different factors involved in the degradation phenomenon, among which heavy commercial vehicle traffic flow and spectrum play a critical role. To this purpose, following a brief review of skid resistance degradation models available in literature, a friction deterioration model has been derived from site measurements carried out on a dual carriageway road within the Naples area. Traffic flow and spectrum monitoring, on one hand, and friction (through British Pendulum) and macrotexture (through Sand Patch method) measurements, on the other, have been performed for almost two years on a conventional asphalt concrete wearing course and on an experimental high performance modified asphalt concrete mix. By making use of the differential surface wear occurring in the transversal direction due to the variability of lateral position of vehicular traffic, it has been possible to derive a friction deterioration model for both wearing courses within a reasonably short period of time according to two equivalence damage criteria. Preliminary numerical analysis seems to confirm that a strong relationship exists between friction values and accumulated traffic expressed in terms of equivalent light vehicles for both the bituminous mixes if an equivalence damage criterion based on total tyre footprint area of vehicle is adopted. Furthermore, friction level provided by the high-performance mix appears to be always larger than that provided by the conventional asphalt concrete wearing course. For the covering abstract see ITRD E121480.

**TRIS Files:** ITRD

**Pagination:** p. 1146-60

**Authors:** D'APUZZO, M  
FESTA, B

**Features:** References (16)

**Corporate Authors:** FOUNDATION EURASPHALT  
PO BOX 255  
BREUKELEN 3620 AG

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9080288446>

**ISBN:** 90-802884-4-6

**Publication Date:** 20040000

**Serial:** PROCEEDINGS OF THE 3RD EURASPHALT AND EUROBITUME  
CONGRESS HELD VIENNA, MAY 2004  
Volume: 1  
Publisher: FOUNDATION EURASPHALT

**Index Terms:** Conference; Conferences; Congresses; Evaluation (assessment);  
Evaluation and assessment; Friction; Friction; Italy; Italy; Mathematical  
model; Mathematical models; Pavement; Pavements; Skid resistance;  
Skidding resistance; Surface properties; Surface texture; Surface  
texture; Surveillance; Surveillance; Symposia; Texture; Wear; Wear

**Subject Areas:** Highways; Pavements

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**Title:** **Wet-Pavement Hydroplaning Risk and Skid Resistance: Modeling**

**Accession Number:** 01079522

**Record Type:** Component

**Language:** English

**Record URL:** <http://ascelibrary.aip.org/getabs/serv...000010000590000001&idtype=cvips&gifs=Yes>

**Abstract:** The risk of hydroplaning and reduction of skid resistance are two major safety concerns in wet weathering traffic operations on highways and runways. The writers earlier developed an analytical computer model to simulate the phenomenon of hydroplaning. The simulation of wet-pavement skid resistance is analytically a more complex problem to handle than hydroplaning simulation. The present paper adopts a more elaborate theoretical approach and proposes an

improved analytical computer model to simulate hydroplaning as well as the reduction of wet-pavement skid resistance as the sliding wheel speed increases. The theoretical formulation and development of a three-dimensional finite-element model based on solid mechanics and fluid dynamics is presented. The computed hydroplaning speeds by the proposed model were analyzed and verified against the well-known experimentally derived National Aeronautics and Space Administration (NASA) hydroplaning-speed equation. The analysis confirmed that the NASA equation is a special case of a general solution, and that it is applicable only to a specific range of tire footprint aspect ratios. An analysis of the decreasing trend of wet-pavement skid resistance with vehicle speed and its validation against measured experimental data will be the subject of another paper.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 590-598

**Authors:** Ong, Ghim Ping  
Phone: 765-494-2255  
Fax: 765-496-7996  
[ongr@purdue.edu](mailto:ongr@purdue.edu)  
Purdue University

Fwa, T F  
Phone: 65-6516-2276  
Fax: 65-6779-1635  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)  
National University of Singapore

**Features:** Figures (6) ; References; Tables (4)

**Availability :** Find a library where document is available  
Order URL: <http://worldcat.org/oclc/8674831>

**Publication Date:** 20071000

**Serial:** Journal of Transportation Engineering  
Volume: 133  
Issue Number: 10  
Publisher: American Society of Civil Engineers  
ISSN: 0733-947X  
OCLC: 8674831  
Serial URL: <http://ascelibrary.aip.org/teo>

**Index Terms:** Airport pavements; Airport runways; Computer models; Computer simulation; Finite element analysis; Finite element method; Fluid dynamics; Highway factors

in accidents; Hydroplaning; Runways (Aeronautics); Simulation; Skid resistance; Speed; Wet pavements; Wet weather

**Subject Areas:** Aviation; Design; Highways; Pavements; Safety and Human Factors; Terminals and Facilities; I22: Design of Pavements, Railways and Guideways; I82: Accidents and Transport Infrastructure

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**Title:** Application of Drag Coefficients to ABS Related Sideslip

**Accession Number:** 01088664

**Record Type:** Component

**Language:** English

**Abstract:** Accelerometers currently are the preferred method of determining roadway/tire drag coefficients. Since many vehicles now include antilock brake systems (ABS), questions have been raised about which friction value obtained from an accelerometer is applied to variously equipped vehicles which undergo a yaw motion or other collision-related event. Accelerometers often provide peak and average friction values; and testing can be performed with or without the ABS enabled. Experience and research have identified variables that affect roadway/tire drag coefficients or friction values. This brings into question which of the accelerometer outputs should be applied to an ABS-equipped vehicle involved in a particular action. This study examines the proper application of the accelerometer outputs to ABS-equipped vehicles and the effect of ABS application to a vehicle involved in a yaw or critical speed sideslip. The tests found that the application of an ABS, during the course of critical speed sideslip, does not affect the ability of the investigator to accurately predict vehicle speed through the chord and middle ordinate method. Additionally, the average friction values of conventional skid tests provided by the accelerometer consistently predicted the actual speed during the critical speed yaw. Conversely, the peak friction values, regardless of the status of the ABS, consistently overestimated the speed of the vehicle. These results seem to dispel the idea that ABS-affected yaw requires friction tests to be performed with an ABS activated. The roadway/locked tire interface provides the great accuracy with the least chance of speed overestimation.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 46-51

**Authors:** Dye, David

**Features:** Photos (2) ; References (4) ; Tables (4)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/19348681>

**Publication Date:** 20070000

**Period Covered:** Fall

**Serial:** Collision. The International Compendium for Crash Research  
Volume: 2  
Issue Number: 2  
Publisher: Collision Publishing LLC  
ISSN: 1934-8681

**Index Terms:** ABS; Accelerometers; Accident investigation; Aerodynamic drag; Antilock brake systems; Coefficient of friction; Critical speed analysis; Drag; Estimating; Friction; Friction coefficient; Frictional coefficient; Rolling contact; Side slip angle; Skid resistance tests; Skidding; Speed; Tire pavement interface; Vehicle testing; Vehicle tests; Wheel rail interaction; Yaw

**Subject Areas:** Highways; Safety and Human Factors; Vehicles and Equipment; I80: Accident Studies; I95: Vehicle Inspection

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**Title:** **Environmental effects on Pacejka's scaling factors**

**Accession Number:** 01032694

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E130135

**Abstract:** A set of scaling factors has been introduced by Pacejka [Pacejka, H.B., 2002, Tyre and Vehicle Dynamics (Oxford: Butterworth Heinemann Editions) into his Magic Formula tyre model to take into account the influence of a number of external overall parameters such as road roughness, weather conditions, suspension characteristics and so on. These scaling factors are important for a correct prediction of tyre-road contact forces, but are not a function of the tyre itself. Changing the

point of view, one could say that scaling factors should remain constant for different tyres on the same circuit, with the same weather conditions and with the same car. After characterizing different tyres through indoor tests (that do not consider external overall parameters) and after having identified Pacejka's coefficients with scaling factors equal to one, several outdoor experimental tests have been carried out to assess the influence of vehicle and road surface conditions on scaling factors. These experimental data allowed us to identify, through a minimization approach, the 'best' set of Pacejka's scaling factors for that vehicle and for that tyre on that track. Scaling factors for equal track and vehicle but different tyres were compared to check whether their values remained constant. To assess the validity of scaling factors, a comparison between experimental data, collected on an instrumented passenger car, and MB simulations considering unity and identified scaling factors' values, were carried out. All experimental data shown in this article come from tests carried out within the VERTEC project, a European funded research project (Task 2.a and 2.b) that puts together knowledge coming from vehicle manufacturers (Volvo, Porsche and Centro Ricerche Fiat CRF), tyre manufacturers (Pirelli and Nokian Tyres), control logic manufacturers (Lucas Varity GmbH), road maintenance experts (Centres d'Études Techniques de l'Équipement CETE), transport research organizations (Transport Research Laboratory TRL, Swedish National Road and Transport Research Institute VTI) and universities (Helsinki University of Technology HUT, Politecnico di Milano and University of Florence UNIFI). (A)

**TRIS Files:** ITRD

**Pagination:** 547-568

**Authors:** BRAGHIN, F  
Politecnico di Milano, Italy

Cheli, F  
[federico.cheli@polimi.it](mailto:federico.cheli@polimi.it)  
Politecnico di Milano, Italy

Sabbioni, E  
Politecnico di Milano, Italy

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/00423114>

**Publication Date:** 20060700

**Serial:** Vehicle System Dynamics  
Volume: 44  
Issue Number: 7

Publisher: Taylor & Francis  
ISSN: 0042-3114  
EISSN: 1744-5159

**Index Terms:** Computer simulation; Contact (tyre road); Force; Force; Forecast; Forecasting; Friction; Friction; Inside; Inside; Mathematical model; Mathematical models; Outside; Outside; Projections; Rolling contact; Rubber tires; Scale; Scales; Scenarios; Simulation; Simulation; Test; Tests; Tire pavement interface; Tires; Tyre; Tyres; Weather; Weather; Weighing devices; Wheel rail interaction

**Subject Areas:** Vehicles and Equipment; I90: Vehicles; I91: Vehicle Design and Safety

---

**Title:** GPS Based Real-Time Tire-Road Friction Coefficient Identification

**Accession Number:** 01013330

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.lrrb.org/pdf/200504.pdf>

**Abstract:** This project concentrates on the development of real-time tire-road friction coefficient estimation systems for snowplows that can reliably estimate different road surface friction levels and quickly detect abrupt changes in friction coefficient. Two types of systems are developed - a vehicle-based system and a wheel-based system. The vehicle-based friction measurement system utilizes vehicle motion measurements from differential global positioning system (GPS) and other on-board vehicle sensors. The wheel-based friction measurement system utilizes a redundant wheel that is mounted at a small angle to the longitudinal axis of the vehicle. Complete technical details on the vehicle-based friction measurement system are presented in this report. Compared to previously published results in literature, the advantage of the vehicle-based system developed here is that it is applicable during both vehicle acceleration and braking and works reliably for a wide range of slip ratios, including high slip conditions. The system can be used on front/rear-wheel drive as well as all-wheel drive vehicles. Extensive results are presented from experimental results conducted on various surfaces with a winter maintenance vehicle called the Safeplow. The experimental results show that the system performs reliably and quickly in estimating friction coefficient on different road surfaces during various vehicle maneuvers.

**TRIS Files:** TRIS

**Report Numbers:** MN/RC-2004-04

**Contract Numbers:** (c)81655 (wo)27

**Media Type:** Web

**Pagination:** 92p

**Authors:** Wang, Junmin  
Alexander, Lee  
Rajamani, Rajesh

**Features:** Figures; References; Tables (1)

**Corporate Authors:** University of Minnesota, Twin Cities  
Department of Mechanical Engineering, 111 Church Street, SE  
Minneapolis, MN 55455 USA  
  
Minnesota Department of Transportation  
  
Office of Research Services, 395 John Ireland Boulevard  
St Paul, MN 55155 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20040900

**Edition:** Final Report

**Index Terms:** Blanket course; Coefficient of friction; Design of experiments; Estimating; Experimentation; Experiments; Friction coefficient; Friction tests; Frictional coefficient; Global Positioning System; GPS; Primary detectors; Real time data processing; Road surfaces; Rolling contact; Sensors; Slip ratio; Snow ploughs; Snow plows; Snowplows; Surface course (Pavements); Test vehicles; Tire pavement interface; Wheel rail interaction; Wheels

**Subject Areas:** Highways; Maintenance and Preservation; Pavements; Vehicles and Equipment; I23: Properties of Road Surfaces; I61: Equipment and Maintenance Methods

---

**Title:** **MODEL-BASED ROAD FRICTION ESTIMATION**

**Accession Number:** 00975757

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** IRRD E120839

**Abstract:** The tire/road friction coefficient has a significant role in vehicle longitudinal and lateral control, and there has been associated efforts to measure or estimate the road surface condition to provide additional information for stability augmentation systems of automobiles. In this paper, a model based road friction estimation algorithm is proposed from easily measured signals such as yaw rate and wheel speed. For the development of the estimator, a low order vehicle model incorporated with simple but effective tire model. Field tests of the estimator using actual vehicle measurements show promising results. (A)

**TRIS Files:** ITRD

**Pagination:** p. 249-76

**Authors:** SHIM, T  
Margolis, D

**Features:** References (19)

**Corporate Authors:** Swets & Zeitlinger  
P.O. Box 825  
2160 SZ Lisse Netherlands

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/00423114>

**Publication Date:** 20040400

**Serial:** Vehicle System Dynamics  
Volume: 41  
Issue Number: 4  
Publisher: Taylor & Francis  
ISSN: 0042-3114  
EISSN: 1744-5159

**Index Terms:** Calculation; Calculation; Contact (tyre road); Dimension; Dimensions; Estimating; Estimation theory; Forecast; Friction; Friction; Method; Methodologies; Methodology; Rolling contact; Size; Stability; Stability (Mechanics); Surface; Surfaces; Tire pavement interface; Vehicle; Vehicles; Wheel rail interaction; Yaw; Yaw; Yawing (veh)

**Subject Areas:** Vehicles and Equipment

---

**Title:** **An Optimal Pole-matching Observer Design for Estimating Tyre-road Friction Force**

**Accession Number:** 01206895

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.informaworld.com/10.1080/00423110903362594>

**Abstract:** In this paper, considering the dynamical model of tyre-road contacts, the authors design a nonlinear observer for the on-line estimation of tyre-road friction force using the average lumped LuGre model without any simplification. The design is the extension of a previously offered observer to allow a much more realistic estimation by considering the effect of the rolling resistance and a term related to the relative velocity in the observer. The aim is not to introduce a new friction model, but to present a more accurate nonlinear observer for the assumed model. The authors derive linear matrix equality conditions to obtain an observer gain with minimum pole mismatch for the desired observer error dynamic system. The authors prove the convergence of the observer for the non-simplified model. Finally, the authors compare the performance of the proposed observer with that of the previously mentioned nonlinear observer, which shows significant improvement in the accuracy of estimation.

**Supplemental Notes:** Abstract reprinted with permission from Taylor & Francis.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 1155-1166

**Authors:** Faraji, Mohammad  
Tarbiat Modares University  
Majd, Vahid Johari  
Tarbiat Modares University  
Saghafi, Behrooz  
[b.saghafi@2007.ljmu.ac.uk](mailto:b.saghafi@2007.ljmu.ac.uk)  
Tarbiat Modares University  
Sojoodi, Mahdi

Tarbiat Modares University

**Features:** Figures (4) ; References (16) ; Tables (2)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/00423114>

**Publication Date:** 20100000

**Serial:** Vehicle System Dynamics  
Volume: 48  
Issue Number: 10  
Publisher: Taylor & Francis  
ISSN: 0042-3114  
EISSN: 1744-5159

**Index Terms:** ABS; Antilock brake systems; Antiskid brakes; Friction; Friction brakes; Nonlinear systems; Rolling contact; Rolling friction; Tire pavement interface; Traffic estimation; Trip estimation; Wheel rail interaction

**Subject Areas:** Highways; Vehicles and Equipment

---

**Title:** **Use of an Extended Kalman Filter as a Robust Tyre Force Estimator**

**Accession Number:** 01046824

**Record Type:** Component

**Language:** English

**Abstract:** Control systems designed to optimize vehicle performance, such as antilock braking systems or traction control systems, depend upon a knowledge of the amount of available grip at the tyre-road contact point. There have been both qualitative and quantitative approaches to identify the road surface coefficient. This work proposes a method of estimating the longitudinal and lateral grips for use within a control system. The estimation method is explained and the vehicle model equations used are stated. The estimator is then tested using logged data from a test vehicle, and the force estimates are validated against results from strain-gauged wheel rims. Finally, the direction of future work is described.

**Supplemental Notes:** Abstract reprinted with permission from Taylor and Francis.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 50-59

**Authors:** Wilkin, M A  
[mwilkin@hondracingfl.com](mailto:mwilkin@hondracingfl.com)  
Manning, W J  
Manchester Metropolitan University  
Crolla, D A  
University of Leeds  
Levesley, M C  
University of Leeds

**Features:** Figures (11) ; References (13)

**Monograph Title:** Proceedings of the 19th Symposium of the International Association for Vehicle System Dynamics

**Monograph Accession Number:** 01046775

**Corporate Authors:** Taylor & Francis Limited  
Reading Bridge House  
Reading, Berkshire United Kingdom

**Editors:** S Bruni  
G Mastinu

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780415436168>

**ISBN:** 9780415436168

**Publication Date:** 20060000

**Conference:** 19th Symposium of the International Association for Vehicle System Dynamics  
Location: Milan , Italy  
Date: 20050828 - 20050902  
Sponsors: Politecnico di Milano, Italy

**Serial:** Vehicle System Dynamics  
Volume: 44  
Issue Number: Supplement  
Publisher: Taylor & Francis  
ISSN: 0042-3114  
EISSN: 1744-5159

**Index Terms:** Automated transportation systems; Automated vehicle control; Automatic navigation systems; Automatic transportation systems; Coefficient of friction; Equations; Estimating; Friction coefficient; Frictional coefficient; Grip strength; Kalman filtering; Robust; Rolling contact; Tire forces; Tire pavement interface; Vehicle control; Vehicle guidance; Wheel rail interaction

**Subject Areas:** Highways; Vehicles and Equipment

---

**Title:** **Vehicle and Road State Estimation Using Interacting Multiple Model Approach**

**Accession Number:** 01046777

**Record Type:** Component

**Language:** English

**Abstract:** This article describes the estimation algorithm of the vehicle state and the road condition, which is formulated on the basis of the interacting multiple model algorithm. Ten system modes of tire are modeled (considered nonlinearity) according to the road friction. Ten system modes are provided for switching from one mode to another in a probabilistic manner. The mode probabilities and states of vehicle are estimated based on extended Kalman filter (EKF). This algorithm is evaluated in the simulation study. Simulation results show that the algorithm is effective in the state estimation of vehicle and road surface.

**Supplemental Notes:** Abstract reprinted with permission from Taylor and Francis.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 750-758

**Authors:** Tsunashima, H  
[tsuna@cit.nihon-u.ac.jp](mailto:tsuna@cit.nihon-u.ac.jp)  
Nihon University, Japan

Murakami, M  
Nohmi Basai Limited

Miyata, J  
Nihon University, Japan

**Features:** Figures (5) ; References (3) ; Tables (1)

**Monograph Title:** Proceedings of the 19th Symposium of the International Association for Vehicle System Dynamics

**Monograph Accession Number:** 01046775

**Corporate Authors:** Taylor & Francis Limited  
Reading Bridge House  
Reading, Berkshire United Kingdom

**Editors:** S Bruni  
G Mastinu

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**Conference:** 19th Symposium of the International Association for Vehicle System Dynamics  
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**Serial:** Vehicle System Dynamics  
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**Index Terms:** Algorithms; Computer simulation; Estimation theory; Friction; Highways; Kalman filtering; Models; Rolling contact; Side slip angle; Simulation; Tire pavement interface; Vehicles; Wheel rail interaction

**Subject Areas:** Data and Information Technology; Highways; Vehicles and Equipment

---

**Title:** Estimation of Contact Forces and Road Profile Using High-Order Sliding Modes

**Accession Number:** 01226675

**Record Type:** Component

**Language:** English

**Abstract:** The authors propose an algorithm to estimate tire contact forces (e.g., functions of wheel slip, slip angles) and the road profile, based on a second-order sliding mode (i.e., High-Order Sliding Modes). Sliding modes are observed through a vehicle model the authors develop, which makes use of a sensor-equipped vehicle. Different sensors are employed as the vehicle performs in several trials. The authors' proposed observation method, which is an enhancement of a previously proposed method, is shown to be both effective and robust.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 23-38

**Authors:** Rabhi, A  
[abdelhamid.rabhi@u-picardie.fr](mailto:abdelhamid.rabhi@u-picardie.fr)  
University of Picardie Jules Verne

M'Sirdi, N K  
[nacer.msirdi@Isis.org](mailto:nacer.msirdi@Isis.org)  
University of Paul Cezanne

Naamane, A  
[aziz.naamane@polytech.univ-mrs.fr](mailto:aziz.naamane@polytech.univ-mrs.fr)  
University of Paul Cezanne

Jaballah, B  
[belgacem.jaballah@Isis.org](mailto:belgacem.jaballah@Isis.org)  
University of Paul Cezanne

**Features:** Appendices (1) ; Bibliography; Figures (8) ; Illustrations (2) ; Photos (2) ; References

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/oclc/50135871>

**Publication Date:** 20100000

**Serial:** International Journal of Vehicle Autonomous Systems  
Volume: 8  
Issue Number: 1  
Publisher: Inderscience Enterprises Limited  
ISSN: 1471-0226  
OCLC: 50135871

**Index Terms:** Algorithms; Automotive sensors; Blanket course; Estimation theory; In vehicle sensors; Observational method; Road profile; Road surfaces; Road tests; Rolling contact; Sliding friction; Surface course

(Pavements); Tire forces; Tire pavement interface; Vehicle model; Vehicle testing; Vehicle tests; Wheel rail interaction; Wheel slip

**Subject Areas:** Highways; Pavements; Vehicles and Equipment; I23: Properties of Road Surfaces; I90: Vehicles

---

**Title:** **EVALUATION OF INVESTIGATIONS INTO THE APPLICATION OF THE IFI (INTERNATIONAL FRICTION INDEX)**

**Translated Title:** EVALUATION DES RECHERCHES SUR L'APPLICATION DE L'INDICE DE FROTTEMENT (IFI)

**Accession Number:** 00961503

**Record Type:** Component

**Language:** English

**Abstract:** The paper discusses the organization by the PIARC Committee on Surface Characteristics of an international experiment to compare and harmonize skid resistance and texture measurements. Specifically, the goal was to harmonize the many different pavement friction measurement methods used in different countries. The paper describes several studies conducted in several European countries. These studies are reviewed: Belgium: a prenormative research for European normalization; France: use of two different devices to assess the skid resistance of the wearing course; Denmark, Germany and the Netherlands: a joint experiment comparing the results of different skid resistance devices; Hungary: the use of IFI for a probabilistic pavement performance modeling framework; Mexico: a comparative analysis between the British Pendulum and the Mu Meter.

**Supplemental Notes:** Both English and French versions of the paper are provided.

**TRIS Files:** TRIS

**Pagination:** p. 35-51

**Authors:** Bennis, T A  
de Wit, L B

**Features:** Figures (4) ; References (9)

**Corporate Authors:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

**Availability:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

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Order URL: <http://worldcat.org/oclc/31984593>

**Publication Date:** 20030400

**Serial:** Routes/Roads  
Issue Number: 318  
Publisher: World Road Association - PIARC  
ISSN: 0004-556X  
OCLC: 31984593  
Serial URL: <http://www.piarc.org/en/publications/routes-roads/>

**Index Terms:** Blanket course; Friction; Pavement maintenance; Performance; Road surfaces; Skid resistance; Surface course (Pavements)

**Subject Areas:** Construction; Highways; Pavements

---

**Title:** **Evaluation of pavement temperature on skid frictional of asphalt concrete surface**

**Accession Number:** 01328446

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.informaworld.com/10.1080/10298436.2010.501864>

**Abstract:** This paper presents the investigation of the effect of pavement surface temperature on the frictional properties of the pavement-tyre interface. Many skid tests were carried out on different wearing surfaces and under different climatic conditions using both ribbed and smooth tyres over 15 months. The pavement and air temperatures were obtained in each test using thermocouples located directly under the wearing course and close to the pavement surface, respectively. Regression analyses were carried out to determine the effect of pavement temperature on the measured skid number at different speeds, along with friction model parameters. The main conclusion of this investigation demonstrates that the pavement temperature has a significant effect on pavement frictional measurements and on the sensitivity of the measurements to the test speed. Both the skid number at zero speed (SN0) and the per cent normalised gradient tend to decrease with increased pavement temperature. At low speed, pavement friction tends to decrease with increased pavement temperature, and at high speed, the effect is

reverted and pavement friction tends to increase with increasing pavement temperature. Temperature-dependent friction vs. speed models were developed for one of the mixes studied. These models could be used to define temperature correction factors.

- Supplemental Notes:** Abstract reprinted with permission from Taylor and Francis.
- TRIS Files:** TRIS
- Media Type:** Print
- Pagination:** pp 47-58
- Authors:** Jahromi, Saeed Ghaffarpour  
[saeed\\_ghf@srttu.edu](mailto:saeed_ghf@srttu.edu)  
Shahid Rajaei Teacher Training University
- Mortazavi, S Mohammad Reza  
Shahid Rajaei Teacher Training University
- Voussough, Shahram  
Shahid Rajaei Teacher Training University
- Yingjian, Luo  
Virginia Polytechnic Institute and State University, Blacksburg
- Features:** Bibliography; Figures (7) ; Tables (15)
- Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/oclc/44544515>
- Publication Date:** 20110000
- Serial:** International Journal of Pavement Engineering  
Volume: 12  
Issue Number: 1  
Publisher: Taylor & Francis Limited  
ISSN: 1029-8436  
OCLC: 44544515  
Serial URL: <http://www.tandf.co.uk/journals/titles/10298436.html>
- Index Terms:** Asphalt concrete pavements; Asphaltic concrete pavements; Blanket course; Friction; Regression; Regression analysis; Ribbed tires; Road surfaces; Rolling contact; Skid resistance; Smooth tires; Surface course (Pavements); Temperature; Tire pavement interface; Wheel rail interaction
- Subject Areas:** Highways; Materials; Pavements
-

**Title:** Online Estimation of Friction Coefficients of Winter Road Surfaces Using the Unscented Kalman Filter

**Accession Number:** 01046308

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2015-13>

**Abstract:** An innovation to a previously proposed method for estimating friction coefficients of winter road surfaces was achieved through the introduction of a relatively new algorithm, the unscented Kalman filter. Its use, instead of a generic algorithm, made estimating friction coefficients in real time possible while keeping the core vehicular motion model unchanged. The problem of estimating such coefficients was too complicated to apply conventional feedback techniques, such as an extended Kalman filter, because of the presence of not only a nonlinear algebra equation but also a set of multiple differential equations. The unscented Kalman filter did not require any explicit function of state and observation equations in deriving Kalman gain. This paper describes the usefulness of this new filter in solving the problem and describes numerical experiments that validated the effectiveness of the proposed new method in terms of computational efficiencies. The friction coefficients estimated with the new technique were in fairly good accordance with those measured in the field.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 113-122

**Authors:** Nakatsuji, Takashi  
[naka@eng.hokudai.ac.jp](mailto:naka@eng.hokudai.ac.jp)  
Hokkaido University

Hayashi, Ikuko  
[ikuko.hayashi.xc@hitachi.com](mailto:ikuko.hayashi.xc@hitachi.com)  
Hitachi, Limited

Ranjitkar, Prakash  
[pranjitkar@yahoo.com](mailto:pranjitkar@yahoo.com)  
Hokkaido University

Shirakawa, Tatsuo  
[shirakaw@mail.kitami-it.ac.jp](mailto:shirakaw@mail.kitami-it.ac.jp)  
Kitami Institute of Technology

Kawamura, Akira  
[kawamura@vortex.civil.kitami-it.ac.jp](mailto:kawamura@vortex.civil.kitami-it.ac.jp)  
Kitami Institute of Technology

**Features:** Appendices (1) ; Figures (8) ; References (15) ; Tables (1)

**Monograph Title:** Maintenance Operations: Work Zones, Pavement Markings, and Weather

**Monograph Accession Number:** 01084471

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://www.trb.org/news/blurb\\_detail.asp?id=8632](http://www.trb.org/news/blurb_detail.asp?id=8632)

Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780309104418>

**ISBN:** 9780309104418

**Publication Date:** 20070000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2015  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Algorithms; Blanket course; Coefficient of friction; Computational efficiency; Estimating; Friction coefficient; Frictional coefficient; Kalman filtering; Road surfaces; Surface course (Pavements); Winter maintenance

**Subject Areas:** Highways; Maintenance and Preservation; I62: Winter Maintenance

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**Title:** Precision Estimates of AASHTO T 242

**Accession Number:** 01141656

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_w142.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w142.pdf)

**Abstract:** This report presents results of the study to prepare precision estimates for AASHTO T 242, "Frictional Properties of Paved Surfaces Using a

Full-Scale Tire.” The data used in this study were provided by Texas Transportation Institute (TTI) and Transportation Research Center (TRC) from evaluation of state friction measurement systems that have been calibrated at their field test centers. Two sets of data were analyzed from each test center: “Initial” or “Arrival” and “Final” or “Departure“. The Initial set was collected by state systems as they arrived to each center for calibration. The Final set was collected after adjustments were made to the state systems to put them into compliance with AASHTO T 242. The variability of the friction measurements were examined for both Initial and Final systems to evaluate the effect of calibration on variability of the measurements. Only the Final State System data were used to determine the precision estimates for measuring frictional properties of paved surfaces. A draft precision statement for AASHTO T 242 is proposed and included in this report.

<b>TRIS Files:</b>	TRIS
<b>Report Numbers:</b>	NCHRP Project 09-26A
<b>Media Type:</b>	Web
<b>Pagination:</b>	91p
<b>Authors:</b>	Azari, Haleh Phone: 301-975-2112 <a href="mailto:hazari@amrl.net">hazari@amrl.net</a> National Institute of Standards and Technology
	Lutz, Robert National Institute of Standards and Technology
<b>Features:</b>	Appendices (5) ; Figures; References (9) ; Tables
<b>Publication Date:</b>	20090700
<b>Edition:</b>	Contractor Final Report
<b>Serial:</b>	NCHRP Web Document Issue Number: 142 Publisher: Transportation Research Board
<b>Index Terms:</b>	AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing; AASHTO T 242; Blanket course; Calibrating; Calibration; Friction; Measurement; Measuring; Pavements; Precision; Road surfaces; Surface course (Pavements)
<b>Subject Areas:</b>	Highways; Materials; Pavements; I23: Properties of Road Surfaces

---

**Title:** **PREDICTION OF ROAD SURFACE FRICTION COEFFICIENT USING ONLY MACRO- AND MICROTEXTURE MEASUREMENTS**

**Accession Number:** 00987596

**Record Type:** Component

**Language:** English

**Abstract:** This paper explains the prediction of road surface friction coefficient from macro- and microtexture parameters. Road sections on the Belgian road network with different road surface characteristics are chosen for friction, macrotexture, and microtexture measurements on the Belgian road network for analysis. This study comprises field testing and laboratory testing. In the first step of the field testing, the speed versus friction coefficient relation is established using the side force method. In the second step, macrotexture measurements are made by a laser profilometer. The last step of the field testing covers to take core samples for microtexture measurements. The laboratory testing consists of the establishment of a new microtexture measurement method called the new image analysis system. Finally, after statistically analyzing both measurements, a new model is founded to predict road surface friction coefficients from only macro- and microtexture at all speeds. Results show that at any speed there are strong effects from both macro- and microtexture on road surface frictions.

**TRIS Files:** TRIS

**Pagination:** p. 311-319

**Authors:** Ergun, M  
Iyinar, S  
Iyinar, A F

**Features:** Figures (6) ; References (14) ; Tables (5)

**Corporate Authors:** American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, VA 20191-4400 USA

**Availability:** American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, VA 20191-4400 USA

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Order URL: <http://worldcat.org/oclc/8674831>

**Publication Date:** 20050400

**Serial:** Journal of Transportation Engineering  
Volume: 131  
Issue Number: 4  
Publisher: American Society of Civil Engineers  
ISSN: 0733-947X  
OCLC: 8674831  
Serial URL: <http://ascelibrary.aip.org/teo>

**Index Terms:** Belgium; Blanket course; Coefficient of friction; Friction coefficient; Frictional coefficient; Highway safety; Macrotexture; Mathematical prediction; Microtexture; Pavements; Road safety; Road surfaces; Speed; Surface course (Pavements); Surface texture tests

**Subject Areas:** Data and Information Technology; Highways; Pavements; I23: Properties of Road Surfaces

---

**Title:** **SKID RESISTANCE PREDICTION BY COMPUTER SIMULATION**

**Accession Number:** 00986124

**Record Type:** Component

**Language:** English

**Abstract:** The British pendulum tester is widely used for the measurement of friction characteristics of pavement surfaces. To better understand the complex interaction between the tester and test surface, finite element simulation is applied in this paper to perform detailed analyses of rubber-pavement contact. It offers a useful tool to analyze the test behavior of the British pendulum tester. A three-dimensional finite element model is used to determine not only the skid resistance value of a test surface, but also other contact information which cannot be easily measured experimentally. The findings suggest that the skid resistance measurement of a pavement material can be determined without having to physically perform the British pendulum test. Experimental tests were carried out to verify the results obtained from the model.

**TRIS Files:** TRIS

**Pagination:** p. 465-469

**Authors:** Lee, YPK  
Yurong, L  
Ying, L  
Fwa, T F  
Phone: 65-6516-2276

Fax: 65-6779-1635  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)  
National University of Singapore

Choo, Y S  
National University of Singapore

**Features:** Figures (2) ; References (5) ; Tables (2)

**Corporate Authors:** American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, VA 20191-4400 USA

**Editors:** K C Sinha  
T F Fwa  
Phone: 65-6516-2276  
Fax: 65-6779-1635  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)  
National University of Singapore

R L Cheu  
D-h Lee

**Availability:** American Society of Civil Engineers  
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Reston, VA 20191-4400 USA

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**ISBN:** 0784407304

**Publication Date:** 20040000

**Conference:** Applications of Advanced Technologies in Transportation Engineering.  
Eighth International Conference  
Location: Beijing, China  
Date: 20040526 - 20040528  
Sponsors: China Academy of Transportation Engineers; American Society of Civil Engineers; China Highway and Transportation Society; China Navigation Institute; Transportation Research Board; Tsinghua University, China

**Index Terms:** Blanket course; Computer simulation; Computers; Electronic computers; Finite element analysis; Finite element method; Friction; Hardware (Computers); Pavements; Pendulum tests; Road surfaces; Rubber; Rubber tires; Simulation; Skid resistance; Surface course (Pavements); Tires; Tyres

**Subject Areas:** Design; Highways; Pavements; Vehicles and Equipment; I22: Design of Pavements, Railways and Guideways

---

**Title:** **Transverse Pavement Grooving against Hydroplaning. I: Simulation Model**

**Accession Number:** 01026163

**Record Type:** Component

**Language:** English

**Abstract:** Hydroplaning on a pavement surface with a film of water occurs when a vehicle reaches a critical speed and results in a loss of contact between its tires and the pavement surface. Pavement groovings, especially transverse pavement groovings, have been used in practice to reduce the occurrences of hydroplaning. This paper presents the development of a three-dimensional finite-volume model to simulate the hydroplaning phenomenon on pavements with and without transverse groovings. The theoretical considerations involved in the flow simulation model are described. The flow simulation makes use of fluid dynamics theories, utilizing the continuity equation, the Navier–Stokes equations, and the standard k-epsilon turbulence model to model hydroplaning. The simulation results for the case of a smooth plane pavement surface are found to be in good agreement with experimental results in the literature and the well-known National Aeronautics and Space Administration (NASA) hydroplaning equation. The tire pressure-hydroplaning speed relationship predicted by the model is found to match very well with the empirical NASA hydroplaning equation. The model is applied to analyze pavement surfaces with three different transverse pavement groovings and verified against experimental results reported in the literature. The analysis also highlights the effectiveness of transverse pavement grooving in delaying hydroplaning occurrence (i.e., raising the speed at which hydroplaning occurs) and improving braking control during incipient hydroplaning. The analytical design of transverse pavement grooving to reduce the risk of hydroplaning is found in a companion paper.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 441-448

**Authors:** Ong, Ghim Ping  
[g0306013@nus.edu.sg](mailto:g0306013@nus.edu.sg)

National University of Singapore

Fwa, T F

Phone: 65-6516-2276

Fax: 65-6779-1635

[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)

National University of Singapore

- Features:** Figures (9) ; References; Tables (3)
- Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/oclc/8674831>
- Publication Date:** 20060600
- Serial:** Journal of Transportation Engineering  
Volume: 132  
Issue Number: 6  
Publisher: American Society of Civil Engineers  
ISSN: 0733-947X  
OCLC: 8674831  
Serial URL: <http://ascelibrary.aip.org/teo>
- Index Terms:** Antiskid treatment; Blanket course; Computer models; Computer simulation; Equations; Flow; Fluid dynamics; Hydroplaning; Pavement grooving; Pavements; Road surfaces; Rolling contact; Simulation; Surface course (Pavements); Three dimensional models; Tining (Pavements); Tire pavement interface; Tire pressure; Transverse grooving; Wheel rail interaction
- Subject Areas:** Design; Highways; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces
- 

- Title:** **SKID RESISTANCE - MEASUREMENT AND INTERPRETATION**
- Accession Number:** 00944723
- Record Type:** Monograph
- Language:** English
- Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom
- Source Data:** IRRD E117822

**Abstract:** Microtexture and macrotexture are identified as the two important properties of the pavement surface for the determination of skidding resistance. Both types of texture are controlled through the specification of materials. However microtexture is polished away by passing traffic, necessitating surveillance of the road surface. Measurement principles such as friction coefficients, skid resistance, comparison of results and the development of the European Friction Index are outlined. The portable skid resistance tester, SCRIM (Sideway force Coefficient Routine Investigation Machine), the Grip Tester and high-speed devices are described. The function of skid resistance standards is to provide a framework for targeting the provision of high skid resistance within a road network. Accident risk and skid resistance are discussed in relation to wet roads. Default investigatory levels for trunk roads are tabulated. Site specific risk assessment, accident data, UK skid resistance policies, and the possibility of litigation (including the erection of slippery road warning signs) are outlined.

**TRIS Files:** ITRD

**Pagination:** 20 p.

**Authors:** Viner, H

**Features:** References (13)

**Corporate Authors:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Publication Date:** 20020000

**Index Terms:** Accident; Accidents; Apparatus; Conference; Conferences; Congresses; Devices; Equipment; Equipment; Government policy; Highway signs; Legislation; Legislation; Legislative support; Maintenance; Maintenance; Maintenance and repair; Measurement; Measurement; Measuring; Policies; Policy; Policy; Regulatory policy; Risk assessment; Risk assessment; Skid resistance; Skidding resistance; Specification (standard); Standards; Statistics; Statistics; Surfacing; Surfacing; Symposia; Traffic sign; Traffic signs; United kingdom; United Kingdom; Vulnerability assessment; Warning; Warning systems

**Subject Areas:** Data and Information Technology; Law; Maintenance and Preservation; Policy; Safety and Human Factors

---

**Title:**

**An Original Evaluation of the  
Wearing Course Macrotexture  
Evolution using the Abbot**

<b>Accession Number:</b>	<b>Curve</b> 01144847
<b>Record Type:</b>	Component
<b>Language:</b>	English
<b>Abstract:</b>	<p>The wearing course is the top surface layer of the road. The road surface has multiple functions with the main one being traffic safety, which is conditioned by skid resistance. This skid resistance is conditioned by pavement texture. This paper presents an experimental procedure allowing to evaluate surface macrotexture evolution of an asphalt concrete specimen by laboratory testing. Specimen surface changes through the application of a sinusoidal repeated load at high temperature. The studied surface is scanned before and after mechanical testing using a laser profiler. Texture maps are analyzed using Abbott curve which is also called bearing ratio curve. The 3-D analysis enables to quantify macrotexture evolution under repeated traffic conditions and to analyze the influence of both temperature and binder.</p>
<b>TRIS Files:</b>	TRIS
<b>Media Type:</b>	Print
<b>Pagination:</b>	pp 471-494
<b>Authors:</b>	Ech, Mohsen EUROVIA Morel, Stephane CNRS-INRA Yotte, Sylvie

Universite Bordeaux 1  
Breysse, Denys  
Universite Bordeaux 1  
Pouteau, Bertrand  
EUROVIA

**Features:** Figures; Photos; References;  
Tables (4)

**Availability:** Find a library where document is  
available  
Order URL:  
<http://worldcat.org/issn/14680629>

**Publication Date:** 20090000

**Serial:** Road Materials and Pavement  
Design  
Volume: 10  
Issue Number: 3  
Publisher: Hermes Science  
Publications  
ISSN: 1468-0629

**Index Terms:** Asphalt concrete; Asphalt  
concrete pavements; Asphaltic  
concrete; Asphaltic concrete  
pavements; Bituminous concrete;  
Pavement layers; Skid resistance;  
Surface properties; Surface  
texture; Texture; Wearing course  
(Pavements)

**Subject Areas:** Highways; Pavements; I22:  
Design of Pavements, Railways  
and Guideways

---

**Title:** **Evaluation of Traffic and Environment Effects on Skid Resistance and Safety Performance of Rubberized Open-grade Asphalt Concrete**

**Accession Number:** 01163252

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.path.berkeley.edu/PATH/Publications/PDF/PRR/2010/PRR-2010-14.pdf>

**Source Agency:** UC Berkeley Transportation Library

**Source Data:** Caltrans 1811

**Abstract:** For most Departments of Transportation (DOTs) in the nation, excluding California, pavements for which the skid number (SN40) is below 30 are deemed unacceptable and corrective actions are required. The main objectives of this study are to evaluate and analyze skid test results from the test data inventory, and to identify and analyze before-and-after collision data at sites where three experimental types of pavements (Open Graded Asphalt Concrete, Groove Pavement, and Rubberized Open Graded Asphalt Concrete) have been implemented. Study results suggest that a significant relationship exists between SN40 and seasonal effects such as temperature, average monthly precipitation, and the number of dry months prior last precipitation. A significant relationship also exists in high-risk locations where average daily traffic is higher, and in the more heavily used shoulder lanes. If highway agencies wish to prioritize pavement improvements using SN40, SN40 must be standardized. The model developed in this study can provide the needed adjustment factors. In addition, while further research is needed, results suggest that new pavement types such as OGAC can improve safety performance of roadways.

**TRIS Files:** CALTRANS, TRIS

**Report Numbers:** UCB-ITS-PRR-2010-14

**Contract Numbers:** Task Order 6218

**Media Type:** Print

**Pagination:** 36p

**OCLC:** 643135301

**Authors:** Oh, Soon Mi  
University of California, Berkeley  
Ragland, David R  
Phone: 510-642-0655  
Fax: 510-643-9922  
[davidr@berkeley.edu](mailto:davidr@berkeley.edu)  
University of California, Berkeley  
Chan, Ching-Yao  
Phone: 510-665-3621  
Fax: 510-665-3757  
[cychan@path.berkeley.edu](mailto:cychan@path.berkeley.edu)

University of California, Berkeley

**Features:** Figures (12) ; References (14) ; Tables (12)

**Corporate Authors:** University of California, Berkeley  
Berkeley, CA 94720-1720 USA  
University of California, Berkeley  
California PATH Program, Institute of Transportation Studies  
Richmond Field Station, 1357 South 46th Street  
Richmond, CA 94804-4648 USA  
California Department of Transportation  
1120 N Street  
Sacramento, CA 95814 USA  
University of California, Berkeley  
Traffic Safety Center, 2614 Dwight Way  
Berkeley, CA 94720-7374 USA

**Availability:** Available from UC Berkeley Transportation Library through interlibrary loan or document delivery  
Order URL: <http://library.its.berkeley.edu>  
Find a library where document is available  
Order URL: <http://worldcat.org/oclc/643135301>

**Publication Date:** 20100400

**Edition:** Final Report

**Serial:** PATH Research Report  
Publisher: University of California, Berkeley  
ISSN: 1055-1425

**Index Terms:** Accident black spots; Accident prone locations; Asphalt concrete pavements; Asphalt rubber; Asphaltic concrete pavements; ASTM E-274; California; Friction course; High accident locations; Hotspot; Open graded aggregates; Rubberized asphalt; Skid resistance tests; Standards; Wet weather

**Subject Areas:** Highways; Pavements; Safety and Human Factors

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**Title:** **A quantitative model of road-surface safety**

**Accession Number:** 01344032

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.saferroads.org.uk/2011papers.asp>

**Source Agency:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Abstract:** Safe operation of vehicles is affected by natural factors, human factors, and traffic loads. A reduction in the quality of the road surface leads to a decrease in the safe following distance and stability on curves and causes accidents such as rear-end collisions and skids. In addition to the surfacing type, road alignment, and operating speed, traffic safety is also related to the pavement roughness, texture, and skid resistance as well as other road surface conditions. Eight road surface skid-resistance evaluation parameters, including the maximum longitudinal and transverse friction coefficients, the allowable longitudinal friction coefficient fTA, the allowable transverse friction coefficient fSA, the expected longitudinal friction coefficient fTR, the expected transverse friction coefficient fSR, and the longitudinal and transverse critical values of road surface safety condition, were used to establish a quantitative model of road-surface safety. A case study and road-surface model showed that the critical values of road surface safety condition of test sections of a road in China was 13.2, indicating that the minimum technical standard for the friction coefficient of bituminous penetration-type pavement is lower in China than in other countries and is one of the critical factors in skidding accidents.

**Supplemental Notes:** Need to request password to view papers online

**TRIS Files:** ITRD, ARRB

**Pagination:** 13p

**Authors:** Hu, J  
Beijing University of Technology

**Monograph Title:** 3rd International Road Surface Friction Conference, Gold Coast, Queensland, 15-18 May 2011

**Monograph Accession Number:** 01344041

**Publication Date:** 20110500

**Conference:** International Surface Friction Conference, 3rd, 2011  
Location: Gold Coast Queensland, Australia  
Date: 20110515 - 20110518

**Index Terms:** Behavior; Behaviour; Case study; China; Design standards; Drivers; Harmonisation; Harmonization; Highway safety; Human behavior; Motor vehicle operators; Public safety; Road networks; Road safety; Safe systems (road users); Safe systems (roads); Safety; Safety measures; Skidding resistance; Standardisation; Standardization; Uniformity; Vehicle spacing

**Subject Areas:** Safety and Human Factors; I23: Properties of Road Surfaces

---

**Title:** **Review of High-Friction Surface Technologies -- Constructability and Field Performance**

**Accession Number:** 01152386

**Record Type:** Component

**Language:** English

**Order URL:** <http://pubsindex.trb.org/orderform.html>

**Source Data:** Transportation Research Board Annual Meeting 2010 Paper #10-2072

**Abstract:** Even though the relationship between roadway safety and pavement friction has long been recognized, lack of sufficient friction at the tire-pavement interaction is still a significant contributing factor to vehicle crashes. To reduce skid-related crashes and the related fatalities on highways, optimum levels of pavement friction must be maintained under all weather conditions. Specially designed high-friction surfaces (HFS) are being more commonly considered for areas where demand for friction is high because these surfaces provide superior pavement friction without negatively affecting other surface characteristics such as noise or durability. The objectives of this paper are to review some of the high-friction surfaces available in the United States market, and contrast the performance (friction and macrotexture) of different applications in various locations. Six products used in the U.S. are contrasted in terms of performance and durability. Typical friction and texture values for the various products are presented.

**TRIS Files:** TRIS, TRB

**Report Numbers:** 10-2072

**Media Type:** DVD

**Pagination:** 16p

**Authors:** Flintsch, Gerardo W  
Phone: 540-231-9748  
Fax: 540-231-7532  
[GFlintsch@vtti.vt.edu](mailto:GFlintsch@vtti.vt.edu); [flintsch@vt.edu](mailto:flintsch@vt.edu)  
Virginia Polytechnic Institute and State University, Blacksburg  
de Leon Izeppi, Edgar  
Phone: 540-231-1504  
Fax: 540-231-1555  
[EdeLeonIzeppi@vtti.vt.edu](mailto:EdeLeonIzeppi@vtti.vt.edu)  
Virginia Polytechnic Institute and State University, Blacksburg  
McGhee, Kevin Kenneth  
Phone: 434-293-1956  
Fax: 434-293-1990  
[Kevin.McGhee@VirginiaDOT.org](mailto:Kevin.McGhee@VirginiaDOT.org);  
[Kevin.McGhee@VDOT.Virginia.gov](mailto:Kevin.McGhee@VDOT.Virginia.gov)  
Virginia Transportation Research Council  
Roa, Julio Alberto  
[julioroa@vt.edu](mailto:julioroa@vt.edu)  
Virginia Polytechnic Institute and State University, Blacksburg

**Features:** Figures; Photos; References (17) ; Tables (3)

**Monograph Title:** TRB 89th Annual Meeting Compendium of Papers DVD

**Monograph Accession Number:** 01147878

**Corporate Authors:** Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Publication Date:** 20100000

**Conference:** Transportation Research Board 89th Annual Meeting  
Location: Washington DC  
Date: 20100110 - 20100114  
Sponsors: Transportation Research Board

**Index Terms:** Adverse conditions; Blanket course; Death; Fatal accidents; Fatalities; Friction course; Highway accidents; Highway safety; Pavement

management; Pavement management systems; Road safety; Road surfaces; Rolling contact; Surface course (Pavements); Tire pavement interface; Traffic accidents; Traffic fatalities; Weather conditions; Wheel rail interaction

**Subject Areas:** Highways; Pavements; Safety and Human Factors; I82: Accidents and Transport Infrastructure

---

**Title:** Relationship Between Highway Pavement Condition, Crash Frequency, and Crash Type

**Accession Number:** 01148433

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.informaworld.com/10.1080/19439960903391395>

**Abstract:** Research has been conducted to relate highway pavement conditions with vehicle accidents. Utilizing the Tennessee Pavement Management System (PMS) and Accident History Database (AHD), this study developed 20 negative binomial regression models to examine the relationships between pavement condition parameters, crash frequency, and crash types. The modeling results indicated that either Present Serviceability Index (PSI) or International Roughness Index (IRI) was a significant pavement condition parameter for predicting the crash frequency of highway segment; whereas, the Rut Depth (RD) was not statistically significant in the crash prediction models. Due to the collinearity between PSI and IRI, it was found that when the two parameters were applied together into the crash regression models, the statistical regression results could not be well explained. Comparing to the IRI and RD models, the models' goodness-of-fit results indicated that PSI models had the best performance consistently in predicting the frequency for each type of crashes. Additionally, regression results indicated that either right shoulder width or left clearance to median up to 8 feet wide would significantly reduce the crash frequency.

**Supplemental Notes:** Abstract reprinted with permission from Taylor & Francis.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp. 268-281

**Authors:** Chan, Chun Yip  
Huang, Baoshan

[bhuang@utk.edu](mailto:bhuang@utk.edu)

University of Tennessee, Knoxville

Yan, Xuedong

Richards, Stephen

**Features:** References; Tables (9)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/19439962>

**Publication Date:** 20090000

**Serial:** Journal of Transportation Safety & Security  
Volume: 1  
Issue Number: 4  
Publisher: Taylor & Francis  
ISSN: 1943-9962  
EISSN: 1943-9970

**Index Terms:** Accident proneness; Crash frequency; Highway safety; International Roughness Index; Pavement management; Pavement management systems; Pipeline condition; Road safety; Roughness; Ruts (Pavements); Surface roughness; Tennessee; Unevenness; Wheeltracks

**Subject Areas:** Highways; Pavements; Safety and Human Factors; I82: Accidents and Transport Infrastructure

---

**Title:** **Roadway Factors Associated with Motorcycle Crashes**

**Accession Number:** 01342782

**Record Type:** Component

**Language:** English

**Abstract:** Increases in registered motorcycles and related crashes and fatalities were observed in recent years in the Commonwealth of Puerto Rico, as it was the case for the United States and several European countries. Although road crashes are strongly dependent on human behavior, the effects of the roadway design, condition, and environment cannot be just ignored, particularly for motorcycles crashes. The risk of crash and the potential for higher severity once a crash happens is certainly higher for motorcycles than for other types of motor vehicles. This paper focuses on the evaluation of road information and motorcycle crash data to identify roadway design elements that are significantly associated with motorcycle crashes. The study performed a road inspection process of 39 road segments and employed the use of correlation, ANOVA, and multiple regression analyses. In addition, a

survey of motorcycle riders was performed to identify their perception about the relation between the roadway condition and motorcycle safety. The study results indicate that the main roadway elements associated with motorcycle crash rates are the cross-section type and width, the intersection density, the posted speed limit, the presence of on street parking, pavement defects, and residential developments. These roadway elements and conditions can be targeted on new road construction and roadway improvement projects, in which motorcycles are considered in the road design. Establishing effective road maintenance practices that focus on these particular roadway elements can alleviate the problem of motorcycle crashes.

**TRIS Files:** TRIS

**Media Type:** Web

**Pagination:** n.p.

**Authors:** Medina, Alberto M Figueroa  
Purdue University  
Soto, Juan C Torrens

**Monograph Title:** Moving Toward Zero. 2011 ITE Technical Conference and Exhibit

**Monograph Accession Number:** 01342755

**Corporate Authors:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

**Availability:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

**Publication Date:** 20110000

**Conference:** Moving Toward Zero. 2011 ITE Technical Conference and Exhibit  
Location: Lake Buena Vista FL  
Date: 20110403 - 20110406  
Sponsors: Institute of Transportation Engineers

**Index Terms:** Accident risk forecasting; Analysis of variance; Death; Fatal accidents; Fatalities; Highway accidents; Highway design; Highway maintenance; Human factors in accidents; Motorcycle accidents; Motorcycle driving; Puerto Rico; Regression; Regression analysis; Road conditions; Road design; Road maintenance; Roadwork; Traffic accidents; Traffic fatalities; Variance analysis

**Subject Areas:** Highways; Safety and Human Factors; I80: Accident Studies; I82:

**Title:** Economic appraisal and optimization process in road safety projects

**Accession Number:** 01207998

**Record Type:** Component

**Language:** English

**Source Agency:** Swedish National Road and Transport Research Institute (VTI)  
Olaus Magnus vaeg 35  
Linkoeping SE-581 95 Sweden

**Source Data:** VTI 2010.0160

**Abstract:** Setting a procedure to assess the efficiency in provision of the funds and operational expenses in road safety projects requires to establish a process involving the economic appraisal and optimization tasks. In the optimization process developed in the paper, five types of geometric features may be considered in the analysis including: (1) lane width and pavement condition, (2) horizontal curves, (3) vertical curves, (4) roadside condition, and (5) narrow bridges. The model enables the users to evaluate a variety of improvement alternatives for each predetermined geometric feature along the route under study, following which all possible mutually exclusive proposals are achieved for each site. Both calculating the executive costs and estimating the monetary benefits according to the reduction of road accidents for each proposal are the main components in estimating the net benefit attributable to each mutually exclusive proposal. Afterwards, an optimization process using linear integer programming is fed by the outputs of the cost-benefit analysis to find out the highest net benefit (as an efficiency criteria) among all provided proposals for all sites under study.

**TRIS Files:** ITRD, VTI

**Pagination:** s 1208-1216

**Authors:** Behnood, Hamid R  
Roozikhah, Hossein  
Khatami, Sina

**Publication Date:** 20100000

**Serial:** Road safety on four continents: 15th international conference, Abu Dhabi, United Arab Emirates, 28-30 March 2010. Paper

**Index Terms:** Accident black spots; Accident prevention; Accident prone locations; Benefit cost analysis; Calculation; Conferences; Congresses; Cost benefit analysis; Economic efficiency; Geometric design; High accident locations; Hotspot; Mathematical models; Optimisation; Optimization; Rural road; Symposia

**Subject Areas:** Economics

---

**Title:** Skid resistance performance profiles

**Accession Number:** 01344011

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.saferroads.org.uk/2011papers.asp>

**Source Agency:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Abstract:** Managing skid resistance is an essential part of Queensland Department of Transport and Main Roads (TMR) responsibilities to ensure traffic safety. TMR released its skid resistance management plan as a central strategy for managing skid resistance. In managing skid resistance on Queensland state-controlled road networks, a Road Analyser and Recorder device had been used in monitoring skid resistance. TMR endeavours to provide proactive approaches in managing skid resistance. However, it is extremely difficult to predict skid resistance deterioration rates in future so that skid resistance treatments could be planned ahead. With the availability of skid resistance data at the network level, TMR wishes to make use of these data to find ways to predict skid resistance performance in future. A cooperative research project was established between TMR and the Australian Asphalt Pavement Association (AAPA) to analyse these skid resistance data and to develop skid resistance performance profiles (i.e. skid resistance deterioration rates) for its road network. Skid resistance data collected between 2004 and 2007 were used in the analysis. This paper presents a proposed methodology employed in developing skid resistance performance profiles.

**Supplemental Notes:** Need to request password to view papers online

**TRIS Files:** ITRD, ARRB

**Pagination:** 13p

**Authors:** Piyatrapoomi, N  
Queensland Department of Transport and Main Roads  
WELIGAMAGE, J  
Queensland Department of Transport and Main Roads  
Vos, R  
Australian Asphalt Pavement Association (AAPA)

**Monograph Title:** 3rd International Road Surface Friction Conference, Gold Coast, Queensland, 15-18 May 2011

**Monograph Accession Number:** 01344041

**Publication Date:** 20110500

**Conference:** International Surface Friction Conference, 3rd, 2011  
Location: Gold Coast Queensland, Australia  
Date: 20110515 - 20110518

**Index Terms:** Australia; Data analysis; Deterioration; Highway design; Properties; Queensland; Road design; Road design and asset management; Road networks; Road surface properties; Safe systems (roads); Skidding resistance; Surfaces

**Subject Areas:** Design; Highways; I10: Economics and Administration; I23: Properties of Road Surfaces

---

**Title:** **The future of skid resistance?**

**Accession Number:** 01344034

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.saferroads.org.uk/2011papers.asp>

**Source Agency:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Abstract:** This paper explores the possible role of skid resistance in the not-too-distant future when roads carry a rather different mix of vehicles from that using them today. Three factors are likely to reduce the demand for skid resistance. Reductions in excessive speeds are likely to be achieved through developments such as increased enforcement in conjunction with intelligent speed adaptation. Reductions in the

demand for unexpected braking are likely to be achieved through road design changes and advisory technologies at intersections, and by in-vehicle systems to warn of impending collisions. Intelligent braking systems (an extension of anti-lock braking systems) will eliminate skidding, reduce stopping distance and allow steering while braking. The effectiveness of all these technologies is likely to be enhanced by vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communications which inform other vehicles in the vicinity when warning messages or avoiding action is being initiated. These developments suggest that skid resistance may become less critical in providing a safe road system in the future. However, increasing community expectations for safety as reflected in the wide adoption of Safe System principles or their equivalent will not allow skid resistance to be traded off against improved vehicle braking performance. Increased travel by powered two-wheelers in response to increasing oil prices is likely to present new challenges in maintaining adequate skid resistance and in eliminating major inconsistencies in skid resistance. Skid resistance is likely to remain a key element in the provision of a safe road system into the future, although priorities for the detailed manner in which it is provided may change.

<b>Supplemental Notes:</b>	Need to request password to view papers online
<b>TRIS Files:</b>	ITRD, ARRB
<b>Pagination:</b>	8p
<b>Authors:</b>	Cairney, P ARRB Group Limited
<b>Monograph Title:</b>	3rd International Road Surface Friction Conference, Gold Coast, Queensland, 15-18 May 2011
<b>Monograph Accession Number:</b>	01344041
<b>Publication Date:</b>	20110500
<b>Conference:</b>	International Surface Friction Conference, 3rd, 2011 Location: Gold Coast Queensland, Australia Date: 20110515 - 20110518
<b>Index Terms:</b>	Braking; Government policy; Highway safety; Modal shift; Policies; Policy; Priority; PRIORITY (GEN); Public safety; Regulatory policy; Road networks; Road safety; Safe systems (roads); Safety; Safety measures; Skidding; Skidding resistance
<b>Subject Areas:</b>	Policy; Safety and Human Factors; I10: Economics and Administration; I23: Properties of Road Surfaces

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**Title:** TYROSAFE: tyre and road surface optimisation for skid resistance and further effects

**Accession Number:** 01344022

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.saferroads.org.uk/2011papers.asp>

**Source Agency:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Abstract:** The project TYROSAFE (Tyre and Road Surface Optimisation for Skid Resistance and Further Effects) was a coordinated action funded by the European Community's seventh framework program (FP7, 2007 - 2013). The main objectives of the project were to raise awareness, in order to coordinate and prepare for European harmonisation of skid resistance policies and to optimise the assessment and management of essential tyre/road interaction parameters, within the broader context of increasing safety and reducing the impact of European road transport. To achieve this, the project focused on tyres, the road surface, and the interaction between the two, because only an optimised interaction can deliver road safety benefits and simultaneously ensure the most positive greening effect through reduction of CO2 output and noise emissions. The project provided a synopsis of the current status of scientific understanding in these areas, the application of this knowledge in national and European standards, and existing skid resistance measurement policies, methods, and parameters. This allowed future research requirements to be identified, and a proposal made with regards to the future objectives of European road administrations in order to optimise three key properties: skid resistance, rolling resistance and tyre/road noise emission.

**Supplemental Notes:** Need to request password to view papers online

**TRIS Files:** ITRD, ARRB

**Pagination:** 14p

**Authors:** Scharnigg, K  
BAST  
Schwalbe, G  
BAST

Haider, M  
Austrian Institute of Technology

**Monograph Title:** 3rd International Road Surface Friction Conference, Gold Coast, Queensland, 15-18 May 2011

**Monograph Accession Number:** 01344041

**Publication Date:** 20110500

**Conference:** International Surface Friction Conference, 3rd, 2011  
Location: Gold Coast Queensland, Australia  
Date: 20110515 - 20110518

**Index Terms:** Carbon dioxide; Europe; Highway safety; Noise; Noise pollution; Properties; Public safety; Road design and asset management; Road networks; Road safety; Road surface properties; Rubber tires; Safe systems (roads); Safety; Safety measures; Skidding resistance; Surfacing; Tires; Tyres

**Subject Areas:** Safety and Human Factors; I15: Environment; I23: Properties of Road Surfaces

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**Title:** **Influence of Roadway Surface Discontinuities on Safety: State of the Art Report**

**Accession Number:** 01131595

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://onlinepubs.trb.org/onlinepubs/circulars/ec134.pdf>

**Abstract:** This circular is an update to a 1983 report of the same title. Issues addressed in this updated state-of-the-art report on the impact of pavement surface discontinuities on safety include hydroplaning, holes and bumps, edge conditions, and the positive effects of road surface discontinuities such as rumble strips and speed bumps.

**TRIS Files:** TRIS, TRB

**Media Type:** Web

**Pagination:** 88p

**Features:** Figures; Photos; References; Tables

**Availability:** Find a library where document is available

Order URL: <http://worldcat.org/issn/00978515>

**Publication Date:** 20090500

**Serial:** Transportation Research E-Circular  
Issue Number: E-C134  
Publisher: Transportation Research Board  
ISSN: 0097-8515

**Index Terms:** Blanket course; Chuckholes; Dropoffs (Pavements); Highway safety; Hydroplaning; Literature reviews; Literature surveys; Pavement edge; Potholes (Pavements); Road humps (Artificial); Road safety; Road surfaces; Roughness; Rumble strips; Ruts (Pavements); Speed bumps; Speed control humps; State of the art reports; Surface course (Pavements); Surface course irregularities; Surface roughness; Unevenness; Wheeltracks

**Subject Areas:** Design; Highways; Pavements; Safety and Human Factors; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

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**Title:** **Pavement Surface Condition/Performance Assessment: Reliability and Relevancy of Procedures and Technologies**

**Accession Number:** 01138996

**Record Type:** Monograph

**Language:** English

**Abstract:** This publication contains papers presented at the Symposium of the same title which was held in Washington, DC, on 7-8 December, 2004. The Symposium was sponsored by ASTM Committee E17 on Vehicle – Pavement Systems. This new ASTM publication presents the latest information on the practical and developmental aspects of pavement surface evaluation procedures and technologies, including their reliability and relevancy. Pavement distress assessment and friction characteristics measurements have become important tools in the performance evaluation and management of roadway systems. They are being used to identify potentially hazardous conditions, monitor the surface characteristics of the various in-service pavements, and assess the need for rehabilitation and maintenance. This need to quantify pavement surface condition has resulted in a number of techniques and equipment. Also, advances in testing, sensor and inertial navigation technologies have enhanced the functionality of pavement evaluation equipment, allowing highway engineers and practitioners to capitalize on the large amount of information offered by the state of the art

equipment. However, with the ever evolving technologies and increasing needs for faster, more accurate and harmonized pavement performance monitoring technique/ procedures, and data interpretation, more venues for sharing, documenting, and disseminating information are needed.

<b>TRIS Files:</b>	TRIS
<b>Report Numbers:</b>	STP 1486
<b>Media Type:</b>	Print
<b>Pagination:</b>	80p
<b>Features:</b>	Figures; Photos; References; Tables
<b>Corporate Authors:</b>	American Society for Testing and Materials 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken, PA 19428-2957 USA
<b>Editors:</b>	Bouzid Choubane
<b>Availability:</b>	American Society for Testing and Materials 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken, PA 19428-2957 USA Find a library where document is available Order URL: <a href="http://worldcat.org/isbn/9780803155213">http://worldcat.org/isbn/9780803155213</a>
<b>ISBN:</b>	9780803155213
<b>Publication Date:</b>	20070000
<b>Conference:</b>	Symposium on Pavement Surface Condition/Performance Assessment: Reliability and Relevancy of Procedures and Technologies Location: Washington DC Date: 20041207 - 20041208 Sponsors: American Society for Testing and Materials
<b>Index Terms:</b>	Advanced technology; Blanket course; Condition surveys; Friction; Inspection equipment; Pavement distress; Pavement maintenance; Pavement performance; Performance monitoring; Road surfaces; State of the art; Surface course (Pavements); Technological innovations
<b>Subject Areas:</b>	Highways; Maintenance and Preservation; Pavements; I23: Properties of Road Surfaces

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**Title:** Road Pavements Design and Traffic Safety - Evaluation of

## **Relationships Between Accident Risk and Functional Properties of Road Pavements**

- Accession Number:** 01129992
- Record Type:** Component
- Language:** English
- Abstract:** Nowadays, the functional properties of road pavements have gained additional significance due to a large supply of new materials and technologies. Ride comfort and safety are the two main goals of functional pavement design. Unfortunately, common pavement design methods only take into account the bearing capacity and an important gain of knowledge is still needed concerning pavement surface properties and its relationship with traffic safety. Since last year, it is being developed a PhD programme at Technical University of Lisbon which main objective is to provide an important contribution to the improvement of the quality of the road network so as to reduce accident severity on Portuguese roads by developing an innovative design methodology of road pavements, considering its functional performance. The paper content is based on the first task of this research work which consists on finding relationships between accident risk and functional properties of asphalt pavements, traffic flow and speed, road layout and weather conditions. For that, a selected group of roads of the Portuguese network have been studied, in order to make available skid resistance, texture and road accident data segregated by site category (bends, approaches to junctions, high gradients). These results and conclusions will be useful for future research, first to model traffic performance behaviours for each wearing course techniques and finally to support a new methodology for the design of functional pavement wearing courses based on traffic safety criteria.
- TRIS Files:** TRIS
- Media Type:** Print
- Pagination:** pp 397-402
- Authors:** das Neves, Jose Manuel Coelho  
[neves@civil.ist.utl.pt](mailto:neves@civil.ist.utl.pt)  
Technical University of Lisbon  
Fernandes, Ana Isabel Capote  
[acapote@civil.ist.utl.pt](mailto:acapote@civil.ist.utl.pt)  
Technical University of Lisbon
- Features:** References
- Monograph Title:** International Conference on Maintenance and Rehabilitation of

Pavements and Technological Control (MAIREPAV5), Fifth Proceedings

**Monograph Accession Number:**

01129995

**Corporate Authors:**

University of Iowa, Iowa City  
Department of Civil and Environmental Engineering  
Iowa City, IA 52242 USA

**Editors:**

Hosin Lee  
Phone: 319-335-6818  
Fax: 319-335-6801  
[hlee@engineering.uiowa.edu](mailto:hlee@engineering.uiowa.edu)  
University of Iowa, Iowa City  
M Asghar Bhatti  
[mabhatti@uiowa.edu](mailto:mabhatti@uiowa.edu)  
University of Iowa, Iowa City

**Availability:**

University of Iowa, Iowa City  
Department of Civil and Environmental Engineering  
Iowa City, IA 52242 USA  
Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780874141597>

**ISBN:**

9780874141597

**Publication Date:**

20070000

**Conference:**

Fifth International Conference on Maintenance and Rehabilitation of Pavements and Technological Control (MAIREPAV5)  
Location: Park City UT  
Date: 20070808 - 20070810  
Sponsors: University of Iowa, Iowa City; Federal Highway Administration; American Society of Civil Engineers; Transportation Research Board

**Index Terms:**

Accident risk forecasting; Asphalt pavements; Bends (Roads); Highway curves; Highway safety; Pavement design; Portugal; Road curves; Road safety; Skid resistance; Surface properties; Surface texture; Texture; Traffic flow; Traffic safety; Traffic speed; Weather

**Subject Areas:**

Design; Highways; Pavements; Safety and Human Factors; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

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**Title:** Slippery when dry? Low dry friction and binder-rich road surfaces

**Accession Number:** 01026745

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E212887

**Abstract:** This paper describes the history of the bituplaning phenomenon, documents its occurrence in the literature and briefly describes the development of one standard procedure to alert the road user to the inherent risk. Bituplaning has previously been documented twice in the United Kingdom, first in 1986 then in 2001. The first case of bituplaning related to a "traditional" hot-rolled-asphalt (HRA) surface, reinforcing the belief that any surface course aggregate coated with excess binder could exhibit the bituplaning effect. A number of experiments to measure the temperatures generated at the tyre/road interface of a locked wheel on a dry road surface are also described, along with comments concerning features of negative textured road surfaces, which may influence road user behaviour to increase accident rates on these new surfaces. Various strategies for signing new surfaces are in operation in the UK. A standard, based on detailed research, is already in place to monitor and warn road users of the manifestation of the bituplaning phenomenon on new porous asphalt surfaces in the Netherlands. (a) For the covering entry of this conference, please see ITRD abstract no. E212865.

**TRIS Files:** ITRD

**Pagination:** 19P (SESSION 4)

**Authors:** Bullas, J C  
[johnb@soton.ac.uk](mailto:johnb@soton.ac.uk)  
University of Southampton

**Monograph Title:** International Surface Friction Conference: roads and runways: improving safety through assessment and design, 1-4 May 2005, Christchurch, New Zealand

**Monograph Accession Number:** 01026723

**Publication Date:** 20050500

**Serial:** INTERNATIONAL SURFACE FRICTION CONFERENCE, 2005,  
CHRISTCHURCH, NEW ZEALAND  
Publisher: TRANSIT NEW ZEALAND

**Index Terms:** Asphalt; Binder; Binders; Braking; Braking; Conference; Conferences;  
Congresses; Dryness; Dryness; Engineering properties; Friction;  
Friction; Highway; Highway signs; Pavement; Pavements; Porous  
asphalt; Porous materials; Properties; Properties of materials; Roads;  
Rubber tires; Skid resistance; Skidding resistance; Surface; Surfaces;  
Symposia; Tires; Traffic sign; Traffic signs; Tyre; Tyres; Vehicle;  
Vehicles; Warning; Warning systems

**Subject Areas:** Highways; Materials; Operations and Traffic Management; Pavements;  
Vehicles and Equipment; I23: Properties of Road Surfaces; I73: Traffic  
Control

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**Title:** **Evaluation of ODOT Roadway/Weather Sensor Systems for Snow  
& Ice Removal Operations - Part V: Vehicular Speed Associated  
with Winter Pavement Conditions**

**Accession Number:** 01044278

**Record Type:** Monograph

**Language:** English

**Abstract:** The major objective of the study was to develop a procedure to determine the level of service using the Road Weather Information System (RWIS) speed measurements. The procedure developed can be used by Ohio Department of Transportation (ODOT) to evaluate winter maintenance activities and for winter maintenance decision making. Average traffic speeds for five minute intervals were measured using NuMetrics road sensors and they were related to the pavement and driving conditions. In addition speed data from two other studies was used. The pavement conditions were determined by conducting surveys at rest area buildings using a questionnaire form. It was found that the average traffic speeds were significantly lower during a major snow event even when periodic plowing and salting was done. The average speeds decreased almost linearly for the period of the snow storm reached the minimum and then climbed back slowly towards higher speeds. The speeds appear to be a fairly sensitive measure to judge the condition of the pavement. The motorist judgments about the pavement condition and their perception of the safety of driving decreases during a rather severe winter storm which is mirrored in the speed decrease. It appears from the survey that about two thirds of the motorists judge the deterioration of the road conditions and the inadequate level of road

maintenance during a winter storm as bad or moderately bad. The responses obtained for the car and the truck drivers are fairly close to each other indicating that both groups can judge bad road condition equally well. The observed road conditions appear to influence the drivers in terms of how they subjectively feel about the level of safety and stress experienced during driving in the winter storm. A simple procedure was developed for winter maintenance management to determine the condition of the road (freeways) based on the average speeds observed by the RWIS sensors. If the average winter speed of the traffic is equal or greater than the historical established wet/salted pavement speed, the level of service is considered adequate. According to the Swiss study, the wet/salted surface winter speeds are about 85% of the dry surface speeds for freeways and 96% for city streets. If the average winter speed is below the wet/salted surface speed, the level of service is considered inadequate. Any speed less than 50% of the wet/salted surface speed indicates fairly bad road conditions and an extremely inadequate level of service. It should be noted that the winter pavement conditions can be highly dynamic. Depending on the rate of accumulation of snow, frequency of the snow plowing, length of the snow plow route, the pavement condition can improve and deteriorate a number of times during a winter storm. The level of service can get worse even with maximum snow plowing and salting effort in a situation with a high rate of snow accumulation. The winter speeds observed as a percentage of the average dry surface speed can be correlated with the level of service. A relatively more fine graduation of the level of service as a function of the percentage of the average dry surface speed is proposed in the recommendations of the report.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/OH-2006/22

**Contract Numbers:** 147580

**Media Type:** Print

**Pagination:** 184p

**Authors:** Zwahlen, Helmut T  
Ohio University, Athens

Oner, Erdinc  
Phone: 740-597-1790  
Fax: 740  
[eo189602@ohio.edu](mailto:eo189602@ohio.edu)  
Ohio University, Athens

Suravaram, Kiran  
Phone: 740-597-1790

Fax: 740-593-0625  
[ks146905@ohio.edu](mailto:ks146905@ohio.edu)  
Ohio University, Athens

**Features:** Appendices (4) ; Figures (112) ; Maps (2) ; Photos (24) ; References (7) ; Tables (100)

**Corporate Authors:** Ohio University, Athens  
Ohio Research Institute for Transportation and the Environment  
141 Stocker Engineering and Technology Center  
Athens, OH 45701-2979 USA

Ohio Department of Transportation  
1980 West Broad Street  
Columbus, OH 43223 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20061000

**Edition:** Final Report

**Index Terms:** Chemical deicing agents; Deicing chemicals; Deicing salt; Driving conditions; Highway safety; Level of service; Pavement conditions; Pavements; Primary detectors; Road safety; Road weather information systems; RWIS; Sensors; Snow melters; Snow ploughs; Snow plows; Snowplows; Snowstorms; Speed measurement; Surveys; Traffic; Traffic speed; Winter maintenance

**Subject Areas:** Highways; Maintenance and Preservation; Operations and Traffic Management; Pavements; Vehicles and Equipment; I62: Winter Maintenance

---

**Title:** Experimental evaluation of fog warning system

**Accession Number:** 01080920

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.1016/j.aap.2005.05.007>

**Record URL:** <http://www.sciencedirect.com/science/a...D2V-1/2/17739185c50283980bd9a704e467a89e>

**Abstract:** Highway safety is a major concern to the public and to transportation professionals, so the number of crashes caused by poor visibility due to fog form an alarming statistic. Drivers respond to poor visibility conditions in different ways: some slow down; others do not. Many drivers simply follow the taillights of the vehicle ahead. Accordingly, hazardous conditions are created in which speeds are both too high for the prevailing conditions and highly variable. Findings are presented from a study of traffic crashes due to fog in the southern region of Saudi Arabia. The primary objective was to assess the effectiveness of fog detection and warning system on driver behavior regarding speed and headway. This warning system includes visibility sensors that automatically activate a variable message sign that posts an advisory speed when hazardous conditions due to fog occur. The system was installed on a 2 km section of a two-lane, rural highway. A data set of 36,013 observations from both experimental and control sections at two study sites was collected and analyzed. The data included vehicle speed, volume, and classification; time headway, time of day, and visibility distance. Although the warning system was ineffective in reducing speed variability, mean speed throughout the experimental sections was reduced by about 6.5 kph. This reduction indicates that the warning system appeared to have a positive effect on driver behavior in fog even though the observed mean speeds were still higher than the posted advisory speed. From relationships found in the literature between mean driving speed and number of crashes, a speed reduction of only 5 kph would yield a 15% decrease in the number of crashes.

**Supplemental Notes:** Abstract reprinted with permission from Elsevier

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp. 1065-1072

**Authors:** Al-Ghamdi, Ali S  
[asghamdi@ksu.edu.sa](mailto:asghamdi@ksu.edu.sa)  
King Saud University

**Features:** Figures (4) ; References; Tables (4)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/00014575>

**Publication Date:** 20071100

**Serial:** Accident Analysis & Prevention  
Volume: 39  
Issue Number: 6  
Publisher: Elsevier  
ISSN: 0001-4575  
Serial URL: <http://www.sciencedirect.com/science/journal/00014575>

**Index Terms:** Changeable message signs; Conspicuity; Design of experiments; Driving; Dynamic message signs; Evaluation; Experimentation; Experiments; Fog; Headways; Highway safety; Motor vehicle handling; Road safety; Rural highways; Saudi Arabia; Speed; Two lane highways; Two lane roads; Variable message signs; Vehicle handling; Vehicle navigation; Visibility; Warning systems

**Subject Areas:** Highways; Safety and Human Factors; I82: Accidents and Transport Infrastructure; I83: Accidents and the Human Factor; I85: Safety Devices used in Transport Infrastructure

---

**Title:** **Pennsylvania Turnpike Commission (PTC) Fog Detection, Traveler Information and Dynamic Traffic Control System PTC Fog Warning System (FWS)**

**Accession Number:** 01323312

**Record Type:** Monograph

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E144757

**Abstract:** The Pennsylvania Turnpike Commission (PTC) commissioned a turn-key Fog Warning System (FWS) to eliminate fog-related crashes and to reduce secondary crashes along a 19 km (12 mile) stretch of the Turnpike. The Fog Warning System provides real-time, automated detection as well as appropriate responses to counteract reduced visibility conditions by informing drivers of conditions present and lowering the speed limits to match the reduced visibility conditions. For the covering abstract see ITRD E140665.

**TRIS Files:** ITRD

**Authors:** ROSENBOHM, J N

TFI,USA

LITTLETON, B

ORTH RODGERS & ASSOCIATES,USA

CORTELAZZI, L

PENNSYLVANIA TURNPIKE COMISSION,USA

**Publication Date:** 20070000

**Serial:** PROCEEDINGS OF THE 14TH WORLD CONGRESS ON INTELLIGENT TRANSPORT SYSTEMS (ITS), HELD BEIJING, OCTOBER 2007  
Publisher: ITS America

**Index Terms:** Advanced transport telematics; ATT; Conference; Conferences; Congresses; Fog; Fog; Intelligent transport system; Intelligent transportation systems; Intelligent vehicle highway systems; ITS (Intelligent transportation systems); IVHS; Road transport informatics; RTI; Symposia; Traffic control; Traffic control; United States; Usa; Warning; Warning systems

**Subject Areas:** Operations and Traffic Management; I73: Traffic Control

---

**Title:** I-68 Reduced Visibility Fog Detection and Warning System: Evaluation Report

**Accession Number:** 01042160

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://knowledge.fhwa.dot.gov/cops/hcx...2/\\$FILE/EvaluationFinalReport-061101.pdf](http://knowledge.fhwa.dot.gov/cops/hcx...2/$FILE/EvaluationFinalReport-061101.pdf)

**Abstract:** This report describes the evaluation of the "Reduced Visibility" warning system on I-68 in Garrett and Allegany Counties in western Maryland. The system uses "Reduced Visibility Possible" signs located in two fog-prone areas, one near Big Savage Mountain and the other near Keyzers Ridge. The evaluation had three objectives: to evaluate motorists' response to the "Reduced Visibility" sign; to evaluate the system's response based on its concept design; and to evaluate the system's operation, including all components such as the fog sensor, radio equipment, sign and flashing mechanism and communications interface. The study revealed a total of 13 fog events, each of which is analyzed in this report. The system was considered a success in the sense that it detected fog when fog was present

and provided the relevant information to drivers on I-68 via the sign message. The system operated flawlessly throughout the study period.

**TRIS Files:** TRIS

**Media Type:** Web

**Pagination:** 21p

**Features:** Figures; Maps (1) ; Photos; Tables (18)

**Corporate Authors:** Sabra, Wang and Associates, Incorporated  
1504 Joh Avenue, Suite 160  
Baltimore, MD 21227 USA

**Publication Date:** 20060000 (approximate)

**Index Terms:** Allegany County (Maryland); Driver communications; Driver information systems; Evaluation and assessment; Fog; Fog detection; Garrett County (Maryland); Highway communications; In vehicle advisory; In vehicle communications; Primary detectors; Reduced visibility; Sensors; Traffic information systems; Warning systems

**Subject Areas:** Highways; Operations and Traffic Management; I73: Traffic Control

---

**Title:** **EVALUATION OF FOG-DETECTION AND ADVISORY-SPEED SYSTEM**

**Accession Number:** 00977891

**Record Type:** Component

**Language:** English

**Abstract:** This paper presents findings from a study of traffic crashes due to fog in southern Saudi Arabia. The main aim was to assess the effectiveness of a fog detection and warning system on driver behavior regarding speed and headway. The warning system includes visibility sensors that automatically activate a variable message sign that posts an advisory speed when hazardous conditions due to fog occur. The system was installed on a 2-km section of a 2-lane, rural highway. A data set of 36,013 observations from both experimental and control sections at 2 study sites was collected and analyzed. Although the warning system was ineffective in reducing speed variability, mean speed throughout the experimental sections was reduced by about 6.5 kph. This reduction indicates that the warning system appeared to have a positive effect on driver behavior in fog even though observed mean speeds were still higher than the posted speed. From relationships found in the literature

between mean driving speed and number of accidents, a speed reduction of only 5 kph would yield a 15% decrease in the number of accidents.

- TRIS Files:** TRIS
- Pagination:** p. 457-464
- Authors:** AL-GHAMDI, A S
- Features:** Figures (2) ; References (10) ; Tables (2)
- Corporate Authors:** WIT Press  
Ashurst Lodge  
Ashurst, Southampton SO40 7AA United Kingdom
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25 Bridge Street  
Billerica, MA 01821 USA
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Order URL: <http://worldcat.org/isbn/1853127167>
- ISBN:** 1853127167
- Publication Date:** 20040500
- Conference:** Urban Transport X. Urban Transport and the Environment in the 21st Century  
Location: Dresden, Germany  
Date: 20040519 - 20040521  
Sponsors: Wessex Institute of Technology
- Serial:** Publication of: WIT Press  
Publisher: WIT Press  
ISSN: 1462-608X
- Index Terms:** Accident black spots; Accident causes; Accident factors; Accident prone locations; Accident responsibility; Automobile driving; Automobile travel; Automobile usage; Automobile use; Changeable message signs; Conspicuity; Dynamic message signs; Fog; Headways; High accident locations; Highway accidents; Highway safety; Hotspot; Human factors; Road safety; Saudi Arabia; Speed control; Traffic accidents; Variable message signs; Visibility; Warning systems
- Subject Areas:** Highways; Safety and Human Factors; I85: Safety Devices used in Transport Infrastructure
-

**Title:** I-68 FOG DETECTION SYSTEM PLANNING REPORT

**Accession Number:** 00976281

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://knowledge.fhwa.dot.gov/cops/hex...75162D/\\$FILE/MD%20I68%20Fog%20Report.pdf](http://knowledge.fhwa.dot.gov/cops/hex...75162D/$FILE/MD%20I68%20Fog%20Report.pdf)

**Abstract:** On May 23, 2003, a multi-vehicle accident was reported on Interstate 68 at mile post 29, eastbound. When Fire and Rescue Units arrived, they found several vehicles involved in the eastbound accident. Garrett County Sheriff's Dept. Communications Operator Bill Wiltison noted that this accident occurred around 1:20 p.m. Friday; and a second, larger accident, involving more than 50 vehicles, began almost an hour later in the westbound lanes. This second accident quickly turned into a nightmare involving a chain reaction with nearly 90 vehicles, including tractor trailers. Heavy fog was blamed for the accident. Interstate 68 remained closed for approximately 24 hours after the first accident occurred. Fog is a cloud that forms at the surface of the earth. It consists of a multitude of minute water droplets suspended in the atmosphere. According to international definitions, fog is present when horizontal visibility drops below 0.62 miles or one kilometer. Heavy fog is defined as visibility below 0.25 miles. This serious multivehicle accident, the latest in a series of accidents caused by reduced visibility in fog, was the impetus for this investigation into remedial measures can be applied in this fog-prone corridor. The corridor in question extends along I-68 from the West Virginia state line to the vicinity of Frostburg, Maryland, a distance of approximately 35 miles. The objective of this project is to install a system that will identify conditions of low visibility and notify approaching drivers of the limited visibility situation before they encounter it. Following an introduction, this report provides a discussion of similar projects and the technology they employed. With this background, the report examines the project site and identifies fog-prone areas. It then defines sensor locations and traffic sign locations within these areas. The state highway administration (SHA) has an investment in road weather information systems (RWIS) infrastructure in this corridor. The next section identifies key components of this infrastructure. The final section of the report provides a description of various alternative approaches and recommends a specific solution. In this last section, the recommended solution is described in detail and costed.

**TRIS Files:** TRIS

**Pagination :** 25 p.

**Features:** Figures

**Corporate Authors:** Sabra, Wang & Associates  
1504 Joh Avenue, Suite 160  
Baltimore, MD 21227 USA  
  
Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** Sabra, Wang & Associates  
1504 Joh Avenue, Suite 160  
Baltimore, MD 21227 USA

**Publication Date:** 20031107

**Index Terms:** Accident causes; Accident factors; Accident responsibility; Car truck accidents; Chain reactions (Traffic accidents); Conspicuity; Detectors; Driver communications; Driver information systems; Fog; Highway accidents; Highway communications; Highway corridors; Highway safety; In vehicle advisory; In vehicle communications; Interstate highways; Maryland; Multiple car accidents; Multiple vehicle accidents; Road safety; Road weather information systems; RWIS; Site distance; Tractor trailer combinations; Traffic accidents; Traffic corridors; Traffic information systems; Traffic safety; Visibility; Visibility distance; Weather; West Virginia

**Subject Areas:** Highways; Motor Carriers; Safety and Human Factors; I80: Accident Studies

---

## EBSCOHOST – Warning systems

**Record: 1**

**Title:**

**Active Warning Systems: Synthesis.**

**Authors:**

Sisiopiku, Virginia P.<sup>1</sup>  
Elliott, John R.<sup>2</sup>

**Source:**

Journal of Transportation Engineering; Mar2005, Vol. 131 Issue 3, p205-210, 6p

**Document Type:**

Article

**Subject Terms:**

\*WARNINGS  
\*TRAFFIC safety  
\*TRAFFIC engineering

\*TRAFFIC signs & signals

\*TRANSPORTATION

**Author-Supplied Keywords:**

Intelligent transportation systems

Traffic control devices

Traffic safety

Traffic signs

NAICS/Industry Codes561990 All Other Support Services

488999 All Other Support Activities for Transportation

481212 Nonscheduled Chartered Freight Air Transportation

**Abstract:**

Active warning systems are traffic control devices consisting of variable signs or flashing beacons with conventional warning signs, which are activated by sensors detecting real-time roadway, environmental, and operational hazards. Currently most active warning systems detect and warn drivers of variable weather or pavement conditions, high-risk vehicle operating speeds, or the presence of intermittent hazards such as other vehicles, pedestrians, or wild animals. Within the Intelligent Transportation Systems framework, active warning systems applications detect these and other variable hazards and communicate these warnings directly to the vehicle or operator. Because most active warning systems are relatively recent, limited long-term system performance data are available. Testing and evaluation of active warning signs should continue to more firmly establish their benefits to highway safety and traffic operations. This paper provides an overview of available active warning systems and discusses their implementation requirements and potential benefits based on results and recommendations from evaluation studies. [ABSTRACT FROM AUTHOR]

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**Author Affiliations:**

<sup>1</sup>Associate Professor, Dept. of Civil and Environmental Engineering, Univ. of Alabama, Birmingham, Birmingham, AL 35294

<sup>2</sup>Graduate Student, Dept. of Civil and Environmental Engineering, Michigan State Univ., E. Lansing, MI 48244

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href="http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=16145762&site=ehost-live">Active Warning Systems: Synthesis.</A>

**Database:**

Academic Search Complete

---

**Record: 2****Title:**

**New System for Detecting Road Ice Formation.**

**Authors:**

Troiano, Amedeo<sup>1</sup>  
Pasero, Eros<sup>1</sup>  
Mesin, Luca<sup>1</sup>

**Source:**

IEEE Transactions on Instrumentation & Measurement; 03/01/2011, Vol. 60 Issue 3, p1091-1101, 11p

**Document Type:**

Article

**Subject Terms:**

\*DETECTORS  
\*TEMPERATURE measurements  
\*MATHEMATICAL models  
\*ROADS  
\*ALGORITHMS  
\*ESTIMATION theory  
\*ELECTRIC capacity  
ICE formation & growth

**Author-Supplied Keywords:**

Capacitance  
Capacitance measurement  
Frequency measurement  
Ice  
ice detection  
Mathematical model  
road information  
Roads  
sensor  
Temperature measurement  
Temperature sensors  
water detection

**Abstract:**

The reliable detection of water and ice over road surfaces is an important issue in improving the traffic safety and in reducing the costs for maintenance, particularly during winter. A low-cost capacitive sensor for the estimation of road conditions is studied. A simulation model was developed to investigate the capacitance of the sensor when air,

water, or ice is covering its surface and to assess the effect of the variation of an environmental temperature or of the thickness of water or ice. An algorithm for the estimation of the state of the sensor (dry, wet, or icy) was developed based on the results of the simulations, which indicated that the time derivative of the estimated capacitance provided optimal information. The accuracy and reliability of the estimates provided by the sensor were assessed in laboratory experiments, placing more sensors in a climatic chamber and investigating the estimated state of the sensors and the timing of the identification of wet-icy or icy-wet transitions. Reliable estimates were obtained by all the sensors, with a dispersion of the transition times on the order of a few minutes. The sensor was also investigated in the field. Two sensors (one of which was bituminized) were embedded in a road pavement to monitor continuously the road surface condition for a month. Both sensors provided indications in line with the environmental conditions, identifying properly the icy condition and indicating the wet state of the road during both rain and fog. Thus, the sensor is suggested as a feasible tool for monitoring the road conditions to support information systems improving the security and efficient maintenance of roads during winter. [ABSTRACT FROM AUTHOR]

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**Author Affiliations:**

<sup>1</sup>Dipartimento di Elettronica, Politecnico di Torino, Torino, Italy

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<A href="http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=58006664&site=ehost-live">New System for Detecting Road Ice Formation.</A>

**Database:**

Academic Search Complete

---

**Record: 3**

**Title:**

**Road Surface Condition Forecasting in France.**

**Authors:**

Bouilloud, L.<sup>1,2</sup> *ludovic.bouilloud@hmg.inpg.fr*  
Martin, E.<sup>1</sup>  
Habets, F.<sup>3</sup>  
Boone, A.<sup>1</sup>  
Le Moigne, P.<sup>1</sup>  
Livet, J.<sup>4</sup>  
Marchetti, M.<sup>4</sup>  
Foidart, A.<sup>5</sup>  
Franchistéguy, L.<sup>6</sup>  
Morel, S.<sup>7</sup>  
Noilhan, J.<sup>1</sup>  
Pettré, P.<sup>5</sup>

**Source:**

Journal of Applied Meteorology & Climatology; Dec2009, Vol. 48 Issue 12, p2513-2527, 15p, 1 Diagram, 7 Charts, 7 Graphs, 2 Maps

**Document Type:**

Article

**Subject Terms:**

\*GEOPHYSICAL prediction  
\*ROADS -- France  
\*SNOW accumulation  
\*TRANSPORTATION -- Management

**Geographic Terms:**

FRANCE

**Abstract:**

A numerical model designed to simulate the evolution of a snow layer on a road surface was forced by meteorological forecasts so as to assess its potential for use within an operational suite for road management in winter. The suite is intended for use throughout France, even in areas where no observations of surface conditions are available. It relies on short-term meteorological forecasts and long-term simulations of surface conditions using spatialized meteorological data to provide the initial conditions. The prediction of road surface conditions (road surface temperature and presence of snow on the road) was tested at an experimental site using data from a comprehensive experimental field campaign. The results were satisfactory, with detection of the majority of snow and negative road surface temperature events. The model was then extended to all of France with an 8-km grid resolution, using forcing data from a real-time meteorological analysis system. Many events with snow on the roads were simulated for the 2004/05 winter. Results for road surface temperature were checked against road station data from several highways, and results for the presence of snow on the road were checked against measurements from the Météo-France weather station network. [ABSTRACT FROM AUTHOR]

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*original published version of the material for the full abstract.* (Copyright applies to all Abstracts.)

**Author Affiliations:**

<sup>1</sup>GAME-CNRM, Météo-France, CNRS, Toulouse, France

<sup>2</sup>CNRS/LTHE, Grenoble, France

<sup>3</sup>CNRS/UMR Sisyphe 7619, Fontainebleau, France

<sup>4</sup>Laboratoire Régional des Ponts et Chaussées, Nancy, France

<sup>5</sup>DP, Météo-France, Toulouse, France

<sup>6</sup>DCLIM, Météo-France, Toulouse, France

<sup>7</sup>DIRIC, Météo-France, Paris, France

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href="http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=47417992&site=ehost-live">Road Surface Condition Forecasting in France.</A>

**Database:**

Academic Search Complete

---

**Record: 4**

**Title:**

**WARNING: Weather Ahead.**

**Authors:**

D'Alto, Nick

**Source:**

Weatherwise; May/Jun2006, Vol. 59 Issue 3, p22-26, 5p

**Document Type:**

Article

**Subject Terms:**

\*ROADS

\*CLIMATOLOGY

\*RAIN & rainfall

\*WATER

**Geographic Terms:**

VIRGINIA

**Abstract:**

The article focuses on Smart Road, the world's only climate-controlled test highway in Virginia. Realistic rain from a light mist to torrential downpours are being produced through seventy-five weather-making towers located along the road. Half-million gallon

water tanks are being used to produce rain. The value of the meteorological test track is \$50 million. INSET: Take a Test Drive.

**Full Text Word Count:**

1560

**ISSN:**

00431672

**Accession Number:**

20771430

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href="http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=20771430&site=ehost-live">WARNING: Weather Ahead.</A>

**Database:**

Academic Search Complete

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## Vehicle infrastructure integration: Condition monitoring and Driver warning

**Title:** Effects of Road Surface Appearance and Low Friction Warning Systems on Driver Behaviour and Confidence in the Warning System

**Accession Number:** 01165605

**Record Type:** Component

**Language:** English

**Abstract:** Warning systems for slippery road conditions are a potential newcomer among driver support systems. 75 participants drove in a high-fidelity driving simulator on roads with both visible and invisible ice, to investigate to which extent drivers rely on a low friction warning system. Three experimental groups with different versions of a low friction warning system and a control group without warning system were compared. All drivers ranked the systems according to trust. A system displaying recommended speed received the best ratings. Driving speed was analyzed for 3 particular segments of the route. Generally, lowest speeds were achieved with the recommended speed system. The participants drove more slowly on a slippery segment that looked icy than on the segments that looked dry when they did not receive a low friction warning. When they received a warning for low friction they also lowered their speed for the segment looking like asphalt. The results provide guidelines for how to present low friction

warnings to drivers. The design has substantial effects on the resulting behavior and therefore it can have a high impact on traffic safety. So far, not much research on low friction warning systems has been reported.

**Supplemental Notes:** Abstract reprinted with permission from Taylor and Francis

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 165-176

**Authors:** Kircher, Katja  
Swedish National Road Administration  
Thorslund, B  
Swedish Road Administration

**Features:** References

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/00140139>

**Publication Date:** 20090200

**Serial:** Ergonomics  
Volume: 52  
Issue Number: 2  
Publisher: Taylor & Francis Limited  
ISSN: 0014-0139

**Index Terms:** Advanced Driver Assistance Systems; Automobile driving; Automobile driving simulators; Blanket course; Driver assistance systems (In vehicle); Driver support systems; Driving performance; Driving simulators; Electronic co-pilots; Highway safety; Icy roads; Road safety; Road surfaces; Surface course (Pavements); Warning systems

**Subject Areas:** Highways; Vehicles and Equipment; I91: Vehicle Design and Safety

---

**Title:** **Enhancing Road Weather Information Through Vehicle Infrastructure Integration**

**Accession Number:** 01043553

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2015-15>

**Abstract:** Vehicle infrastructure integration (VII) represents a concept with the potential to aid in the reduction of weather-related accidents on U.S. roadways while increasing surface transportation mobility and efficiency. Technological advancements in the automotive and telecommunications industries have resulted in the ability of vehicles to acquire and use high temporal- and spatial-resolution information associated with environmental and roadway conditions. VII would enable vehicle-to-vehicle and vehicle-to-infrastructure communications through dedicated short-range communications (wireless radio communication at 5.9 GHz). This capability could potentially serve as a means of gathering and distributing vehicle data in support of applications and products designed to diagnose and predict road weather conditions. It is believed that the inclusion of VII-enabled data in road weather applications will improve weather and road condition analyses and forecasts. A summary is given of vehicle data elements that are likely to contribute to development and improvement of road weather products. A synopsis of probable VII product enhancements is provided, along with examples of how vehicle data can be used in the application development process. Developing a broad understanding of how to use vehicle data properly will require a significant amount of research. Research needs aimed at addressing the technical issues and barriers associated with the use of VII-enabled data are discussed.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 132-140

**Authors:** Petty, Kevin R  
Phone: 303-497-2705  
Fax: 303-497-8401  
[kpetty@ucar.edu](mailto:kpetty@ucar.edu)  
National Center for Atmospheric Research  
Mahoney III, William Paul  
Phone: 303-497-8426  
Fax: 303-497-8401  
[mahoney@ucar.edu](mailto:mahoney@ucar.edu)  
National Center for Atmospheric Research

**Features:** Figures (2) ; References (9) ; Tables (1)

**Monograph Title:** Maintenance Operations: Work Zones, Pavement Markings, and Weather

**Monograph Accession Number:** 01084471

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://www.trb.org/news/blurb\\_detail.asp?id=8632](http://www.trb.org/news/blurb_detail.asp?id=8632)  
Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780309104418>

**ISBN:** 9780309104418

**Publication Date:** 20070000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2015  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Adverse conditions; Automotive sensors; Data acquisition; Data collection; Dedicated short range communications; DSRC; Highway transportation; In vehicle sensors; Information management; Instrumented vehicles; Inter-vehicle communications; Radio; Research; Road transportation; Road weather information systems; Roadside to vehicle communications; RWIS; Vehicle infrastructure integration; Vehicle to roadside communications; Vehicle to vehicle communications; Weather; Weather conditions; Weather forecasting; Wireless communication systems

**Subject Areas:** Data and Information Technology; Highways; Operations and Traffic Management; Safety and Human Factors; Vehicles and Equipment; I73: Traffic Control; I91: Vehicle Design and Safety

---

**Title:** **Expediting Vehicle Infrastructure Integration (EVII) : Where the Rubber Meets (and Talks to) the Road**

**Accession Number:** 01151214

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.dot.ca.gov/research/researchreports/reports/2008/06-0714.pdf>

**Source Agency:** UC Berkeley Transportation Library

**Source Data:** Caltrans 1617

**Abstract:** This research effort between Caltrans, California PATH and

DaimlerChrysler RTNA that demonstrated two potential VII services, one in traffic data probes and another with safety, using real cars and on Caltrans roadways. It presages an operational test and a deployment, and it lays the groundwork for technical and institutional know-how that will be leveraged onto the much larger VII California effort. As such, this project explores and resolves key engineering issues associated with the point deployment of these services in a realistic setting, California roadways and the first-ever private vehicle (owned by an automobile manufacturer's laboratory, DaimlerChrysler Research Technology North America) that "talked" to the roadside, with the roadside backhaul interfacing into an existing Caltrans database and archival application, the Performance Measurement System. In the end, the project demonstrated that Caltrans could do VII and create VII champions, within and outside of Caltrans.

- Supplemental Notes:** Originally published in October 2006 with the title: Expediting Vehicle Infrastructure Integration (EVII). California PATH Research Report UCB-ITS-PRR-2006-20.
- TRIS Files:** CALTRANS, TRIS
- Report Numbers:** CA06-0714  
UCB-ITS-PRR-2006-20
- Contract Numbers:** 65A0191
- Media Type:** Print
- Pagination:** 62p
- OCLC:** 503472351
- Authors:** Varaiya, Pravin  
Phone: 1 510 642 5270  
Fax: 1 510 642 7815  
[varaiya@eecs.berkeley.edu](mailto:varaiya@eecs.berkeley.edu)  
University of California, Berkeley
- Features:** Appendices; Figures; Photos; Tables
- Corporate Authors:** University of California, Berkeley  
California PATH Program, Institute of Transportation Studies  
Richmond Field Station, 1357 South 46th Street  
Richmond, CA 94804-4648 USA  
California Department of Transportation  
Division of Research and Innovation, 1227 O Street, P.O. Box 942873  
Sacramento, CA 94273-0001 USA
- Availability:** Available from UC Berkeley Transportation Library through interlibrary loan or document delivery

Order URL: <http://library.its.berkeley.edu>

National Technical Information Service

5301 Shawnee Road

Alexandria, VA 22312 USA

Find a library where document is available

Order URL: <http://worldcat.org/oclc/503472351>

**Publication Date:** 20081200

**Edition:** Final Report

**Index Terms:** Advanced transport telematics; ATT; California; Dedicated short range communications; DSRC; Floating cars; Intelligent transportation systems; Intelligent vehicle highway systems; ITS (Intelligent transportation systems); IVHS; Monitoring; Monitoring systems; Performance Measurement System (Database); Probe vehicles; Road transport informatics; Roadside to vehicle communications; RTI; Vehicle infrastructure integration; Vehicle to roadside communications

**Subject Areas:** Data and Information Technology; Highways; Safety and Human Factors

---

**Title:** **A New Paradigm in Observing the Near Surface and Pavement: Clarus and Vehicle Infrastructure Integration**

**Accession Number:** 01103950

**Record Type:** Component

**Language:** English

**Record URL:** <http://onlinepubs.trb.org/onlinepubs/circulars/ec126.pdf>

**Abstract:** The nation's weather enterprise generally relies on a network of a couple thousand automated weather observing stations to sense and report on the state of the lower atmosphere. These stations are typically situated in pristine fields adjoining airport runways. And while these stations fulfill the requirements for airport ground operations, they do little to report accurately on pavement and near surface conditions on the nation's roads. The FHWA is doing something about this data coverage gap through two initiatives: Clarus and Vehicle Infrastructure Integration (VII). First, the Clarus Initiative seeks to maximize the utility of road weather observations by running quality checks on the data and then disseminating the observations to the weather and transportation communities. The Clarus Initiative involves the creation of an advanced data management system that will be able to assimilate all environmental sensor station observations across North America and

provide quality-checked road weather observations for any user. The second initiative involves utilizing passenger vehicles as mobile weather probes. The VII Initiative is based on having automobile manufacturers equip cars with onboard units and transceivers that are capable of collecting snapshots of dozens of onboard systems (e.g., windshield wiper state or outside air temperature) and transmitting these data to a national communications infrastructure. Successful deployment of such a national system could result in the generation of millions of new vehicle-based observations that could reveal new details about the state of the atmosphere at the driver's level and conditions on the pavement surface. This paper provides details on the progress of both the Clarus and VII Initiatives, which have the potential to change the way that the nation observes and manages surface weather data.

**TRIS Files:** TRIS, TRB

**Report Numbers:** Weather08-012

**Media Type:** Web

**Pagination:** pp 3-15

**Authors:** Pisano, Paul A  
Phone: 202-366-1301  
Fax: 202-366-3225  
[paul.pisano@fhwa.dot.gov](mailto:paul.pisano@fhwa.dot.gov)  
Federal Highway Administration

Kennedy, Patrick J  
Phone: 202-366-9498  
Fax: 202-366-3225  
[pat.kennedy@dot.gov](mailto:pat.kennedy@dot.gov)  
Federal Highway Administration

Stern, Andrew D  
Phone: 703-610-1754  
Fax: 703-610-1563  
[astern@noblis.org](mailto:astern@noblis.org)  
Noblis, Incorporated

**Features:** Figures (6) ; References (6)

**Monograph Title:** Surface Transportation Weather and Snow Removal and Ice Control Technology: Fourth National Conference on Surface Transportation Weather and Seventh International Symposium on Snow Removal and Ice Control Technology, June 16-19, 2008, Indianapolis, Indiana

**Monograph Accession Number:** 01103914

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/00978515>

**Publication Date:** 20080600

**Conference:** Fourth National Conference on Surface Transportation Weather;  
Seventh International Symposium on Snow Removal and Ice Control  
Technology  
Location: Indianapolis Indiana, United States  
Date: 20080616 - 20080619  
Sponsors: Transportation Research Board; Indiana Department of  
Transportation; American Association of State Highway and  
Transportation Officials; Federal Highway Administration

**Serial:** Transportation Research E-Circular  
Issue Number: E-C126  
Publisher: Transportation Research Board  
ISSN: 0097-8515

**Index Terms:** Adverse conditions; Clarus; Data management systems; Event data  
recorders; Information dissemination; Road weather information  
systems; RWIS; Technology assessment; Vehicle infrastructure  
integration; Weather conditions

**Subject Areas:** Administration and Management; Data and Information Technology;  
Highways; I10: Economics and Administration

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**Title:** **Latest Developments in Fixed and Mobile Road Weather  
Observing As They Relate to the CLARUS and Vehicle  
Infrastructure Integration (VII) Initiatives**

**Accession Number:** 01144573

**Record Type:** Component

**Language:** English

**Abstract:** On average, 7,400 people are killed each year in vehicle crashes that are associated with adverse weather conditions. The U.S. Department of Transportation (USDOT), through the Federal Highway Administration (FHWA) and the Research and Innovative Technology Administration (RITA), has invested in two major initiatives, Clarus and Vehicle Infrastructure Integration (VII), whose products will help to reduce the impacts of adverse weather conditions on surface transportation users. In addition to the high-level goals associated with improving safety and traffic operations, these programs will address the concern that most of today's weather forecasts are primarily driven by atmospheric data and

are therefore unable to accurately address the complex interactions that occur at the land surface-atmosphere interface (the lowest portion of the atmosphere from the driver level to the pavement and down into the subsurface). This shortfall results in part from a lack of plentiful, high-quality surface and subsurface observations. Moreover, there is a limited amount of information regarding how weather affects pavement conditions, as well as what roles pavement and subsurface characteristics play in determining the factors that directly impact roadway safety and mobility. This paper will provide details regarding the latest developments on both the Clarus and VII initiatives and describe activities ranging from a new generation of quality checking algorithms to research based on data from both passenger vehicles and long haul trucks.

**TRIS Files:** TRIS

**Media Type:** CD-ROM

**Pagination:** 12p

**Authors:** Stern, Andrew D  
Phone: 703-610-1754  
Fax: 703-610-1563  
[astern@noblis.org](mailto:astern@noblis.org)  
Noblis, Incorporated

Pisano, Paul A  
Phone: 202-366-1301  
Fax: 202-366-3225  
[paul.pisano@fhwa.dot.gov](mailto:paul.pisano@fhwa.dot.gov)  
Federal Highway Administration

Kennedy, Patrick J  
Phone: 202-366-9498  
Fax: 202-366-3225  
[pat.kennedy@dot.gov](mailto:pat.kennedy@dot.gov)  
Federal Highway Administration

McKeever, Benjamin  
Phone: 202-366-4876  
[ben.mckeever@dot.gov](mailto:ben.mckeever@dot.gov)  
Department of Transportation

**Features:** Figures (4) ; Maps (1) ; References (5)

**Monograph Title:** ITS Connections: Saving Time. Saving Lives

**Monograph Accession Number:** 01130159

**Corporate Authors:** ITS America

1100 17th Street NW, 12th Floor  
Washington 20036 USA

**Availability:** ITS America  
1100 17th Street NW, 12th Floor  
Washington 20036 USA

**Publication Date:** 20080000

**Conference:** 15th World Congress on Intelligent Transport Systems and ITS  
America's 2008 Annual Meeting  
Location: New York NY  
Date: 20081116 - 20081120  
Sponsors: ITS America; ERTICO; ITS Japan; Transcore

**Index Terms:** Adverse conditions; Automobiles; Base course (Pavements); Cargo vehicles; Clarus; Heavy goods vehicles; Highway safety; Lorries; Mobility; Pavement bases; Pavement conditions; Road freight vehicles; Road safety; Roadbase; Roadside to vehicle communications; Surface activity; Surface behavior; Surface phenomena; Trucks; Vehicle infrastructure integration; Vehicle to roadside communications; Weather conditions

**Subject Areas:** Data and Information Technology; Freight Transportation; Highways; Safety and Human Factors; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

---

**Title:** **Opportunity to Leverage Vehicle Infrastructure Integration (VII) Data for Pavement Condition Monitoring**

**Accession Number:** 01089448

**Record Type:** Component

**Language:** English

**Order URL:** <http://pubsindex.trb.org/paperorderform.pdf>

**Source Data:** Transportation Research Board Annual Meeting 2008 Paper #08-0532

**Abstract:** The USDOT's planned Vehicle Infrastructure Integration (VII) program is still in its infancy and presents an opportunity for the automotive industry and state/local departments of transportation to develop strategic partnerships to leverage each other's data and infrastructure. This paper presents a method to monitor pavement condition by proposing procedures to leverage vehicle accelerometer and position data using the emerging VII infrastructure. In the study, test vehicles were mounted with accelerometers and GPS units. Body

mounted accelerometers are very effective at detecting potholes and other pavement distress. However, the spatial uncertainty of GPS data precludes the simple averaging of data. This paper illustrates the importance of post-processing accelerometer data with correlation algorithms to effectively identify pavement distress. Using the data, the paper proposes a method of implementing a real time, distributed network of equipped vehicles to provide a cost-effective, frequently updated survey of ride quality over a wide geographic area, which could provide data to aid in routine maintenance, network-level repaving, and risk management decisions.

**TRIS Files:** BTRIS, TRIS, TRB

**Report Numbers:** 08-0532

**Media Type:** DVD

**Pagination:** 24p

**Authors:** Barker, Alan M  
[barkera@purdue.edu](mailto:barkera@purdue.edu)  
Purdue University  
Ndoye, Mandoye  
[mndoye@purdue.edu](mailto:mndoye@purdue.edu)  
Purdue University  
Bullock, Darcy M  
Phone: 765-494-2222  
Fax: 765-496-7996  
[darcy@purdue.edu](mailto:darcy@purdue.edu)  
Purdue University  
Krogmeier, James V  
Phone: 765-494-3530  
[jvk@ecn.purdue.edu](mailto:jvk@ecn.purdue.edu)  
Purdue University

**Features:** Figures (11) ; References (18)

**Monograph Title:** TRB 87th Annual Meeting Compendium of Papers DVD

**Monograph Accession Number:** 01084478

**Corporate Authors:** Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW

Washington, DC 20001 USA

**Publication Date:** 20080000

**Conference:** Transportation Research Board 87th Annual Meeting  
Location: Washington DC  
Date: 20080113 - 20080117  
Sponsors: Transportation Research Board

**Index Terms:** Accelerators (Devices); Instruments for measuring roughness; Pavement management; Pavement management systems; Pavement performance; Real time information; Remote detectors; Remote sensing; Remote sensors; Ride quality; Smoothness; Vehicle infrastructure integration

**Subject Areas:** Administration and Management; Design; Highways; Pavements; I10: Economics and Administration; I22: Design of Pavements, Railways and Guideways

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**Title:** **Statewide Wireless Communications Project; Volume 3: Data Collection and Signal Processing for Improvement of Road Profiling and Proof of Concept of a Vehicle-Infrastructure Based Road Surface Monitoring Application**

**Accession Number:** 01104826

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://rebar.ecn.purdue.edu/JTRP\\_Compl...inalReport/SPR\\_2852\\_Final/SPR\\_0513-3.pdf](http://rebar.ecn.purdue.edu/JTRP_Compl...inalReport/SPR_2852_Final/SPR_0513-3.pdf)

**Abstract:** The Statewide Wireless Communications Project was an umbrella project intended to support various INDOT activities in the area of wireless communications. As these activities were conducted independently the report for the project is organized into three volumes. Volume 1 contains the results of satellite and cellular communications field testing undertaken in support of INDOT's SiteManager application. Volume 1 also contains the results of an evaluation of spread spectrum radios for long-range communications. Volume 2 contains the results of detection zone evaluation for loop detection of bicycles and the results of testing algorithms for travel time estimation using vehicle re-identification based on inductive and micro-loop signatures. Finally, Volume 3 contains the results of preliminary testing of a vehicle-infrastructure integration application in road condition monitoring. In Volume 1 we found that SiteManager could not be adequately run over a satellite link because the long round trip delay of the communication link negatively interacted with SiteManager's internal client-server

communications protocol to severely reduce overall throughput. A solution to the problem was to use terminal emulation in the field with the client software running on a computer connected to the server via a high bandwidth, low delay link. The downside to the terminal emulation approach is that it requires that the field engineer have a communication link wherever the application is run. In Volume 1 we also found that current generation spread spectrum radio ranges in Indiana topography with antenna heights corresponding to signal arm mounting were on the order of 3 miles. This was too short by a factor of 3 to support a multihop network for traffic signal control and telemetry. In Volume 2 we developed a numerical technique for mapping the bicycle detection zones of loop detectors. A number of recommendations were made concerning loop geometry, depth, detector sensitivity, and pavement markings for purposes of improving bicycle detection. We also developed algorithms for travel time estimation based on vehicle signatures captured from commercially available inductive and micro-loop detector cards. The travel time estimation algorithms were field tested and show promise. In Volume 3 a prototype road condition monitoring system was built upon a passenger van platform and preliminary field testing and data analysis was done. Algorithms were developed to address positional uncertainties present in GPS measurements in order to allow the averaging of data taken in multiple independent runs. The results were also field tested using INDOT's Laser Profiling vehicle.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/IN/JTRP-2005/13

**Contract Numbers:** SPR-2852

**Media Type:** Web

**Pagination:** 33p

**Authors:** Krogmeier, James V  
Phone: 765-494-3530  
[jvk@ecn.purdue.edu](mailto:jvk@ecn.purdue.edu)  
Purdue University  
Bullock, Darcy M  
Phone: 765-494-2222  
Fax: 765-496-7996  
[darcy@purdue.edu](mailto:darcy@purdue.edu)  
Purdue University

**Features:** Figures; Photos; References; Tables

**Corporate:** Purdue University/Indiana Department of Transportation JHRP

**Authors:** Purdue University, School of Civil Engineering  
West Lafayette, IN 47907-1284 USA  
Indiana Department of Transportation  
100 N Senate Avenue  
Indianapolis, IN 46204 USA  
Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability** National Technical Information Service  
:  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20080700

**Edition:** Final Report

**Index Terms:** Bicycle travel; Bicycle usage; Cell phones; Cellular telephones; Communication systems; Communications networks; Field tests; Global Positioning System; GPS; In situ tests; Journey time; Satellite communication; Transportation planning; Travel time; Vehicle infrastructure integration; Wireless communication systems

**Subject Areas:** Highways; Pedestrians and Bicyclists; Planning and Forecasting; I72: Traffic and Transport Planning

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**Title:** **Vehicle Infrastructure Integration (VII) Based Road-Condition Warning System for Highway Collision Prevention**

**Accession Number:** 01140921

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://ntl.bts.gov/lib/31000/31100/31178/476660-00043-1.pdf>

**Record URL:** <http://swutc.tamu.edu/publications/technicalreports/476660-00043-1.pdf>

**Abstract:** As a major Intelligent Transportation Systems (ITS) initiative, the Vehicle Infrastructure Integration (VII) program is to revolutionize transportation by creating an enabling communication infrastructure that will open up a wide range of safety applications. The road-condition warning system is a unique application of VII technology, which is to provide drivers with real-time information about unexpected roadway conditions ahead, such as accidents, speed reduction zones, hazardous weather conditions, etc. The safety effectiveness of the VII-

based warning systems needs to be investigated under various driving conditions. In this study, three different types of warning systems: Rural Highway Driver Warning System (RHDWS), Highway Lane Change Warning System (HLCWS) and Work Zone Driver Warning System (WZDWS), were designed and tested in the designed highway scenarios by driving simulator experiments. The experimental results show that all three systems can reduce the crashes in the designed environment. According to the survey result, the system is easy for the driver and helpful to them in driving safely under various driving conditions. The results of this research will be helpful for the decision making on the application of VII technology.

**Supplemental Notes:** This research was supported by a grant from the U.S. Department of Transportation, University Transportation Centers Program.

**TRIS Files:** UTC, NTL, TRIS

**Report Numbers:** SWUTC/09/476660-00043-1  
Report 476660-00043-1

**Contract Numbers:** DTRT07-G-0006 (Grant)

**Media Type:** Web

**Pagination:** 83p

**Authors:** Qi, Yi  
Phone: 713-313-6809  
Fax: 713-313-1856  
[qiy@tsu.edu](mailto:qiy@tsu.edu)  
Texas Southern University, Houston  
Chen, Xin  
[chenxx@tsu.edu](mailto:chenxx@tsu.edu)  
Texas Southern University, Houston  
Yang, Lang  
[yangl@tsu.edu](mailto:yangl@tsu.edu)  
Texas Southern University, Houston  
Wang, Bin  
[wangbin07@gmail.com](mailto:wangbin07@gmail.com)  
Texas Southern University, Houston  
Yu, Lei  
Phone: 713-313-7282  
Fax: 713-313-1856  
[yu\\_lx@tsu.edu](mailto:yu_lx@tsu.edu)  
Texas Southern University, Houston

**Features:** Figures (34) ; References (31) ; Tables (10)

**Corporate Authors:** Texas Southern University, Houston  
Center for Transportation Training and Research, 3100 Cleburne  
Avenue  
Houston, TX 77004 USA  
Southwest Region University Transportation Center  
Texas Transportation Institute, Texas A&M University  
College Station, TX 77843-3135 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20090500

**Index Terms:** Advanced transport telematics; Adverse conditions; ATT; Automobile driving simulators; Driving simulators; Highway accidents; Highway safety; Intelligent transportation systems; Intelligent vehicle highway systems; ITS (Intelligent transportation systems); IVHS; Lane changing; Real time information; Road safety; Road transport informatics; RTI; Rural highways; Speed zones; Traffic accidents; Vehicle infrastructure integration; Warning systems; Weather conditions; Work zones

**Subject Areas:** Highways; Operations and Traffic Management; Safety and Human Factors; I73: Traffic Control

---

**Title:** **Vehicle Infrastructure Integration Test Beds Planned for Detroit**

**Accession Number:** 01077150

**Record Type:** Component

**Language:** English

**Source Agency:** UC Berkeley Transportation Library

**Abstract:** In this article, the author describes a number of tests conducted by the Michigan Department of Transportation (MDOT) regarding Vehicle Infrastructure Integration (VII). The tests, conducted in the Detroit area, collect vehicular information such as speed of travel, road surface conditions, windshield wiper use, air temperature, and shock and antilock brake use. Intelligent Transportation Systems (ITS) concepts such as VII are implemented in order to increase both mobility and safety. Using a dedicated short-range radio system (DSRC), which links cars to one another via vehicle-to-vehicle as well as to wayside hubs, researchers hope to determine whether a fast moving vehicle can engage in local wireless network communications as effectively as

stationary objects. Other such VII tests are being conducted in the San Francisco Bay Area by the California Department of Transportation (Caltrans) and the University of California, Berkeley.

**TRIS Files:** BTRIS, TRIS

**Media Type:** Print

**Pagination:** pp 42-43

**Authors:** Cardno, Catherine A

**Availability:** Available from UC Berkeley Transportation Library through interlibrary loan or document delivery  
Order URL: <http://library.its.berkeley.edu>  
Find a library where document is available  
Order URL: <http://worldcat.org/oclc/10480594>

**Publication Date:** 20070900

**Serial:** Civil Engineering  
Volume: 77  
Issue Number: 9  
Publisher: American Society of Civil Engineers  
ISSN: 0885-7024  
OCLC: 10480594  
Serial URL: <http://www.pubs.asce.org/ceonline/newce/html>

**Index Terms:** Dedicated short range communications; Detroit (Michigan); DSRC; Inter-vehicle communications; Vehicle infrastructure integration; Vehicle to vehicle communications; Wireless communication systems; Wireless LANs; Wireless local area networks

**Subject Areas:** Highways; Operations and Traffic Management; I70: Traffic and Transport

---

**Title:** **Weather Applications and Products Enabled Through Vehicle Infrastructure Integration (VII) Feasibility and Concept Development Study**

**Accession Number:** 01050465

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://ntl.bts.gov/lib/jpodocs/repts\\_te/14350.htm](http://ntl.bts.gov/lib/jpodocs/repts_te/14350.htm)

**Record URL:** [http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS\\_TE/14350.htm](http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/14350.htm)

**Record URL:** <http://www.ops.fhwa.dot.gov/publications/viirpt/viirpt.pdf>

**Abstract:** Vehicle Infrastructure Integration (VII) involves the two-way wireless transmission of data from vehicle-to-vehicle and vehicle-to-infrastructure utilizing Dedicated Short Range Communications (DSRC). VII will enable the development of weather-related products and applications designed to improve safety and increase mobility and efficiency along the nation's roadways. This report examines current and future vehicle data elements that have the potential to be used directly or indirectly to sense weather and road conditions. The potential contribution of VII-derived atmospheric and road condition information in the analysis and prediction of weather-related hazards is also explored. To make effective use of mobile data for weather-related applications, it is necessary to invest in research to understand issues associated with current and anticipated data elements; therefore, VII-related research and development topics are surveyed, as well as the feasibility of utilizing VII-enabled data to mitigate the impact of road weather-related hazards.

**TRIS Files:** NTL, TRIS

**Report Numbers:** FHWA-HOP-07-084

**Contract Numbers:** DTFH61-05-C-00029

**Media Type:** Web

**Pagination:** 124p

**Authors:** Petty, Kevin R  
Phone: 303-497-2705  
Fax: 303-497-8401  
[kpetty@ucar.edu](mailto:kpetty@ucar.edu)  
National Center for Atmospheric Research  
Mahoney III, William P  
National Center for Atmospheric Research

**Features:** Appendices (3) ; Figures; References (25) ; Tables

**Corporate Authors:** National Center for Atmospheric Research  
Research Applications Laboratory  
P.O. Box 3000  
Boulder, CO 80307-3000 USA  
Federal Highway Administration  
Office of Operations, 1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** Federal Highway Administration  
Office of Operations, 1200 New Jersey Avenue, SE

Washington, DC 20590 USA

**Publication Date:** 20070100

**Edition:** Feasibility and Concept Development Study

**Index Terms:** Adverse conditions; Applications; Atmospheric phenomena; Data elements (Databases); Data processing; Dedicated short range communications; DSRC; Feasibility analysis; Highway safety; Information processing; Information systems; Infrastructure; Inter-vehicle communications; Mobility; Products; Research; Road conditions; Road safety; Road weather information systems; Roadside to vehicle communications; RWIS; Vehicle infrastructure integration; Vehicle to roadside communications; Vehicle to vehicle communications; Weather; Weather conditions; Weather forecasting

**Subject Areas:** Highways; Planning and Forecasting; Research; I72: Traffic and Transport Planning

---

**Title:** **A STUDY OF A SAFETY SUPPORT SYSTEM THAT USES INFORMATION FROM THE ROAD INFRASTRUCTURE. IN: HUMAN FACTORS IN DRIVING AND TELEMATICS, AND SEATING COMFORT**

**Accession Number:** 00977545

**Record Type:** Component

**Language:** English

**Abstract:** Driver's early recognition of potential danger is effective in reducing the number of traffic accidents. This paper describes an in-vehicle safety support system that uses various support services to provide drivers with information concerning upcoming curves, presence of forward obstacles, and road surface conditions. The paper also discusses how the system described, the Advanced-assist Highway System (AHS), uses various types of sensors installed along the road to detect the road surface condition, presence of obstacles and other useful information.

**TRIS Files:** TRIS

**Report Numbers:** SAE/SP-1877,  
2004-01-0232  
2004-01-0233

**Pagination:** p. 109-114

**Authors:** TAKAHASHI, S

TAMURA, M  
Yamamura, Y  
Kojima, M

**Features:** Figures (7) ; References (3)

**Corporate Authors:** Society of Automotive Engineers  
400 Commonwealth Drive  
Warrendale, PA 15096 USA

**Availability:** Society of Automotive Engineers  
400 Commonwealth Drive  
Warrendale, PA 15096 USA  
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Order URL: <http://worldcat.org/isbn/0768014131>

**ISBN:** 0768014131

**Publication Date:** 20040000

**Serial:** Publication of: Society of Automotive Engineers  
Publisher: Society of Automotive Engineers

**Index Terms:** Advanced Cruise-assist Highway System (AHS); Automotive sensors; Guidance references (Highways); In vehicle sensors; Information technology; Magnetic markers (Highways); Roadway guidance markers; Safety appliances; Safety devices; Safety equipment; Vehicle design

**Subject Areas:** Data and Information Technology; Design; Highways; Safety and Human Factors; Vehicles and Equipment; I92: Vehicle Comfort

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## Surface Treatment Effectiveness – Second round of searches

Safety and Effectiveness and ("overlays" or "whitetopping" or "seal coat\*" or "chip seal\*" or "tining" or "pavement grooving" or "antiskid") with date between 200112 and 201203

**Title:** Relative Effectiveness of Grooves in Tire and Pavement for Reducing Vehicle Hydroplaning Risk

**Accession Number:** 01150938

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2155-08>

**Abstract:** Grooving of pavement surface and tire tread has been accepted as good practice to enhance road travel safety against wet weather skidding and hydroplaning. Many guidelines on this practice have been derived from findings of experimental studies and field experience. However, theoretical studies to provide insights into the factors and mechanisms involved are lacking. A theoretically derived analytical simulation model was used to study the relative effectiveness of pavement grooving and tire grooving in reducing vehicle hydroplaning risk. Three basic grooving configurations were considered: ungrooved, longitudinally grooved, and transversely grooved. There are nine different combinations of grooving configurations. To form a common basis for comparison, constant values of groove width, groove spacing, and water-film thickness were considered in the computation of hydroplaning speeds for different groove depths. Transverse grooves performed better than longitudinal grooves in raising hydroplaning speed (i.e., reducing hydroplaning risk), and pavement grooving was a more effective measure than tire tread grooving in reducing hydroplaning risk. Further detailed examinations of the results were conducted to study the practical implications of the findings. For longitudinal grooving, which is commonly adopted in highways, pavement and tire grooving are of equal importance in their contributions toward reducing hydroplaning risk. In the case of runways where transverse grooving is the standard practice, pavement grooving is the dominating component in guarding against hydroplaning.

**TRIS Files:** PRP, TRIS, TRB

**Report Numbers:** 10-1086

**Media Type:** Print

**Pagination:** pp 73-81

**Authors:** Fwa, T F  
Phone: 65-6516-2276  
Fax: 65-6779-1635  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)  
National University of Singapore

Anupam, Kumar  
[g0600315@nus.edu.sg](mailto:g0600315@nus.edu.sg)  
National University of Singapore

Ong, G P  
[ongr@purdue.edu](mailto:ongr@purdue.edu)  
Purdue University

**Features:** Figures (5) ; References (20) ; Tables (8)

**Monograph Title:** Pavement Management 2010, Volume 3

**Monograph Accession Number:** 01170024

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL:  
[http://www.trb.org/Main/Blurbs/Pavement\\_Management\\_2010\\_Volume\\_3\\_164037.aspx](http://www.trb.org/Main/Blurbs/Pavement_Management_2010_Volume_3_164037.aspx)

Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780309142854>

**ISBN:** 9780309142854

**Publication Date:** 20100000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2155  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Accident risk forecasting; Antiskid treatment; Hydroplaning; Pavement grooving; Rolling contact; Skid resistance; Tining (Pavements); Tire pavement interface; Traffic safety; Transverse grooving; Wet weather; Wheel rail interaction

**Subject:** Design; Highways; Pavements; Safety and Human Factors; I22: Design of

**Areas:** Pavements, Railways and Guideways; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

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**Title:** **Centerline Rumble Strips Help Cars and Bicyclists**

**Accession Number:** 01006850

**Record Type:** Component

**Language:** English

**Abstract:** Jefferson County Colorado has foothill canyons with winding mountain roads that serve vehicular traffic including a significant number of bicyclists. Two roads had experienced high accident rates related to vehicles crossing the centerline at high speeds around curves. Jefferson County chose to apply centerline rumble strips to address the problem. Bicycle groups loudly objected in fear that the rumble strips would induce more hazards to bicyclists. They feared the motorists would be less likely to cross the centerline to pass a bicyclist on the edge of the traveled lane thereby increasing risk to bicyclists. The county decided to proceed with the project since the safety problem of speeding vehicles crossing the centerline was the overriding consideration and expected that motorists would drive on the grooved pavement before hitting a bicyclist. A rumble strip groove design developed by the Colorado Department of Transportation, consisted of shallow grooves that provide a buzz to vehicles and are easily negotiated by bicyclists. The bicycle groups were concerned about passing room provided to the cyclists and conducted their own study. They found the cars actually gave bicyclists additional clearance compared to passing in similar conditions with no centerline rumble strips. The vehicle and bicycle accidents have been reduced. The treatment of centerline rumble strips is deemed effective to reduce speeds and induce drivers to stay in their lane around curves while also improving safety for cyclists.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** 6p

**Authors:** Zebauers, Valdis

**Features:** CD-ROM; Figures (1) ; Photos (2) ; Tables (2)

**Monograph Title:** ITE 2005 Annual Meeting and Exhibit Compendium of Technical Papers

**Monograph Accession** 01006879

**Number:**

**Corporate Authors:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Availability:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

Find a library where document is available

Order URL: <http://worldcat.org/isbn/1933452080>

**ISBN:** 1933452080

**Publication Date:** 20050000

**Conference:** ITE 2005 Annual Meeting and Exhibit Compendium of Technical  
Papers  
Location: Melbourne , Australia  
Date: 20050807 - 20050810  
Sponsors: Institute of Transportation Engineers; ARRB Group Limited

**Index Terms:** Accident frequency; Accident rates; Antiskid treatment; Bicycle  
accidents; Bicycle riders; Bicyclists; Center lines; Centerlines;  
Colorado; Cycling accidents; Cyclists; Highway safety; Overtaking;  
Passing; Pavement grooving; Road safety; Rumble strips; Speed;  
Tining (Pavements); Transverse grooving

**Subject Areas:** Highways; Pedestrians and Bicyclists; Safety and Human Factors; I82:  
Accidents and Transport Infrastructure

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**Title:** **Evaluating Improvement Measures for Wet-Weather Operational  
Safety**

**Accession Number:** 01130040

**Record Type:** Component

**Language:** English

**Abstract:** Hydroplaning is an important aspect of wet-weather highway safety  
concerns. Currently the understanding of this phenomenon is primarily  
based on past experience or experimental studies. Empirically derived

rules or measures are widely applied in improving the surface properties of highway pavements to prevent vehicle hydroplaning. Typical improvement measures include longitudinal and transverse pavement grooving, surface texturing techniques, and surface treatment measures to improve pavement microtexture and macrotexture. Due to a lack of in-depth understanding of the skid resistance and hydroplaning mechanisms, researchers could not evaluate the effectiveness of these measures in hydroplaning prevention. The authors, from their earlier works, have developed three-dimensional finite-element models that are capable to simulate hydroplaning of a sliding locked tire. This paper demonstrates the ability of these numerical simulation models in evaluating the effectiveness of different hydroplaning-reducing measures used currently in practice. In particular, the use of pavement grooving and the provision of better pavement surface texture depth are studied in this paper. It is found from the numerical simulations that the use of transverse and longitudinal pavement grooving and higher surface texture depth can increase the hydroplaning speed and skid number at incipient hydroplaning, thereby reducing the risk of hydroplaning.

- TRIS Files:** TRIS
- Media Type:** Print
- Pagination:** pp 373-378
- Authors:** Ong, Ghim Ping  
Phone: 765-494-2255  
Fax: 765-496-7996  
[ongr@purdue.edu](mailto:ongr@purdue.edu)  
Purdue University
- Fwa, Tien F  
[cvefwatf@nus.edu.sg](mailto:cvefwatf@nus.edu.sg)  
National University of Singapore
- Features:** Figures (3) ; References; Tables (4)
- Monograph Title:** International Conference on Maintenance and Rehabilitation of Pavements and Technological Control (MAIREPAV5), Fifth Proceedings
- Monograph Accession Number:** 01129995
- Corporate Authors:** University of Iowa, Iowa City  
Department of Civil and Environmental Engineering  
Iowa City, IA 52242 USA

**Editors:** Hosin Lee  
Phone: 319-335-6818  
Fax: 319-335-6801  
[hlee@engineering.uiowa.edu](mailto:hlee@engineering.uiowa.edu)  
University of Iowa, Iowa City

M Asghar Bhatti  
[mabhatti@uiowa.edu](mailto:mabhatti@uiowa.edu)  
University of Iowa, Iowa City

**Availability:** University of Iowa, Iowa City  
Department of Civil and Environmental Engineering  
Iowa City, IA 52242 USA

Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780874141597>

**ISBN:** 9780874141597

**Publication Date:** 20070000

**Conference:** Fifth International Conference on Maintenance and Rehabilitation of Pavements and Technological Control (MAIREPAV5)  
Location: Park City UT  
Date: 20070808 - 20070810  
Sponsors: University of Iowa, Iowa City; Federal Highway Administration; American Society of Civil Engineers; Transportation Research Board

**Index Terms:** Antiskid treatment; Countermeasures; Finite element analysis; Finite element method; Highway operations; Highway safety; Hydroplaning; Pavement grooving; Road safety; Tining (Pavements); Traffic operations; Transverse grooving; Wet weather

**Subject Areas:** Highways; Safety and Human Factors; I82: Accidents and Transport Infrastructure

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**Title:** **Improving Safety as Part of a Pavement Preservation Program**

**Accession Number:** 01018937

**Record Type:** Component

**Language:** English

**Record URL:** <http://onlinepubs.trb.org/onlinepubs/circulars/ec078.pdf>

**Abstract:** One of the benefits associated with the use of a pavement preservation

program is improved safety characteristics. Improved safety can be realized in several ways. For instance, an agency with a pavement preservation program that includes the early application of preventive maintenance (PM) treatments can generally keep the road network in better condition for a longer period of time. As a result, the roads are relatively smooth, which reduces the cost of operating a vehicle and minimizes crashes associated with defensive driving to avoid potholes and other surface irregularities in the pavement. However, in addition to providing a smoother surface, PM treatments can be used to improve the surface characteristics associated with surface texture (friction) to reduce the likelihood of wet weather and dry weather crashes. In the United States and abroad, an increased emphasis is being placed on safety issues to reduce the number of fatal and serious injuries caused by crashes and the resulting traffic delays. However, the effect of microtexture and macrotexture on crash rates has not been quantified. Past studies have often shown a weak link between increased friction and reduced crash rates. Recently, there have been major advances in data collection and analysis capabilities that show promise for improving the ability of transportation agencies to better quantify the effectiveness of pavement preservation treatments on reducing crash rates by improving surface characteristics. For instance, it is now possible to collect continuous pavement macrotexture information at highway speeds. It is also possible to measure macrotexture under the tire during skid trailer friction testing. These technological advances will greatly enhance the ability of highway agencies to identify sites of potentially high accident rates and to proactively take preventive actions as part of a pavement preservation program. This paper focuses on the safety improvements that can be realized as part of a pavement preservation program. Specifically, the following areas are discussed in this paper: (1) the use of network-level evaluations (including features such as pavement macrotexture and annual friction surveys) as a means of identifying pavement sections that could benefit from the use of certain PM treatments to enhance or restore friction values (such as microsurfacing, grinding and/or grooving, or chip seals); (2) the development of safety investigatory levels based on microtexture and macrotexture data for various site categories; and (3) the incorporation of safety features into a pavement management analysis. The application of these characteristics are demonstrated using examples from transportation agencies worldwide. For instance, the Texas Department of Transportation's Wet Weather Accident Analysis Program is an example of the type of study used to illustrate the points raised. Internationally, work being conducted in the United Kingdom and New Zealand on continuous friction measurements and the use of the data to identify pavement sections where poor texture/friction may be contributing to higher than average crash rates are featured. Other examples, such as Australia's recently established goal of achieving

19% of their 40% per capita accident reduction by providing safer roads is also documented.

**TRIS Files:** TRIS, TRB

**Media Type:** Web

**Pagination:** pp 159-172

**Authors:** Zimmerman, Kathryn A  
Phone: (217) 398-3977  
[kzimmer@aol.com](mailto:kzimmer@aol.com)  
Applied Pavement Technology, Incorporated

Larson, Roger

**Features:** Figures (4) ; References; Tables (4)

**Monograph Title:** Roadway Pavement Preservation 2005

**Monograph Accession Number:** 01018923

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/00978515>

**Publication Date:** 20051000

**Conference:** First National Conference on Pavement Preservation  
Location: Kansas City MO, United States  
Date: 20051031 - 20051101  
Sponsors: Transportation Research Board

**Serial:** Transportation Research E-Circular  
Issue Number: E-C078  
Publisher: Transportation Research Board  
ISSN: 0097-8515

**Index Terms:** Accident black spots; Accident frequency; Accident prone locations; Accident rates; Chip seals; Collision injuries; Crash injuries; Data acquisition; Data analysis; Data collection; Friction; Grinding; High accident locations; Highway accidents; Highway safety; Hotspot; Investigatory levels; Macrotexture; Microsurfacing (Surface treating); Microtexture; Network-level pavement evaluation; Pavement management; Pavement management systems; Preservation; Preventive maintenance; Protective treatments; Road safety; Traffic accidents; Traffic delay; Traffic safety; Wet weather

**Subject Areas:** Highways; Maintenance and Preservation; Pavements; Safety and Human Factors; I61: Equipment and Maintenance Methods; I82: Accidents and Transport Infrastructure

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**Title:** The effectiveness of the application of high friction surfacing on crash reduction

**Accession Number:** 01026728

**Record Type:** Component

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E212870

**Abstract:** While the range of the crash types and issues on motorways are generally limited, every now and then a site presents itself whereby the extent of the problem, the causes or even the solutions are not straight forward. The Great North Road city bound on ramp on to Auckland's Northwestern Motorway is just one such example. Close examination showed that speed along with the ramp geometry, seal choice, paint markings, runoff, the shade and the seal types and limits all had a part to play. A traditional approach may have seen this site simply classified as a slippery seal site resulting in a more frequent reseal programme. However, new treatment solutions are always presenting themselves, and the use of high friction surfacing is one of the more recent engineering solutions to be used in New Zealand. Hence, the final choice of treatment was high friction surfacing using Calcined Bauxite aggregate, safe hit posts and changes to the sealing programme. (a) For the covering entry of this conference, please see ITRD abstract no. E212865.

**TRIS Files:** ITRD

**Pagination:** 18P (SESSION 1)

**Authors:** ISKANDER, R  
Beca Infrastructure Limited

STEVENS, A  
Beca Infrastructure Limited

**Monograph Title:** International Surface Friction Conference: roads and runways: improving safety through assessment and design, 1-4 May 2005, Christchurch, New Zealand

**Monograph Accession** 01026723

**Number:**

**Publication Date:** 20050500

**Serial:** INTERNATIONAL SURFACE FRICTION CONFERENCE, 2005,  
CHRISTCHURCH, NEW ZEALAND  
Publisher: TRANSIT NEW ZEALAND

**Index Terms:** Access road; Access roads; Accident black spot; Accident black spots; Accident prevention; Accident prone locations; Aggregate; Aggregates; Conference; Conferences; Congresses; Controlled access highways; Engineering properties; Freeways; Friction; Friction; High accident locations; Hotspot; Motorway; Motorways; Prevention; Properties; Properties of materials; Public safety; Safety; Safety measures; Seal coats; Sealing coat (on top of the surfacing); Surface; Surface dressing; Surface finish; Surfaces; Surfacing; Surfacing; Symposia; Waterproofing course

**Subject Areas:** Geotechnology; Highways; Materials; Pavements; Safety and Human Factors; Security and Emergencies; I23: Properties of Road Surfaces

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**Title:** **Transverse Rumble Strips**

**Accession Number:** 01104972

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.lrrb.org/pdf/trs0701.pdf>

**Abstract:** Many studies on traffic calming look at the effectiveness of different techniques in reducing speeds on city streets, but there is less information available about the application of traffic calming to reduce speeds on high-speed rural roadways. This synthesis examines national and international research that relates to the application of traffic calming on high-speed rural roadways. The Federal Highway Administration(FHWA) defines rumble strips “as raised or grooved patterns on the roadway shoulder that provide both an audible warning (rumbling sound) and a physical vibration to alert drivers that they are leaving the lane.” Cities and counties may use rumble strips as means of enhancing safety to help warn motorists to slow down in anticipation of a stop sign or to help warn motorists that they are leaving the roadway or crossing the centerline.

**TRIS Files:** TRIS

**Report Numbers:** TRS 0701

**Media Type:** Web

**Pagination:** 5p

**Authors:** Gorrill, Darlene  
Minnesota Department of Transportation

**Features:** Photos (1)

**Publication Date:** 20070800

**Serial:** Transportation Research Synthesis  
Issue Number: TRS 0701  
Publisher: Minnesota Department of Transportation  
Serial URL: <http://www.research.dot.state.mn.us>

**Index Terms:** Antiskid treatment; Audible warning devices; Aural signals; Center lines; Centerlines; Crossover accidents; Crossovers; Pavement grooving; Raised road markings; Road shoulders; Road studs; Rumble strips; Shoulders (Roads); Tining (Pavements); Traffic safety; Transverse grooving; Verge; Warning devices

**Subject Areas:** Highways; Safety and Human Factors; I85: Safety Devices used in Transport Infrastructure

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**"Before and After" and (Surface conditions OR Surface treatment/treating OR Surface/wearing/binder/friction/blanket course OR tining OR grooving OR chip seals OR whitetopping OR seal coats)**

**Title:** Evaluation of the SafeLane™ Overlay System for Crash Reduction on Bridge Deck Surfaces

**Accession Number:** 01153466

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.cts.umn.edu/Publications/ResearchReports/pdfdownload.pl?id=1324>

**Summary URL:** <http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=1894>

**Abstract:** The winter performance of the SafeLane™ commercial overlay system has been evaluated at four installations on bridge decks in the state of Minnesota. The study was conducted over a period of a total of three years. Analyses included mechanical and chemical testing of the components, chloride analysis as a

function of depth, friction by skid test and visual inspection. At one site plow operator's comments were gathered to assess retention of deicing chemicals from event to event. All sites were included in a comparison of accident frequency before and after overlay installation.

**TRIS Files:** TRIS

**Report Numbers:** MN/RC 2010-13

**Contract Numbers:** (c) 89261 (wo) 94

**Media Type:** Print

**Pagination:** 33p

**Authors:** Evans, John F  
University of Minnesota, Duluth

**Features:** Appendices (2) ; Figures; Tables (4)

**Corporate Authors:** University of Minnesota, Duluth  
Department of Chemistry and Biochemistry, 1039 University Drive  
Duluth, MN 55812 USA  
Minnesota Department of Transportation  
Research Services Section, 395 John Ireland Boulevard, Mail Stop 330  
St Paul, MN 55155 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20100300

**Edition:** Final Report

**Index Terms:** Blanket course; Bridge decks; Bridge slabs; Bridge surfaces; Highway safety; Minnesota; Overlay course; Overlays (Pavements); Performance measurement; Polymers; Road safety; Road surfaces; Surface course (Pavements); Winter maintenance

**Subject Areas:** Bridges and other structures; Highways; Maintenance and Preservation; I62: Winter Maintenance

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**Title:** Safety Performance of Experimental Pavement Types in California Using Before-and-After Comparisons

**Accession Number:** 01152080

**Record Type:** Component

**Language:** English

**Order URL:** <http://pubsindex.trb.org/orderform.html>

**Source Data:** Transportation Research Board Annual Meeting 2010 Paper #10-2876

**Abstract:** This study focused on safety performance of new pavement surface types. Open graded or coarse-textured roadway surfaces are advisable for high-speed, wet-weather traffic conditions. They provide drainage relief at the tire-pavement interface, reduce the steepness of the speed gradient, decrease the likelihood of hydroplaning, minimize splash and spray, reduce the glare from wet pavements, and improve high-speed skid resistance. Before-and-after comparisons using historical collision data from California Traffic Accident Surveillance and Analysis System (TASAS) were conducted to assess the safety performance of three types of experimental pavement: open-graded asphalt concrete (OGAC), groove pavement (GP), and rubberized open-graded asphalt concrete (R-OGAC) projects implemented in recent years. Because these new types of pavement surfaces are expected to improve drainage, wet pavement related collisions were considered target collisions and analyzed in the before-and-after study. Our findings indicate that resurfacing with OGAC significantly decreased the number of wet-related collisions. However, no significant conclusions were drawn from the results of resurfacing with GP and R-OGAC, due to the lack of sufficient data. While further research is needed, findings from this current study suggest that new pavement types such as OGAC can improve the safety performance of roadways.

**TRIS Files:** TRIS, TRB

**Report Numbers:** 10-2876

**Media Type:** DVD

**Pagination:** 11p

**Authors:** Oh, Soonmi  
Phone: (510) 642-0566  
Fax: (510) 643-9922  
[smoh@berkeley.edu](mailto:smoh@berkeley.edu)  
University of California, Berkeley

Ragland PhD, David R  
Phone: (510) 642-0655  
Fax: (510) 643-9922  
[davidr@berkeley.edu](mailto:davidr@berkeley.edu)

School of Public Health, UC Berkeley  
Chan Ph.D., Ching-Yao  
Phone: (510) 665-3621  
Fax: (510) 665-3757  
[cychan@path.berkeley.edu](mailto:cychan@path.berkeley.edu)  
University of California, Berkeley

**Features:** Figures (4) ; Maps (1) ; References (7) ; Tables (5)

**Monograph Title:** TRB 89th Annual Meeting Compendium of Papers DVD

**Monograph Accession Number:** 01147878

**Corporate Authors:** Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Publication Date:** 20100000

**Conference:** Transportation Research Board 89th Annual Meeting  
Location: Washington DC  
Date: 20100110 - 20100114  
Sponsors: Transportation Research Board

**Index Terms:** Accident causes; Accident factors; Accident responsibility; Asphalt concrete pavements; Asphaltic concrete pavements; Blanket course; California; Conspicuity; Glare; Highway accidents; Highway safety; Hydroplaning; Pavements; Repaving; Resurfacing; Road safety; Road surfaces; Surface course (Pavements); Surface drainage; Traffic accidents; Visibility; Wet weather

**Subject Areas:** Highways; Materials; Operations and Traffic Management; Pavements; I61: Equipment and Maintenance Methods; I82: Accidents and Transport Infrastructure

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**Title:** **The early life skid resistance of road surfaces**

**Accession Number:** 01121380

**Record Type:** Monograph

**Language:** English

**Source Agency:** Transport Research Laboratory  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E140835

**Abstract:** In the UK, TRL Limited has carried out an ongoing programme of research into the effects of early life skidding resistance on road surfacing materials introduced since the mid 1990s. Ways of measuring friction and skidding resistance are described briefly. The first phase of the research programme began in 2001 and concentrated on assessing the physical effects associated with dry friction and wet skidding resistance on new asphalt surfaces. The second stage followed on to review the accident statistics to establish what objective evidence there might be for increased risk. The main component of this phase was an analysis of accidents before and after resurfacing on the Highways Agency network. On the new surfaces, skidding resistance decreased as speed increased, with the greatest loss of friction tending to occur between 20 and 50 km/h. It is considered that the thicker bitumen film masks the microtexture on the new surfacings, leading to relatively lower skidding resistance at higher speeds. However this does not necessarily imply a significantly increased risk of skidding. The low-speed wet skidding resistance from six months onwards decreased but was still high in comparison with what is commonly expected on the UK road network. As the new surfaces aged, the friction on the lightly-trafficked sites tended to fall close to the lower limit expected for older roads. Tests of the effects of speed on dry friction of new surfacing showed that this decreased with increasing speeds up to about 50 km/h after which it remained essentially constant. Dry friction in early life of the road is generally lower than would be expected from a normal trafficked dry road. Dry friction at intermediate speeds increased with time after resurfacing, and this increase occurred sooner at higher traffic levels. Overall there was little change in the number of accidents between the year before and the year after resurfacing, demonstrating that there was little change in the overall accident risk for the lengths of road network included in this analysis.

**TRIS Files:** ITRD

**Authors:** ROE, P G  
Transport Research Laboratory

**Publication Date:** 20081100

**Serial:** TRL STAFF PAPER  
Issue Number: 010  
Publisher: Transport Research Laboratory

**Index Terms:** Before and after studies; Blanket course; Friction; Highway construction; Measurement; Measuring; Road construction; Road surfaces; Rolling contact; Skid resistance; Speed; Surface course (Pavements); Surfacing; Time; Tire pavement interface; Traffic density; Wet pavements; Wet weather; Wheel rail interaction

**Subject Areas:** Construction; Highways; Operations and Traffic Management; I23: Properties of Road Surfaces; I52: Construction of Pavements and Surfacing

---

**Title:** **Evaluation of Innovative Safety Treatments. Volume 3: A Study of the Effectiveness of Tyregrip High Friction Surface Treatment**

**Accession Number:** 01091736

**Record Type:** Monograph

**Language:** English

**Abstract:** The Florida Department of Transportation (FDOT) District 4 Traffic Operations office in consultation with the Federal Highway Administration (FHWA) has installed the Tyregrip high friction surfacing system to help reduce the potential for run-off-road crashes along the on-ramp to northbound I-75 from eastbound Royal Palm Boulevard located in the City of Weston, Broward County, Florida. The Tyregrip system was installed on a 300-foot section of the ramp, just upstream of the gore area between I-75 and the ramp, where the majority of the crashes occurred. This particular ramp was chosen as a candidate for this field test based on its crash history with 12 run-off-road crashes in the three-year period from 2002 to 2004. Eighty-three percent of these crashes occurred under wet road surface conditions. The effectiveness of the Tyregrip surface was evaluated from a materials perspective and from a safety perspective by using various types of data as discussed below. Crash data were obtained from the Florida Department of Transportation Crash Analysis Reporting System (CARS). Over the four-year period prior to the installation of the Tyregrip, the treated section experienced an average of 2.54 crashes per year. In the 12 month period immediately following the installation of Tyregrip surface, the section experienced two crashes. Since the Tyregrip was installed in May 2006, sufficient crash data was not available to determine a statistically significant difference in crash frequency or rate. Due to the crash data limitations, surrogate measures of safety were evaluated to obtain a better understanding of the effects of the Tyregrip treatment as discussed below. Skid tests were performed by the FDOT Materials Testing office for the study section of the ramp before and after the treatment on April 11, 2006 and May

23, 2006, respectively. The results of these tests indicate that the friction number was much higher after application of the Tyregrip treatment, as expected. Speed studies were performed within the treated section before and after the installation of the Tyregrip at different times of the day. The results of these studies indicate that the mean speeds were decreased by an average of 3.72 miles per hour under dry pavement conditions. Under wet conditions, the mean speeds also decreased, by an average of 2.62 miles per hour after the application of the Tyregrip treatment. The proportion of vehicles encroaching either the outer or inner shoulders was examined prior to and after the application of the Tyregrip using the Z-test. The results indicate that the proportion of drivers encroaching the shoulder decreased significantly after the installation of the Tyregrip under wet pavement conditions while no significant difference was found under dry conditions. Overall, the Tyregrip treatment was effective in increasing the friction between the roadway and vehicle tires. The treatment was found to assist motorists in maintaining their lane position under wet pavement conditions. In addition, drivers tended to slow down when traveling over the treated section of the ramp. It appears that the use of Tyregrip may be a practical countermeasure for improving safety at locations that are prone to run-off-road crashes, particularly sharp curves and entry/exit ramps.

<b>TRIS Files:</b>	TRIS
<b>Report Numbers:</b>	40502-PL-010-001
<b>Contract Numbers:</b>	B-D500
<b>Media Type:</b>	CD-ROM
<b>Pagination:</b>	25p
<b>Authors:</b>	Reddy, Vivek Datta, Tapan Savolainen, Peter Pinapaka, Satya
<b>Features:</b>	Appendices (1) ; Figures (2) ; References (2) ; Tables (10)
<b>Corporate Authors:</b>	HNTB Corporation 6363 NW 6th Way, Suite 420 Fort Lauderdale, FL 33309 USA Florida Department of Transportation 605 Suwannee Street Tallahassee, FL 32399-0450 USA
<b>Availability:</b>	National Technical Information Service

5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20080100  
**Edition:** Final Report  
**Period Covered:** June 2006-January 2008  
**Index Terms:** Accident data; Before and after studies; Bends (Roads); Blanket course; Countermeasures; Dry weather; Florida; Friction; Highway curves; Highway safety; Innovation; Ran off road accidents; Road curves; Road safety; Road surfaces; Roadway departure accidents; Running off roadway; Skid resistance tests; Speed; Surface course (Pavements); Traffic safety; Tyregrip; Wet weather  
**Subject Areas:** Highways; Safety and Human Factors; I82: Accidents and Transport Infrastructure

---

**Title:** **Accidents par perte d'adherence : Relation adherence-securite routiere et analyse prealable a l'intervention**

**Accession Number:** 01184932

**Record Type:** Component

**Language:** French

**Source Agency:** Institut National de Recherche sur les Transports et leur Sécurité (INRETS)

**Source Data:** ITRD F100828

**Abstract:** Les accidents de la circulation sur chaussee mouillee demeurent une problematique de securite importante. Les principaux enjeux associes aux caracteristiques d'adherence des chaussees sont d'abord rappelés. L'influence de ces caracteristiques sur le risque d'accidents a ete mise en evidence a plusieurs reprises ; les principaux resultats sont mentionnes ainsi que les difficultes pratiques et methodologiques auxquelles se heurtent les etudes statistiques. Malgre l'importance des problemes de securite lies a l'adherence, les methodes actuelles d'analyse de l'insecurite d'une voie prealablement a une intervention ne sont pas tres explicites sur la facon de les apprehender. Des reperes methodologiques sont donc proposes pour prendre en compte l'adherence sur l'infrastructure dans les differentes phases de l'analyse : approfondissement des enjeux et diagnostic. Ces elements sont illustres par un extrait d'une etude de securite sur une voie urbaine rapide. (A). (Titre en anglais : Accidents du to loss of skid resistance : The skid

resistance-road safety relationship and preliminary intervention analysis).

**TRIS Files:** ITRD

**Pagination:** 169-78

**Authors:** PATTE, L  
LRPC EST PARISIEN

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/11291496>

**Publication Date:** 20050400

**Serial:** BULLETIN DES LABORATOIRES DES PONTS ET CHAUSSEES,  
NUMERO SPECIAL : ADHERENCE  
Issue Number: 255  
Publisher: Laboratoire Central des Ponts et Chausees (LCPC)  
ISSN: 1129-1496

**Index Terms:** Accident; Accidents; ADHERENCE; Before and after studies; Blanket course; Climat; Coefficient de frottement; Coefficient of friction; Etude avant apres; Friction coefficient; Frictional coefficient; Public safety; Road surfaces; Route mouillee; Safety; Safety measures; Securite routiere; Surface course (Pavements); Weather; Wet pavements; Wet weather

**Subject Areas:** Safety and Human Factors; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

---

**Title:** **SKID ACCIDENT REDUCTION PROGRAM (SKARP): TARGETED CRASH REDUCTIONS**

**Accession Number:** 00943866

**Record Type:** Component

**Language:** English

**Abstract:** New York State Department of Transportation's (NYSDOT's) Skid Accident Reduction Program (SKARP) identifies sections of pavement experiencing unusually high proportions of wet road accidents, friction tests them, and treats those sections which are experiencing both high wet road crashes and low friction numbers. The treatment generally involves a 1 and 1/2" resurfacing, or a 1/2" microsurfacing, using non-carbonate aggregates (costing \$20,000 per lane mile). Forty (40) locations treated under the Program have been evaluated. Based on the

size and consistency of the differences in crash experience and friction numbers during each year before and following resurfacing at identified high wet road crash sites, it is concluded that the Program selection and treatment strategies are appropriate and effective. Percentages of wet road crashes (compared with total crashes) have remained consistently high during years before treatment, and consistently low following treatment. Particularly noteworthy, is that the percentages remained high during the before period even during years when the identified high wet road crash sites did not appear on the annual high wet road crash listing (suggesting a minimal effect of regression to the mean at identified high crash sites experiencing low friction numbers). "Before and After" accident analyses have shown that each year more than 740 annually recurring accidents are being reduced as a consequence of treatments undertaken at 40 sites between 1995 and 1997 on Long Island alone. Five hundred and forty (540) of those crashes were wet road crashes. Some simple empirically based tests for regression to the mean were undertaken (in addition to the above). A one year before/after study was performed for 20 of the test locations which did not appear on the wet road crash listing during the one year before period. Results from that evaluation, the general consistency of percentages of wet road crashes in the before period, and previous empirically based findings regarding the effect of regression to the mean at untreated high accident sites, suggest crash modification factors for the SKARP program as follows: total crashes should be expected to decline by 20%, wet road crashes should be expected to decline by 60%, and severe (Fatal and injury) wet road crashes should be expected to decline by 70%. All but one of the 40 sites treated in this study involve intersections. Improving pavement friction at intersections experiencing high wet road crashes and low friction numbers, presents a relatively low cost improvement which should be expected to produce large crash reductions - particularly as regards severe (fatal and injury) crashes.

**TRIS Files:** TRIS

**Report Numbers:** CD-020

**Pagination:** 19p

**Authors:** Bray, J S

**Corporate Authors:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

**Availability:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

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Order URL: <http://worldcat.org/isbn/0935403752>

**ISBN:** 0935403752

**Publication Date:** 20030300

**Conference:** Institute of Transportation Engineers (ITE) 2003 Technical Conference and Exhibit  
Location: Fort Lauderdale, Florida, USA  
Date: 20030323 - 20030326  
Sponsors: Institute of Transportation Engineers

**Index Terms:** Accident analysis; Accident black spots; Accident prone locations; Aggregates; Blanket course; Cross roads; Death; Fatal accidents; Fatalities; Friction; High accident locations; Highway accidents; Highway safety; Hotspot; Improvements; Injuries; Injury; Intersections; Junctions (Traffic); New York (State); Pavement performance; Rehabilitation (Maintenance); Repaving; Resurfacing; Road safety; Road surfaces; Skid Accident Reduction Program (SKARP); Skid resistance; Skidding; State departments of transportation; Surface course (Pavements); Traffic accidents; Traffic fatalities; Traffic safety; Trauma; Wet weather

**Subject Areas:** Geotechnology; Highways; Pavements; Safety and Human Factors; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

---

**Title:** **Safety Effect of Preventive Maintenance: A Case Study of Microsurfacing**

**Accession Number:** 01100691

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2044-09>

**Abstract:** Various North American transportation agencies have implemented several preventive maintenance techniques to improve pavement performance and safety. The York Region, located northeast of Toronto, Ontario, Canada, has been resurfacing and remedying pavements with microsurfacing treatments to improve the pavement surface conditions, but without a good understanding of how the treatment affects road safety. With data made accessible by the region, a before-and-after study was done, with the goal of gaining an understanding of how microsurfacing and resurfacing treatments affect

road safety. The study concludes that microsurfacing and resurfacing can have a positive safety effect, with crash reduction factors as high as 54%. However, those activities are sensitive to the influence of treatment year data (which may be an anomaly period) and average annual daily traffic per lane. Generally, the findings illustrate that microsurfacing has a positive safety effect on locations susceptible to a number of conditions: regular occurrence of wet or slick (not dry) road surface conditions, a trend toward severe crashes, frequent intersection-related crashes, and a high occurrence of rear-end crashes. Findings of this study have opened the door to additional research; integration of safety under the pavement umbrella seems so logical and yet has barely been explored. For now, the crash reduction factors derived from the study can be applied by the region of York and by other jurisdictions to make more sound decisions at the network level when selecting pavement maintenance treatments.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 79-85

**Authors:** Erwin, Tara  
[terwin@itransconsulting.com](mailto:terwin@itransconsulting.com)  
iTRANS Consulting, Incorporated  
Tighe, Susan Louise  
Phone: 519-888-4567ext3152  
Fax: 519-888-6197  
[sltighe@uwaterloo.ca](mailto:sltighe@uwaterloo.ca)  
University of Waterloo

**Features:** Figures (1) ; References (4) ; Tables (4)

**Monograph Title:** Infrastructure Maintenance

**Monograph Accession Number:** 01108912

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://trb.org/news/blurb\\_detail.asp?id=9418](http://trb.org/news/blurb_detail.asp?id=9418)  
Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780309113120>

**ISBN:** 9780309113120

**Publication Date:** 20080000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2044  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Before and after studies; Collisions; Crashes; Highway safety; Microsurfacing; Pavement maintenance; Pavement performance; Preventive maintenance; Rear end collisions; Repaving; Resurfacing; Road safety; Wet weather; York (Canada)

**Subject Areas:** Highways; Maintenance and Preservation; Safety and Human Factors; I61: Equipment and Maintenance Methods; I82: Accidents and Transport Infrastructure

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**Title:** **Evaluation of Concrete Pavement Texturing Practice in Minnesota Using the Wet Weather Accident Evaluation Criterion**

**Accession Number:** 01160587

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.lrrb.org/PDF/200846.pdf>

**Abstract:** Concrete pavements built in Minnesota are currently textured by dragging an inverted Turf or broom in the longitudinal direction. This process imparts a macro texture required to be greater than a mean texture depth of 1mm measured by the ASTM Sand Volumetric test (ASTM E 965-95). At present, this texture guideline is communicated through a special provision in pavement construction. Newly textured pavements are usually evaluated for adequacy in providing a safe riding surface through texture measurements for acceptance and friction measurements as required. The current FHWA Technical Advisory on Texture requires that performance of non-conventional textures be monitored and reported. This report identifies pavement sites in the network where the original texture, mainly the transverse tining plus Burlap, was either overlaid or rebuilt and the new surface finished with longitudinal inverted turf drag, or broom drag. It extracts wet weather accident data from the Mn/DOT Office of Traffic, Safety and Operations (OTSO) database and analyzes the annual wet weather accident and crash rates, preconstruction, during construction and after construction. It performs a descriptive statistics of the period before and the period of the new texturing to determine if, wet weather accident counts, percentage of wet weather accidents in total count and crash rates and/or ratio of annual wet to dry accident counts, and crashes

clearly increased with current texturing practices. Data were analyzed with statistical tools for data comparison including the descriptive statistics, U-test and “before and after“ comparison (Z-test). The analyses of the data for the sections show that current texturing practices did not cause an increase in the annual wet weather accidents, crash rates, or ratio of wet to dry weather accidents.

**TRIS Files:** TRIS

**Report Numbers:** MN/RC 2008-46

**Media Type:** Web

**Pagination:** 70p

**Authors:** Izevbekhai, Bernard  
Phone: 651 366 5454  
Fax: 651 366 5461  
[Bernard.Izevbekhai@dot.state.mn.us](mailto:Bernard.Izevbekhai@dot.state.mn.us)  
Minnesota Department of Transportation  
Watson, Mark  
Minnesota Department of Transportation

**Features:** Appendices (2) ; Figures; Photos; References; Tables

**Corporate Authors:** Minnesota Department of Transportation  
  
Office of Materials, 1400 Gervais Avenue  
Maplewood, MN 55109 USA  
Minnesota Department of Transportation  
Research Services Section, 395 John Ireland Boulevard, Mail Stop 330  
St Paul, MN 55155 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20080600

**Edition:** Final Report

**Index Terms:** Accident data; Accident frequency; Accident rates; Before and after studies; Concrete pavements; Macrotexture; Minnesota; Surface properties; Surface texture; Texture; Wet weather

**Subject Areas:** Highways; Pavements; Safety and Human Factors; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

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**Title:** Does friction and colour equal safety? [road surface treatments]

**Accession Number:** 01026768

**Record Type:** Component

**Language:** English

**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E212910

**Abstract:** This paper introduces a discussion for: 1. identifying what makes a high friction surface treatment; 2. comparing natural quarried aggregates and calcined bauxite in terms of surface friction and polished stone values; 3. the type and durability of coloured surface treatments, and; 4. safety outcomes from the use of both materials in terms of friction and colour. Examples are described where: 1. the material has performed well above its specified requirements; 2. the use of inappropriate materials that have reduced the life of the treatment are discussed, in terms of failure mode describing the material properties and the reasons that led to the failure; 3. the benefits gained from using high friction and coloured surface treatments. The report concludes that when a properly designed and applied high friction or coloured surface treatment is used on a suitable road surface where there is a high incidence of congestion and crashes that an immediate reduction in crashes should be expected with a corresponding reduction in travel time. (a) For the covering entry of this conference, please see ITRD abstract no. xxxxxx.

**TRIS Files:** ITRD

**Pagination:** 11P (SESSION 8)

**Authors:** PARFITT, C  
Prismo Australasia  
LEWANDO, J  
Highway Systems

**Monograph Title:** International Surface Friction Conference: roads and runways: improving safety through assessment and design, 1-4 May 2005, Christchurch, New Zealand

**Monograph Accession Number:** 01026723

**Publication Date:** 20050500

**Serial:** INTERNATIONAL SURFACE FRICTION CONFERENCE, 2005,

CHRISTCHURCH, NEW ZEALAND  
Publisher: TRANSIT NEW ZEALAND

**Index Terms:** Accident prevention; Aggregate; Aggregates; Building materials; Color; Colors; Colour; Colour; Conference; Conferences; Congresses; Construction materials; Durability; Durability; Engineering properties; Friction; Friction; Material (constr); Prevention; Properties; Properties of materials; Public safety; Safety; Safety measures; Skid resistance; Skidding resistance; Surface; Surfaces; Symposia; Wear resistance

**Subject Areas:** Geotechnology; Materials; Pavements; Safety and Human Factors; Security and Emergencies; I23: Properties of Road Surfaces; I36: Aggregates

---

**Title:** **The influence of road surface condition on traffic safety and ride comfort**

**Accession Number:** 01014501

**Record Type:** Component

**Language:** English

**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E212547

**Abstract:** Two separate studies on traffic safety and ride comfort, respectively, are presented in this paper. Regression analyses have mainly been used for this study. In brief, the results from the regression analyses indicate that ruts have little effect on traffic safety, under certain circumstances there is even a tendency for improved traffic safety. The results, however, clearly show that the accident rate increases with increasing unevenness (IRI). The primary aim of the ride comfort study was to investigate, in a field study, the relationship between the unevenness of the road surface and the perceived ride comfort of motorists, as well as their willingness to pay for improved driving comfort. The test subjects were asked which factors are significant for driving comfort. It was found that the road surface condition was considered to be of greatest importance for the ride comfort, followed by the car, the behaviour of other road users and good visibility. (a) For the covering entry of this conference, please see ITRD abstract no. E212095.

**TRIS Files:** ITRD

**Pagination:** 11P

**Authors:** IHS, A  
Swedish National Road and Transport Research Institute (VTI)

**Monograph Title:** 6th International Conference on Managing Pavements: The Lessons, The Challenges, The Way Ahead, 19-24 October 2004, Brisbane, Queensland, Australia. Conference Proceedings

**Monograph Accession Number:** 01036665

**Corporate Authors:** Queensland Department of Main Roads  
GPO Box 1412  
Brisbane, Queensland 4001 Australia

**Availability:** Queensland Department of Main Roads  
GPO Box 1412  
Brisbane, Queensland 4001 Australia

**Publication Date:** 20041000

**Conference:** 6th International Conference on Managing Pavements: The Lessons, The Challenges, The Way Ahead  
Location: Brisbane Queensland, Australia  
Date: 20041019 - 20041024  
Sponsors: Queensland Department of Main Roads; ARRB Group Limited; FRH Group; Exor Corporation; Pavement Management Services; Federal Highway Administration; World Highways; GHD; Brisbane City Council; Tasmania Department of Infrastructure, Energy and Resources; Australian Road Federation (ARF); Hansen; Cooperative Research Centre for Construction Innovation

**Index Terms:** Accident frequency; Accident rate; Accident rates; Citizen participation; Comfort; Comfort; Conference; Conferences; Congresses; Engineering properties; Evenness; Highway; Human comfort; Improvement; Improvements; Local participation; Payment; Payment; Properties; Properties of materials; Public involvement; Public participation; Public participation; Public safety; Roads; Safety; Safety; Safety measures; Smoothness; Surface; Surfaces; Symposia

**Subject Areas:** Finance; Highways; Materials; Pavements; Safety and Human Factors; Society; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

---

**Title:** **Economic appraisal and optimization process in road safety projects**

**Accession Number:** 01207998

**Record Type:** Component

**Language:** English

**Source Agency:** Swedish National Road and Transport Research Institute (VTI)  
Olaus Magnus vaeg 35  
Linkoeping SE-581 95 Sweden

**Source Data:** VTI 2010.0160

**Abstract:** Setting a procedure to assess the efficiency in provision of the funds and operational expenses in road safety projects requires to establish a process involving the economic appraisal and optimization tasks. In the optimization process developed in the paper, five types of geometric features may be considered in the analysis including: (1) lane width and pavement condition, (2) horizontal curves, (3) vertical curves, (4) roadside condition, and (5) narrow bridges. The model enables the users to evaluate a variety of improvement alternatives for each predetermined geometric feature along the route under study, following which all possible mutually exclusive proposals are achieved for each site. Both calculating the executive costs and estimating the monetary benefits according to the reduction of road accidents for each proposal are the main components in estimating the net benefit attributable to each mutually exclusive proposal. Afterwards, an optimization process using linear integer programming is fed by the outputs of the cost-benefit analysis to find out the highest net benefit (as an efficiency criteria) among all provided proposals for all sites under study.

**TRIS Files:** ITRD, VTI

**Pagination:** s 1208-1216

**Authors:** Behnood, Hamid R  
Roozikhah, Hossein  
Khatami, Sina

**Publication Date:** 20100000

**Serial:** Road safety on four continents: 15th international conference, Abu Dhabi, United Arab Emirates, 28-30 March 2010. Paper

**Index Terms:** Accident black spots; Accident prevention; Accident prone locations; Benefit cost analysis; Calculation; Conferences; Congresses; Cost benefit analysis; Economic efficiency; Geometric design; High accident locations; Hotspot; Mathematical models; Optimisation; Optimization; Rural road; Symposia

**Subject Areas:** Economics

---

**Title:** Using high friction surface treatments to reduce traffic accidents

**Accession Number:** 01014394

**Record Type:** Component

**Language:** English

**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E212039

**Abstract:** This paper introduces a process for: calculating the change in braking distance from the use of properly designed, specified and applied high friction surface treatments; comparisons are made between naturally occurring aggregates and the calcined bauxite used in the high friction surface treatments in terms of surface friction and polished stone values. Examples are described where: the material has performed well above its internationally stated capabilities. The report concludes that when a properly designed, specified and applied high friction surface treatment is used on a suitable road surface with a high incidence of traffic accidents that an immediate reduction in traffic accidents should be expected. (a) For the covering entry of this conference, please see ITRD abstract no. E211985.

**TRIS Files:** ITRD

**Pagination:** 12P

**Authors:** PARFITT, C  
Prismo

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/isbn/0730724921PRINT>

**ISBN:** 0730724921 [PRINT]

**Publication Date:** 20040000

**Serial:** ROAD SAFETY RESEARCH, POLICING AND EDUCATION CONFERENCE, 2004, PERTH, WESTERN AUSTRALIA, AUSTRALIA  
Volume: 2  
Publisher: ROAD SAFETY COUNCIL OF WESTERN AUSTRALIA

**Index Terms:** Accident; Accident prevention; Brake efficiency; Braking distance;

Braking performance; Building materials; Conference; Conferences; Congresses; Construction materials; Engineering properties; Friction; Friction; Highway accidents; Material (constr); Pavement; Pavements; Prevention; Properties; Properties of materials; Public safety; Safety; Safety measures; Surface properties; Surface texture; Surface texture; Symposia; Texture; Traffic accidents; Vehicle; Vehicle stopping time; Vehicles

**Subject Areas:** Highways; Materials; Pavements; Safety and Human Factors; Security and Emergencies; Vehicles and Equipment; I23: Properties of Road Surfaces; I82: Accidents and Transport Infrastructure

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**Title:** Innovative surfacing treatments delivering safer roads

**Accession Number:** 01344021

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.saferroads.org.uk/2011papers.asp>

**Source Agency:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Abstract:** A number of cost-effective, innovative surfacing treatments have been developed in New Zealand for low volume roads. This paper describes a sample of these innovative surfacing treatments from throughout New Zealand. Significant changes to asset management models and practices during the past 15 years include increased reliance on network surveys of skid resistance and texture depth to identify sites that require treatment. Industry has made substantial investment in new developments and innovation, in order to extend the road maintenance budget; the innovative treatments described in detail in the paper include: modern computer-controlled sprayers have been developed to apply bitumen at rates that vary transversely across the lane width and are being used when chip seal surfaces have insufficient macrotexture in the wheeltracks as well as a preventative measure for binder rise in the future; ultra high-pressure watercutting is being used to improve both macrotexture and microtexture of surfacings on low volume roads; thin and ultra-thin textured gap-graded hot mixes are being used in, high stress high trafficked areas. The performance to date of these treatments and strategies is discussed in the paper.

**Supplemental Notes:** Need to request password to view papers online

**TRIS Files:** ITRD, ARRB

**Pagination:** 9p

**Authors:** PIDWERBESKY, B  
Fulton Hogan Limited  
Killick, G  
Fulton Hogan Limited  
Waters, J  
Fulton Hogan Limited

**Monograph Title:** 3rd International Road Surface Friction Conference, Gold Coast, Queensland, 15-18 May 2011

**Monograph Accession Number:** 01344041

**Publication Date:** 20110500

**Conference:** International Surface Friction Conference, 3rd, 2011  
Location: Gold Coast Queensland, Australia  
Date: 20110515 - 20110518

**Index Terms:** Highway design; Macrotexture; New Zealand; Pavement performance; Properties; Road design; Road design and asset management; Road networks; Road surface properties; Skidding resistance; Surfacing

**Subject Areas:** Design; Highways; I23: Properties of Road Surfaces

---

**Title:** **Synthesis of Current Practice on the Design, Construction, and Maintenance of Porous Friction Courses**

**Accession Number:** 01030758

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-5262-1.pdf>

**Abstract:** Open-graded friction courses (OGFC), or porous friction courses (PFC) as defined by the Texas Department of Transportation (TxDOT), are a special gap-graded asphalt mixture characterized by a large interconnected air void content. In general, the voids content is at a minimum of 18%. Similar mixtures [porous asphalt (PA)] with voids contents as high as 25% are successfully applied in Europe. These interconnected voids make these mixtures highly permeable with the capacity to reduce tire-pavement noise. These characteristics are

associated with the following advantages that can be obtained from the use of PFC as a surface layer: safety improvements, economic benefits, and environmental benefits. On the other hand, the following aspects are identified as disadvantages of PFC: reduced performance, high construction costs, winter maintenance issues, and limited structural contribution. Substantial efforts have been undertaken to correct previous failures in OGFC, and significant advances have been made since the 1990s with respect to mixture performance and service life. This report summarizes the current state of the practice related to mixture design methods (proposed by different U.S. and international agencies and institutions), construction, maintenance, and performance of surface courses using OGFC and PA identified from a worldwide literature review. In addition, the report presents a synthesis of the relevant aspects related to the current practice and application of PFC in Texas based on the interviews conducted with selected TxDOT districts. The report represents the baseline for a research project aimed to improve the PFC mixture design method using advanced research tools and develop guidelines for construction and maintenance of PFC. In this project, special efforts will be directed to address functionality in terms of permeability and noise reduction, and durability in terms of moisture damage and aging potential.

**Supplemental Notes:** Project Title: Optimizing the Design of Permeable Friction Courses (PFC). Report Date: May 2006; Published: July 2006.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-06/0-5262-1  
Report 0-5262-1

**Contract Numbers:** Project 0-5262

**Media Type:** Web

**Pagination:** 86p

**Authors:** Alvarez, Alex E  
Martin, Amy Epps  
Estakhri, Cindy K  
Phone: 979-845-9551  
Fax: 979-845-0278  
[c-estakhri@tamu.edu](mailto:c-estakhri@tamu.edu)  
Texas Transportation Institute  
Button, Joe W  
Glover, Charles J  
Phone: 979-845-3389  
Fax: 979-845-6776  
[c-glover@tamu.edu](mailto:c-glover@tamu.edu)

Texas Transportation Institute  
Jung, Sung Hoon

- Features:** Figures (2) ; Photos (4) ; References (60) ; Tables (22)
- Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA  
Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA  
Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA
- Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA
- Publication Date:** 20060700
- Edition:** Technical Report
- Period Covered:** September 2005-May 2006
- Index Terms:** Ageing (Materials); Aging (Materials); Air voids; Asphalt mixtures; Asphaltic mixtures; Conductivity (Geology); Construction costs; Design life; Economic benefits; Friction course; Gap graded aggregates; Highway construction; Highway noise; Highway safety; Literature reviews; Literature surveys; Mix design; Moisture damage; Motor vehicle noise; Noise reduction; Open graded aggregates; Pavement maintenance; Pavement performance; Permeability; Porous pavements; Road construction; Road safety; Service life; State of the practice; Traffic noise; Water damage; Watertightness; Winter maintenance
- Subject Areas:** Construction; Design; Economics; Highways; Maintenance and Preservation; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces; I52: Construction of Pavements and Surfacing; I60: Maintenance
- 

**Title:** **Synthesis of Current Research on Permeable Friction Courses: Performance, Design, Construction, and Maintenance**

**Accession Number:** 01155729

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-5836-1.pdf>

**Abstract:** Over the past several years, the Texas Department of Transportation (TxDOT) adopted the use of porous or permeable friction course (PFC) mixtures as a thin asphalt pavement surface layer to provide safety and environmental benefits. This type of mixture is defined in TxDOT Specification Item 342 as a surface course of a compacted permeable mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant. Recent research addressed important design, construction, and maintenance issues associated with PFC, which has been increasingly employed by TxDOT. In order to complete the evaluation of this relatively new hot mix asphalt concrete mixture type as a possible solution for improving pavement safety and reduction of pavement noise, performance will be tracked over time in this research project to assess benefits, cost, and changes in benefits. The main objective of this research project is to develop a database of PFC performance in terms of functionality (noise reduction effectiveness and permeability), durability (resistance to raveling and possibly rutting and cracking), and safety (skid resistance and accident history), in order to produce guidelines for design, construction, and maintenance of PFC mixtures. This report includes a comprehensive and focused review of research conducted since 2004 related to the mix design, performance (i.e., functionality, durability, and safety), construction, and maintenance of surface courses using PFC.

**Supplemental Notes:** Project Title: Performance of Permeable Friction Courses (PFC) Pavements Over Time. Report Date: October 2009; Published: February 2010.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-10/0-5836-1  
Report 0-5836-1

**Contract Numbers:** Project 0-5836

**Media Type:** Web

**Pagination:** 152p

**Authors:** Liu, Kai-Wei  
Texas A&M University, College Station  
Alvarez, Alex E  
Phone: 979-845-9919  
Fax: 979-845-1701

[aalvarez@tamu.edu](mailto:aalvarez@tamu.edu)  
Texas A&M University, College Station

Martin, Amy Epps  
Phone: 979-862-1750  
Fax: 979-845-0278

[a-eppsmartin@tamu.edu](mailto:a-eppsmartin@tamu.edu)  
Texas Transportation Institute

Dossey, Terry  
Phone: 512-232-3124  
Fax: 512-232-3151

[terry.dossey@mail.utexas.edu](mailto:terry.dossey@mail.utexas.edu)  
University of Texas, Austin

Smit, Andre  
University of Texas, Austin

Estakhri, Cindy K  
Phone: 979-845-9551  
Fax: 979-845-0278

[c-estakhri@tamu.edu](mailto:c-estakhri@tamu.edu)  
Texas Transportation Institute

- Features:** Appendices (1) ; Figures; Photos; References (101) ; Tables (46)
- Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA  
Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA  
Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA
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5301 Shawnee Road  
Alexandria, VA 22312 USA
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- Edition:** Technical Report
- Period Covered:** August 2008–August 2009
- Index Terms:** Blanket course; Conductivity (Geology); Durability; Fretting (Pavements); Friction course; Highway safety; Hot mix asphalt mixtures; Hot mix paving mixtures; Literature reviews; Literature surveys; Mix design; Pavement construction; Pavement cracking;

Pavement design; Pavement maintenance; Pavement noise; Pavement performance; Paving; Permeability; Raveling (Pavements); Road safety; Road surfaces; Rutting; Skid resistance; Stripping (Pavements); Surface course (Pavements); Tire noise; Tire/pavement noise; Watertightness; Wear resistance

**Subject Areas:** Construction; Design; Highways; Maintenance and Preservation; Materials; Pavements; I22: Design of Pavements, Railways and Guideways; I31: Bituminous Binders and Materials; I52: Construction of Pavements and Surfacing; I61: Equipment and Maintenance Methods

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**Title:** ROAD SAFETY EFFECTS OF POROUS ASPHALT: A SYSTEMATIC REVIEW OF EVALUATION STUDIES

**Accession Number:** 00989595

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.sciencedirect.com/science/a...VVC-1/1/44dc7c97e42e43be7eff0353c9e626a2>

**Record URL:** <http://www.sciencedirect.com/science/a...VVC-1/2/bba6fe3ffbd82eae6bdde16fb1d48d19>

**Abstract:** Many European countries are using porous asphalt in order to reduce traffic noise and increase road capacity. A European research project SILVIA conducted a systematic review of studies that have evaluated the effects of porous asphalt on road safety. This paper presents the results of that review, in which the following questions were asked: What are the effects on road safety of porous road surfaces? Do the effects on road safety of porous road surfaces vary according to accident severity and road surface condition? Do the effects on road safety of porous road surfaces vary across countries? How long do the effects on road safety of porous road surfaces last? To answer the above questions, this study evaluated the effects of porous asphalt on accident occurrence and on risk factors associated with accident occurrence.

**TRIS Files:** TRIS

**Pagination:** p. 515-522

**Authors:** Elvik, R  
Greibe, P

**Features:** Figures (1) ; References; Tables (4)

**Corporate Authors:** Elsevier  
The Boulevard, Langford Lane  
Kidlington, Oxford OX5 1GB United Kingdom

**Availability:** Elsevier  
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Orlando, FL 32887-4800 USA  
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**Publication Date:** 20050500

**Serial:** Accident Analysis & Prevention  
Volume: 37  
Issue Number: 3  
Publisher: Elsevier  
ISSN: 0001-4575  
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**Index Terms:** Asphalt; European Union countries; Evaluation and assessment;  
Highway safety; Pavement performance; Porous concrete; Risk  
assessment; Road safety; Vulnerability assessment

**Subject Areas:** Highways; Pavements; Safety and Human Factors

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**TRID search 2/27/2012**

**("traffic safety" or "roadway safety" or "highway safety") AND index term "performance" and "measurement" with date between 2000 and 2012**

**Title:** Development of Outcomes Based National Road and Rail Safety Performance Measures

**Accession Number:** 01357513

**Record Type:** Component

**Language:** English

**Abstract:** This paper will discuss how transport delivers many benefits to the community, business, the environment and government. Transport agencies tend to monitor and report on activities and outputs rather than the real outcomes that are rarely measured. Management theory and practice has been developed performance measures in order to improve organizational efficiency and effectiveness which can be applied to transport. This paper reports the foundations for transport performance measurement and safety measures that were prepared for the Australian National Transport Commission (NTC), which sought to develop outcomes based performance measures. The basis is an understanding of the current and developing theory and practice in performance measurement and a description of the context. A framework for performance measures, including criteria for selection, and content requirements provides the outline for the safety measures. The paper concludes with a description of the road and rail performance measures that have been developed. An overview of the development of outcomes based performance measurement for road and rail safety provided in this paper summarizes the information used to develop practical measures for transport that can be used for policy and operations management.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 337-348

**Authors:** Hughes, B P  
Hopkins, S

**Features:** References (10) ; Tables (3)

**Monograph Title:** Safety and Security Engineering IV

**Monograph Accession Number:** 01357514

**Corporate Authors:** WIT Press  
Computational Mechanics, 25 Bridge Street  
Billerica, MA 01821 USA

**Editors:** M Guarascio  
University of Rome, Italy

G Reniers  
C A Brebbia  
Wessex Institute of Technology

F Garzia  
University of Rome

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**Publication Date:** 20110600

**Conference:** The Fourth International Conference on Safety and Security  
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**Index Terms:** Australia; Highway safety; Management; Operations; Performance  
measurement; Public safety; Rail transportation; Railroad  
transportation; Road safety; Safety; Safety measures; Theoretical  
analysis; Theories; Theory

**Subject Areas:** Highways; Railroads; Safety and Human Factors; I10: Economics and  
Administration

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**Title:** Model Performance Measures for State Traffic Records Systems

**Accession Number:** 01341965

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www-nrd.nhtsa.dot.gov/Pubs/811441.pdf>

**Abstract:** Quality traffic safety records are critical to the planning, management, and evaluation of any successful State traffic safety program. This need has become even more pronounced in light of grant requirements in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (Public Law 109-59; SAFETEA-LU) and rising Congressional expectations for data-driven performance management with outcome-oriented measures. The National Highway Traffic Safety Administration is releasing this new collection of 61 performance measures to help States meet this need. These performance measures were crafted with substantial input from a group of 35 experts with experience in at least one of the six core State traffic records systems. The measures are designed to provide traffic records professionals with the information necessary to develop and deploy quantifiable performance measures appropriate for their traffic record systems. The measures are intended for use by Federal, State, and local governments to monitor the development and implementation of traffic record data systems, strategic plans, and data-improvement grant processes. They have been grouped by performance attribute—timeliness, accuracy, completeness, uniformity, integration, and accessibility—across the six core State traffic record data systems -- crash, vehicle, driver, roadway, citation/adjudication, and emergency medical services (EMS)/injury surveillance. These common performance measures and the attendant guidance on their application are expected to help stakeholders quantify systemic improvements to their traffic records systems.

**TRIS Files:** HSL, TRIS

**Report Numbers:** HS-811 441

**Media Type:** Web

**Features:** Tables (1)

**Corporate Authors:** National Highway Traffic Safety Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Publication Date:** 20110200

**Index Terms:** Accident records; Computer files; Data files; Data integrity; Data quality; Databases; Datasets (Data processing); Driver records; Driving records; Performance measurement; Records management; Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users; Traffic records; Traffic safety

**Subject Areas:** Data and Information Technology; Highways; Safety and Human Factors; I72: Traffic and Transport Planning; I81: Accident Statistics

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**Title:** **Traffic Safety Data: State Data System Quality Varies and Limited Resources and Coordination Can Inhibit Further Progress**

**Accession Number:** 01155842

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.gao.gov/new.items/d10454.pdf>

**Abstract:** Traffic crashes kill or injure millions of people each year. High-quality traffic safety data is vital to allocate resources and target programs as the Department of Transportation's (DOT) National Highway Traffic Safety Administration (NHTSA) and states work to improve traffic safety through data-driven approaches. To qualify for federal funding, states must submit plans which include fatality and crash data analyses to identify areas for improvement. This requested report provides information on (1) the extent to which state traffic safety data systems meet NHTSA performance measures for assessing the quality of data systems, and (2) progress states have made in improving traffic safety data systems, and related challenges. The U.S. Government Accountability Office's (GAO's) analysis of traffic records assessments—conducted for states by NHTSA technical teams or contractors at least every 5 years—indicates that the quality of state traffic safety data systems varies across the six data systems maintained by states. Assessments include an evaluation of system quality based on six performance measures. Across all states, GAO found that vehicle and driver data systems met performance measures 71 percent and 60 percent of the time, respectively, while roadway, crash, citation and adjudication, and injury surveillance data systems met performance measures less than 50 percent of the time. Also, data system quality varies by performance measure. For example, across all data systems, states met the performance measure for consistency 72 percent of the time, but states met the integration performance measure 13 percent of the time. According to NHTSA, assessments should be in-depth reviews of state traffic safety data systems; however, in some cases, incomplete or inconsistent information limits assessment usefulness. Of the 51 assessments GAO reviewed, 49 had insufficient information to fully determine the quality of at least one data system. Furthermore, an updated assessment format has resulted in more frequent instances of insufficient information. Despite varying state traffic safety data system performance, data collected by NHTSA show that states are making

some progress toward improving system quality. All states GAO visited have implemented projects to improve data systems, such as switching to electronic data reporting and adopting forms consistent with national guidelines. However, states face resource and coordination challenges in improving traffic safety data systems. For example, custodians of data systems are often located in different state agencies, which may make coordination difficult. In addition, rural and urban areas may face different challenges in improving data systems, such as limited technology options for rural areas or timely processing of large volumes of data in urban areas. States GAO visited have used strategies to overcome these challenges, including establishing an executive-level traffic records coordinating committee, in addition to the technical-level committee that states are required to establish to qualify for traffic safety grant funding. An executive-level committee could help states address challenges by targeting limited resources and facilitating data sharing. GAO recommends that NHTSA take steps to ensure state traffic records assessments are complete and consistent to provide an in-depth evaluation of all state traffic safety data systems across all performance measures. NHTSA should also study and communicate to Congress on the value of requiring an executive-level traffic records coordinating committee for states to qualify for traffic safety grant funding.

<b>TRIS Files:</b>	TRIS
<b>Report Numbers:</b>	GAO-10-454
<b>Media Type:</b>	Web
<b>Pagination:</b>	58p
<b>Features:</b>	Appendices (3) ; Figures (12) ; Tables (4)
<b>Corporate Authors:</b>	U.S. Government Accountability Office 441 G Street, NW Washington, DC 20548 USA
<b>Availability:</b>	U.S. Government Accountability Office 441 G Street, NW Washington, DC 20548 USA
<b>Publication Date:</b>	20100400
<b>Index Terms:</b>	Accident data; Data completeness; Data integrity; Data quality; Highway accidents; Information systems; Performance measurement; States; Traffic accidents; Traffic safety; U.S. National Highway Traffic Safety Administration

**Subject Areas:** Data and Information Technology; Highways; Safety and Human Factors; I81: Accident Statistics

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**Title:** **Measuring Performance Among State DOTs, Sharing Best Practices--Operations Performance Using Incident Response Time**

**Accession Number:** 01339285

**Record Type:** Project

**Language:** English

**Record URL:** <http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=2751>

**Source Agency:** National Cooperative Highway Research Program  
Washington, DC 20001

**Source Data:** RiP Project 22520

**Abstract:** Previous work by the National Cooperative Highway Research Program (NCHRP) has demonstrated the value of comparative performance measurement in three areas to date: Project Delivery, Smooth Pavements, and Safety. Each of these projects has involved compilation of detailed performance data for multiple DOTs, calculation of performance measures for each agency, composition of peer groups for comparative analysis, identification of the top tier of agencies with respect to the selected measures, and interviews to determine practices that may be related to exemplary performance. The first comparison of on-time, on-budget capital project delivery performance project successfully demonstrated how the comparative process developed by NCHRP 20-24(37) is gathering user support as well as delivering timely feedback on best practices that have achieved successful results. The next comparative initiative, which was completed in April 2008, successfully demonstrated that states can benefit from comparative measures. This comparative study highlighted five states that have "smooth pavements" and what practical management methods and technical applications they are using to obtain smooth pavements. The third comparative measures effort is just completing on safety performance using the Fatalities Accident Reporting System data. This effort focused on ten state interviews to identify best practices in governance, budgeting, and technical methods that resulted in the reduction of fatalities. This work has been well received by the transportation community and has resulted in the collection of a wealth of data and information to be shared among agencies. These successful endeavors created momentum for further interest in comparative performance measurement. This momentum can

be continued to address another key concern of transportation officials: improving operational performance in the management of the nation's highways. DOT experience with increased volumes on our roads over the past two decades indicates that one of the most viable methods of improving mobility is to provide better real-time incident management - the faster an accident or breakdown is cleared, the sooner traffic resumes to normal flow. We intend to use incident response times to identify successful practices in operations activities of a state DOT. This performance indicator can highlight best practices in specific incident response techniques as well as organizational structures, relationships with partner organizations, and budgeting practices. Effective incident response programs can make a significant improvement in the reliability of travel time, which is known to be of great importance to travelers. The operations performance comparative effort would use available state DOT data on incident response performance and provide a time series/cross-sectional analysis of incident response performance, which could be measured based on average, median or maximum incident response time, total incident duration or incident clearance time. Through cross-state comparison (factoring for urban and rural differences) and examination of changes in performance over time, the study would identify practices that can be instrumental in reducing incident durations, with associated benefits to travelers. The objective of this project will be to conduct a comparison of state departments of transportation (DOTs) regarding operations-related performance measures and report on successful techniques employed by the leading agencies. As with earlier work conducted under NCHRP 20-24(37), this comparison will include identification of high-performing organizations with respect to a selected set of key performance indicators and determination of the practices that these organizations have employed to achieve these results. The goal of the study is to enhance the performance of participating peer state DOTs by identifying and sharing good practices. As in the previous comparison studies, the purpose is not to rank the participants, but to highlight top performing strategies. Anonymity is maintained for states providing the comparison data with the exception of the top performing states that are highlighted in the reporting of successful practices.

<b>Supplemental Notes:</b>	Contract to a Performing Organization has not yet been awarded.
<b>TRIS Files:</b>	TRB, RiP
<b>Contract Numbers:</b>	Project 20-24(37)D
<b>Funding:</b>	75000.00
<b>Start Date:</b>	20091119
<b>Actual Completion</b>	20100519

**Date:**

**Performing Agencies:** University of Maryland, College Park  
College Park, MD 20742 USA

**Funding Agencies:** Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

American Association of State Highway & Transp Officials  
444 North Capitol Street, NW, Suite 225  
Washington, DC 20001

National Cooperative Highway Research Program  
Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001

**Responsible Individuals:** Derr, B Ray  
[brderr@nas.edu](mailto:brderr@nas.edu)

**Index Terms:** Accident data; Data acquisition; Data collection; Death; Emergency response time; Fatal accidents; Fatalities; Incident detection; Performance measurement; State departments of transportation; Traffic fatalities; Traffic incidents; Traffic safety

**Subject Areas:** Administration and Management; Highways; Planning and Forecasting; Safety and Human Factors

**Title:** **Performance Measurement for Highway Winter Maintenance Operations**

**Accession Number:** 01140919

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://www.iowadot.gov/operationsresea...d\\_tr/reports/TR-491%20Final%20Report.pdf](http://www.iowadot.gov/operationsresea...d_tr/reports/TR-491%20Final%20Report.pdf)

**Record URL:** [http://ntl.bts.gov/lib/31000/31100/31185/TR-491\\_Final\\_Report.pdf](http://ntl.bts.gov/lib/31000/31100/31185/TR-491_Final_Report.pdf)

**Abstract:** The goal of this research project was to develop a method to measure the performance of a winter maintenance program with respect to the task of providing safety and mobility to the travelling public. Developing these measures required a number of steps, each of which

was accomplished. First, the impact of winter weather on safety (crash rates) and mobility (average vehicle speeds) was measured by a combination of literature reviews and analysis of Iowa Department of Transportation traffic and Road Weather Information System data. Second, because not all winter storms are the same in their effects on safety and mobility, a method had to be developed to determine how much the various factors that describe a winter storm actually change safety and mobility. As part of this effort a storm severity index was developed, which ranks each winter storm on a scale between 0 (a very benign storm) and 1 (the worst imaginable storm). Additionally a number of methods of modeling the relationships between weather, winter maintenance actions and road surface conditions were developed and tested. The end result of this study was a performance measure based on average vehicle speed. For a given class of road, a maximum expected average speed reduction has been identified. For a given storm, this maximum expected average speed reduction is modified by the storm severity index to give a target average speed reduction. Thus, if for a given road the maximum expected average speed reduction is 20 mph, and the storm severity for a particular storm is 0.6, then the target average speed reduction for that road in that storm is  $0.6 \times 20$  mph or 12 mph. If the average speed on that road during and after the storm is only 12 mph or less than the average speed on that road in good weather conditions, then the winter maintenance performance goal has been met.

<b>TRIS Files:</b>	NTL, TRIS
<b>Report Numbers:</b>	IHRB Project TR-491 IIHR Technical Report 474
<b>Media Type:</b>	Web
<b>Pagination:</b>	129p
<b>Authors:</b>	Qiu, Lin <a href="mailto:lin-qiu@uiowa.edu">lin-qiu@uiowa.edu</a> University of Iowa, Iowa City  Nixon, Wilfrid A Phone: 319-335-5166 Fax: 319-335-5660 <a href="mailto:wilfrid-nixon@uiowa.edu">wilfrid-nixon@uiowa.edu</a> University of Iowa, Iowa City
<b>Features:</b>	Appendices (3) ; Figures; References; Tables
<b>Corporate Authors:</b>	University of Iowa, Iowa City Iowa Institute of Hydraulic Research, 300 South Riverside Drive

Iowa City, IA 52242-1585 USA

Iowa Department of Transportation  
Iowa Highway Research Board, 800 Lincoln Way  
Ames, IA 50010 USA

**Availability:** Iowa Department of Transportation  
800 Lincoln Way  
Ames, IA 50010 USA

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**Edition:** Final Report

**Index Terms:** Accident frequency; Accident rates; Average travel speed; Highway safety; Mobility; Performance measurement; Road safety; Storm severity; Winter maintenance

**Subject Areas:** Highways; Maintenance and Preservation; I62: Winter Maintenance

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**Title:** **Benchmarking road safety: Lessons to learn from a data envelopment analysis**

**Accession Number:** 01121653

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.sciencedirect.com/science/a...T3X-1/2/adcf8d15b3f492d9a7481565558cdd8>

**Abstract:** Road safety performance indicators (SPI) have recently been proposed as a useful instrument in comparing countries on the performance of different risk aspects of their road safety system. In this respect, SPIs should be actionable, i.e. they should provide clear directions for policymakers about what action is needed and which priorities should be set in order to improve a country's road safety level in the most efficient way. This paper aims at contributing to this issue by proposing a computational model based on data envelopment analysis (DEA). Based on the model output, the good and bad aspects of road safety are identified for each country. Moreover, targets and priorities for policy actions can be set. As our data set contains 21 European countries for which a separate, best possible model is constructed, a number of country-specific policy actions can be recommended. Conclusions are drawn regarding the following performance indicators: alcohol and drugs, speed, protective systems, vehicle, infrastructure and trauma

management. For each country that performs relatively poor, a particular country will be assigned as a useful benchmark.

- Supplemental Notes:** Abstract reprinted with permission from Elsevier
- TRIS Files:** TRIS
- Media Type:** Print
- Pagination:** pp 174-182
- Authors:** Hermans, Elke  
Fax: 32 11 26 91 99  
[elke.hermans@uhasselt.be](mailto:elke.hermans@uhasselt.be)  
Hasselt University
- Brijs, Tom  
Phone: 32-11-26.91.55  
Fax: 32-11-26.91.99  
[tom.brijs@uhasselt.be](mailto:tom.brijs@uhasselt.be)  
Hasselt University
- Wets, Geert  
Phone: 32-11-26.91.58  
Fax: 32-11-26.91.99  
[geert.wets@uhasselt.be](mailto:geert.wets@uhasselt.be)  
Hasselt University
- Vanhoof, Koen  
[koen.vanhoof@uhasselt.be](mailto:koen.vanhoof@uhasselt.be)  
Hasselt University
- Features:** Figures (2) ; References; Tables (5)
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- Index Terms:** Benchmarks; Countries; Data envelopment analysis; Europe; Government policy; Highway safety; Performance measurement; Policies; Policy; Regulatory policy; Road safety

**Subject Areas:** Highways; Safety and Human Factors

---

**Title:** **Comparative Performance Measurement: Safety**

**Accession Number:** 01152960

**Record Type:** Monograph

**Language:** English

**Abstract:** This report presents results of the third in a series of comparative performance measurement efforts sponsored by the AASHTO Standing Committee on Quality, Performance Measurement and Benchmarking Subcommittee. The purpose of these efforts is to identify states that have achieved exemplary performance, find out what practices have contributed to their success, and document these practices for the benefit of other states. This effort focuses on safety.

**TRIS Files:** TRIS

**Report Numbers:** Publication Code: CPMS-1

**Media Type:** Print

**Pagination:** 84p

**Features:** Figures; Maps; Tables

**Corporate Authors:** American Association of State Highway and Transportation Officials  
444 North Capitol Street, NW  
Washington, DC 20001 USA

**Availability:** American Association of State Highway and Transportation Officials  
444 North Capitol Street, NW  
Washington, DC 20001 USA

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**ISBN:** 9781560514619

**Publication Date:** 20090000

**Index Terms:** Accident data; Best practices; Customer service; Data acquisition; Data collection; Highway accidents; Performance measurement; Resource allocation; Traffic accidents; Traffic data; Traffic safety

**Subject Areas:** Administration and Management; Highways; Safety and Human Factors; I10: Economics and Administration

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**Title:** Performance Assessment Methodology for Sustainable Pavement Marking

**Accession Number:** 01128734

**Record Type:** Component

**Language:** English

**Order URL:** <http://pubsindex.trb.org/orderform.html>

**Source Data:** Transportation Research Board Annual Meeting 2009 Paper #09-2983

**Abstract:** One of the most contributing factors to fatal motor vehicles crashes is the inadequate and poorly maintained pavement marking. The cost of these crashes is estimated to range between 10-25 billion Canadian dollars annually. Consequently, the different companies/authorities that manage pavement marking should set a target for themselves to be more cost efficient through building a strategic plan to renew and restripe pavement marking. The objective of this paper is to develop a methodology and model(s) that predict the performance of the pavement marking at different average annual daily traffic, percentage of trucks, age, and type of road. Due to the typical scarcity of data, particularly for performance of pavement marking, there is an essential need to predict this performance. In order to achieve this objective, a sound technique, such as unsupervised neural network, is used. Therefore, the developed models are designed using unsupervised neural network in conjunction with regression analysis. Data for this research were collected from the city of Ottawa, Ontario, Canada for the Alkyd paint material. The developed model is validated and the results show that the percentage average validity is 73%. Similarly, the fitness function value is found to be 789; which means the developed model is a sound fit. Marking performance is assessed using a performance scale, which numerically ranges from “1” to “5” and linguistically from “Excellent” to “Critical”, respectively.

**TRIS Files:** TRIS, TRB

**Report Numbers:** 09-2983

**Media Type:** DVD

**Pagination:** 15p

**Authors:** Fares, Hussam  
[hussamfa@gmail.com](mailto:hussamfa@gmail.com)  
Concordia University

Elwakil, Emad  
[e\\_elwa@encs.concordia.ca](mailto:e_elwa@encs.concordia.ca)  
Concordia University, Canada

Zayed, Tarek  
[zayed@bcee.concordia.ca](mailto:zayed@bcee.concordia.ca)  
Concordia University, Canada

Shahata, Khaled  
[kfsfarouk@yahoo.com](mailto:kfsfarouk@yahoo.com)  
Concordia University, Canada

**Features:** Figures (6) ; References (19) ; Tables (5)

**Monograph Title:** TRB 88th Annual Meeting Compendium of Papers DVD

**Monograph Accession Number:** 01120148

**Corporate Authors:** Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Publication Date:** 20090000

**Conference:** Transportation Research Board 88th Annual Meeting  
Location: Washington DC  
Date: 20090111 - 20090115  
Sponsors: Transportation Research Board

**Index Terms:** ANNs (Artificial neural networks); Annual average daily traffic; Artificial neural networks; Average annual daily traffic; Carriageway markings; Data acquisition; Data collection; Death; Fatal accidents; Fatalities; Highway accidents; Highway safety; Highway signs, signals and markings; Neural networks; Ontario (Canada); Ottawa (Canada); Pavement markings; Performance measurement; Road markings; Road safety; Sustainable pavements; Traffic accidents; Traffic control devices; Traffic fatalities; Traffic markings; Traffic models; Traffic signs and signals; Traffic signs, signals and markings

**Subject Areas:** Highways; Maintenance and Preservation; Pavements; Safety and Human Factors; I60: Maintenance

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**Title:** National Traffic Safety Index

**Accession Number:** 01123257

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2137-02>

**Abstract:** The transportation community has begun to recognize the need for comprehensive performance measures for traffic safety. Using a single crash rate inevitably neglects other aspects of traffic safety. This study proposed a traffic safety index combining three dimensions of traffic safety (fatality, injury, and crash) from two perspectives (person and road) and applied the index to project a comprehensive traffic safety picture of South Korea. The proposed index employed the approach used for the human development index of the United Nations, and its confidence interval was estimated on the basis of moving variance. The proposed index and its confidence interval were shown to be useful in evaluating overall safety performance of the entire nation over time. The index can be tied to a macrolevel safety plan or policy in setting a goal, and it is not limited to South Korea but is applicable to any nation or large area as long as valid historical safety data have been maintained.

**TRIS Files:** TRIS, TRB

**Report Numbers:** 09-0410

**Media Type:** Print

**Pagination:** pp 13-19

**Authors:** Kweon, Young-Jun  
Phone: 434-293-1949  
Fax: 434-293-1990  
[Young-Jun.Kweon@VDOT.Virginia.gov](mailto:Young-Jun.Kweon@VDOT.Virginia.gov)  
Virginia Transportation Research Council

Kim, Kwang Sik  
[kskim@yurim.skku.ac.kr](mailto:kskim@yurim.skku.ac.kr)  
Sungkyunkwan University

**Features:** Figures (6) ; References (15)

**Monograph Title:** Safety 2009: Security; Emergencies; Management; and School Transportation

**Monograph**

**Accession Number:** 01149179

**Availability:** Transportation Research Board Business Office

500 Fifth Street, NW  
Washington, DC 20001 USA

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[http://www.trb.org/Main/Blurbs/Safety...emergencies\\_Management\\_and\\_Sc\\_162995.aspx](http://www.trb.org/Main/Blurbs/Safety...emergencies_Management_and_Sc_162995.aspx)

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**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
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**Index Terms:** Accident data; Collision injuries; Confidence intervals; Crash injuries; Death; Fatal accidents; Fatalities; Macro-level; Performance measurement; Safety index; Safety performance; South Korea; Traffic fatalities; Traffic safety

**Subject Areas:** Highways; Safety and Human Factors; I81: Accident Statistics

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**Title:** **Measuring Performance Among State DOTs, Sharing Best Practices -- Safety**

**Accession Number:** 01339339

**Record Type:** Project

**Language:** English

**Record URL:** <http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=2483>

**Source Agency:** National Cooperative Highway Research Program  
Washington, DC 20001

**Source Data:** RiP Project 21057

**Abstract:** NCHRP Project 20-24(37) has been conducted to describe how use of comparative performance measures may help managers of state

departments of transportation (DOTs) to improve performance of their own systems and organizations. Work to date has demonstrated that widely acceptable performance measures can be developed and provides a foundation for further collaborative development of comparative performance measures by the American Association of State Highway and Transportation Officials (AASHTO) and its member agencies. Initial work under NCHRP 20-24(37) entailed a comparison of on-time, on-budget capital project delivery performance that expanded from an original pilot to include twenty state participants. This work demonstrated a successful approach to attracting user support as well as delivering timely feedback on best practices that have achieved successful results. A second comparative initiative, completed in April 2008, highlighted five states that have "smooth pavements" and what practical management tools they are using to deliver smoothness. Building on the success of these first two initiatives, this project will address another key concern of transportation officials: safety. Apart from certain crash fatality statistics, variability in the characteristics of data reporting complicates performance comparisons among states. The purpose of such comparisons, in this project and in general, is not to rank states' performance, but rather to highlight top-performing management strategies and to give DOT managers benchmarks for judging their own performance. Anonymity is maintained for states providing the comparison data with the exception of the top performing states that are highlighted in the reporting of successful practices. National Highway Traffic Safety Administration (NHTSA) data may be used to conduct time series and cross-sectional analysis of fatality and serious injury rates. After normalizing for urban and rural travel differences and capturing the demographic differences (such as age and ethnicity), the researchers may then be able to identify (using statistical methods) causal factors underlying lower rates observed in some states, for example, laws, adjudication, roadway condition, and emergency medical services. The objective of this project is to use the techniques developed in NCHRP Projects 20-24(37)A and 20-24(37)B) to develop comparative statistics on highway safety, factors likely influencing safety experience of states, and strategies used by states with best safety experience. Accomplishing the project's objective will entail the following tasks: (1) Conduct one or two teleconference meetings with volunteer states to define data to be provided by these states for the project. (2) Conduct one conference call to confirm that each volunteer state can produce the required data defined in the first task; each state will collect and submit the agreed upon data to the consultant for compilation and analysis. (3) Prepare a compilation of data provided by participating states, compute comparative and summary performance statistics, and provide a compilation report to each of the volunteer states. Anonymity of participating states shall be maintained and each

state shall have the option to withdraw from the study at any time. (4) Identify states that are lead performers. Secure approval from these lead performers to disclose their identities for the purpose of determining Best Practices that contribute to superior performance results. (5) Prepare a summary report and PowerPoint presentation of the comparative performance measure data and analyses to illustrate examples of what could be expected from the project. (6) Conduct detailed Best Practice Analysis of the top performing states. To identify likely factors contributing to good safety performance. Survey all participants to solicit recommendations for improvements to data and research procedures for future multi-state comparisons. (7) Prepare a final report documenting the project.

**TRIS Files:** TRB, RiP

**Contract Numbers:** Project 20-24(37)C

**Funding:** 75000.00

**Start Date:** 20081029

**Actual Completion Date:** 20090728

**Performing Agencies:** Spy Pond Partners, LLC

**Funding Agencies:** Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

American Association of State Highway & Transp Officials  
444 North Capitol Street, NW, Suite 225  
Washington, DC 20001

National Cooperative Highway Research Program  
Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001

**Responsible Individuals:** Niessner, Charles W

**Index Terms:** Best practices; Data sharing; Performance measurement; Project management; Research projects; State departments of transportation; System performance

**Subject Areas:** Administration and Management; Highways

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**Title:** Traffic Safety Performance Measures for States and Federal Agencies

**Accession Number:** 01121718

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.nhtsa.dot.gov/staticfiles/D.../Articles/Associated%20Files/811025.pdf>

**Abstract:** The National Highway Traffic Safety Administration (NHTSA) and the Governors Highway Safety Association (GHSA) have agreed on a minimum set of performance measures to be used by States and federal agencies in the development and implementation of behavioral highway safety plans and programs. An expert panel from NHTSA, State Highway Safety Offices, academic and research organizations, and other key groups assisted in developing the measures. The initial minimum set contains 14 measures: ten core outcome measures, one core behavior measure, and three activity measures. The measures cover the major areas common to State highway safety plans and use existing data systems. States will set goals for and report progress on each of the 11 core outcome and behavior measures annually beginning with their 2010 Highway Safety Plans and Annual Reports. States will report the activity measures annually beginning with their 2010 Highway Safety Plans and Annual Reports. States should define and use additional performance measures for their other high-priority highway safety areas as appropriate. NHTSA will use the core measures as an integral part of its reporting to the Congress, the public, and others.

**TRIS Files:** HSL, TRIS

**Report Numbers:** HS-811 025

**Contract Numbers:** DTNH22-07-R-00043

**Media Type:** Print

**Pagination:** 44p

**Authors:** Hedlund, James  
Preusser Research Group, Incorporated

**Features:** Appendices (6) ; Figures; References

**Corporate Authors:** National Highway Traffic Safety Administration  
Office of Behavioral Safety Research, 1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20080800

**Edition:** Final Report

**Index Terms:** Federal government agencies; Measures of effectiveness; Performance measurement; States; Traffic safety

**Subject Areas:** Highways; Planning and Forecasting; Safety and Human Factors; I80: Accident Studies

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**Title:** **Traffic Safety: Improved Reporting and Performance Measures Would Enhance Evaluation of High-Visibility Campaigns**

**Accession Number:** 01099626

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.gao.gov/cgi-bin/getrpt?GAO-08-477>

**Abstract:** Two primary risk behaviors related to fatal traffic crashes are failure to use safety belts and driving while impaired by alcohol. High-visibility enforcement (HVE) campaigns that combine enforcement of a traffic safety law with media to inform the public about the campaign are effective in reducing these behaviors. In 2005, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users authorized funding of an HVE program, including safety belt and impaired-driving campaigns. The National Highway Traffic Safety Administration (NHTSA) within the Department of Transportation (DOT) provides media and coordinates with states to provide enforcement activities for the campaigns. This report addresses (1) the extent to which NHTSA has implemented the HVE program and (2) for selected states, the impact of the campaigns and challenges that exist in conducting the campaigns. NHTSA has fully implemented the high-visibility enforcement program by (1) developing and disseminating advertising, (2) coordinating with states on media and enforcement activities, and (3) annually evaluating the effectiveness of the two HVE campaigns; however, NHTSA's evaluations have shortcomings that limit the agency's ability to determine the effectiveness of the campaigns. Regarding advertising, NHTSA introduced an annual plan in 2005 that sets forth a strategy for the campaign advertisements,

developed advertisements, and purchased national media time for the advertisements. To coordinate with states, NHTSA provides an overall strategy and guidance to assist states in conducting the campaigns, as well as technical assistance and collateral materials, such as posters and model press releases. Officials in selected states reported that NHTSA's coordination efforts provided the support and interaction needed to conduct HVE campaigns. Although NHTSA's annual evaluations of campaign effectiveness indicate that the campaigns are helping to improve safety belt use and reduce impaired driving, the evaluations have shortcomings that limit NHTSA's ability to assess the level of state and local activity—a key component of the campaigns—and the overall effectiveness of the campaigns. For example, the information that NHTSA has on states' activities is inconsistent and incomplete because reporting of such data is generally voluntary for local law enforcement agencies. As a result, NHTSA has reported that it cannot provide meaningful analyses and comparisons of state activities. NHTSA's ability to measure the campaigns' overall effectiveness is also hindered because the performance measures used to evaluate the campaigns are not comprehensive. For example, while NHTSA measures daytime safety belt use, it does not directly measure nighttime safety belt use, despite recent efforts to increase safety belt use at night. In addition, NHTSA's evaluations do not include measures of the effectiveness of the campaigns at reaching all target audiences. NHTSA is working to develop more comprehensive performance measures. According to officials in selected states that the U.S. Government Accountability Office (GAO) visited, the campaigns are contributing to increased safety belt use and reduced alcohol-involved fatalities, but these states face challenges in conducting the campaigns and achieving desired results. From 1997 to 2006, safety belt use increased in all seven of the selected states, and each state experienced a decrease in the alcohol fatality rate. Officials in the selected states said that the campaigns provide additional benefits, such as apprehending suspects involved in other crimes. However, officials in those selected states identified several challenges, such as increasing safety belt use and reducing impaired driving among resistant populations; insufficient staff to conduct the campaigns; and weak prosecution of impaired-driving arrests. NHTSA has initiatives under way to help states address some of these challenges. For example, NHTSA has sponsored a campaign to increase safety belt use in rural areas. In addition, NHTSA provides funds that can be used by states to purchase equipment for local law enforcement agencies, such as breath-testing units, to encourage the agencies to participate in campaigns. GAO recommends that the Secretary of Transportation direct NHTSA to establish a minimum set of reporting requirements for states to report HVE activities that are federally funded and include additional performance measures in campaign evaluations.

**TRIS Files:** TRIS

**Report Numbers:** GAO-08-477

**Media Type:** Web

**Pagination:** 47p

**Features:** Appendices (3) ; Figures (8) ; Tables (1)

**Corporate Authors:** U.S. Government Accountability Office  
441 G Street, NW  
Washington, DC 20548 USA

**Availability:** U.S. Government Accountability Office  
441 G Street, NW  
Washington, DC 20548 USA

**Publication Date:** 20080400

**Index Terms:** Countermeasures; Death; Drinking drivers; Drunk drivers; Effectiveness; Evaluation and assessment; Fatal accidents; Fatalities; Highway accidents; Highway safety; Impaired drivers; Implementation; Performance measurement; Road safety; Safety campaigns; Seat belts; States; Traffic accidents; Traffic fatalities; Traffic law enforcement; Traffic safety; U.S. National Highway Traffic Safety Administration

**Subject Areas:** Highways; Research; Safety and Human Factors; I80: Accident Studies

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**Title:** **SUNflowerNext: Towards A Composite Road Safety Performance Index**

**Accession Number:** 01120536

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.swov.nl/rapport/sunflower/SUNflowerNext.pdf>

**Abstract:** The aim of the SUNflowerNext project is to develop a knowledge-based framework for comprehensive benchmarking of road safety performances and developments of a country or of sub-national jurisdictions. Benchmarking is a process in which actors evaluate various aspects of their performance in relation to others, and to the so-called 'best in class'. In the SUNflowerNext study the authors researched whether countries in the European Union could all be placed in one class, or whether they should consider working with two or more

classes. In the SUNflowerNext project the authors concluded that it is better not to make comparisons between all European countries as one group, but to attempt grouping comparable countries and to then compare the countries within a specific group or class. SUNflowerNext decided to develop an integral and comprehensive set of indicators to measure the road safety performance of a country while including all information in the SUNflower pyramid. Time series analyses and sub-national comparisons are also discussed in the report.

<b>TRIS Files:</b>	TRIS
<b>Media Type:</b>	Web
<b>Pagination:</b>	187p
<b>Authors:</b>	Wegman, Fred <a href="mailto:fred.wegman@swov.nl">fred.wegman@swov.nl</a> Commandeur, Jacques Doveh, Etti Technion - Israel Institute of Technology Eksler, Vojtech European Transport Safety Council Gitelman, Victoria <a href="mailto:trivica@tx.technion.ac.il">trivica@tx.technion.ac.il</a> Technion - Israel Institute of Technology Hakkert, Shalom <a href="mailto:hakkert@tx.technion.ac.il">hakkert@tx.technion.ac.il</a> Technion - Israel Institute of Technology Lynam, David Oppe, Siem <a href="mailto:oppe@tiscali.nl">oppe@tiscali.nl</a> Institute for Road Safety Research (SWOV)
<b>Features:</b>	Appendices (10) ; Figures; References; Tables
<b>Corporate Authors:</b>	Institute for Road Safety Research (SWOV) Duindoorn 32 Leidschendam 2262 AR Netherlands
<b>Availability:</b>	Find a library where document is available Order URL: <a href="http://worldcat.org/isbn/9789073946057">http://worldcat.org/isbn/9789073946057</a>
<b>ISBN:</b>	9789073946057

**Publication Date:** 20080000  
**Index Terms:** Benchmarks; Highway safety; Performance measurement; Research projects; Road safety; Safety programs  
**Subject Areas:** Highways; Research; Safety and Human Factors

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**Title:** **Examination of Macrolevel Annual Safety Performance Measures for Virginia**

**Accession Number:** 01099596

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2083-02>

**Abstract:** Municipal, state, and federal agencies in the United States that are responsible for traffic safety have used crash rates such as fatalities per 100 million vehicle miles traveled (VMT) as traffic safety performance measures. However, the appropriateness of using such rates as performance measures has not been examined empirically, although the rates have been made public. This study examined 20 candidate crash rates (e.g., fatalities per million population and injury crashes per million registered vehicles) for an annual safety performance measure for Virginia by using autoregressive error models and empirical data from 1971 through 2006. The study found that the injury rate per driver and the crash rate per VMT seem appropriate as, respectively, long-term (1971 to 2006) and shorter-term (1995 to 2006) safety performance measures for Virginia. Statistical uncertainty should be considered when these rates are used to measure safety performance.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 9-15

**Authors:** Kweon, Young-Jun  
Phone: 434-293-1949  
Fax: 434-293-1990  
[Young-Jun.Kweon@VDOT.Virginia.gov](mailto:Young-Jun.Kweon@VDOT.Virginia.gov)  
Virginia Transportation Research Council

**Features:** Figures (4) ; References (20)

**Monograph Title:** Safety Data, Analysis, and Modeling

**Monograph Accession Number:** 01120144

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://www.trb.org/news/blurb\\_detail.asp?id=9953](http://www.trb.org/news/blurb_detail.asp?id=9953)

Find a library where document is available  
Order URL: <http://worldcat.org/isbn/9780309125956>

**ISBN:** 9780309125956

**Publication Date:** 20080000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2083  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Accident frequency; Accident rates; Collision injuries; Collisions; Crash injuries; Crashes; Death; Fatal accidents; Fatalities; Injury rates; Performance measurement; Statistics; Traffic fatalities; Traffic safety; Virginia

**Subject Areas:** Data and Information Technology; Highways; Safety and Human Factors; I81: Accident Statistics

---

**Title:** **Safety Data, Analysis, and Modeling**

**Accession Number:** 01120144

**Record Type:** Monograph

**Language:** English

**Abstract:** This collection of 22 papers is concerned with safety data, analysis and modeling. The following specific topics are addressed: data-driven perspective on safety risk management; macrolevel annual safety performance measures; tool with road-level crash prediction for safety planning; congestion and number of lanes on urban freeways relationship to safety; accident modification factors; identifying hazardous road locations; identifying hot spots; safety influence area for four-legged signalized intersections; automated analysis of accident exposure; new simulation-based surrogate safety measure; hit-and-run crashes; speed limit increases effect on injury severity; safety of curbs;

proximity to intersections and injury severity of urban arterial crashes; nested logit model of traffic flow on freeway ramps; intelligent transportation system data for assessing freeway safety; vehicle time spent in following on two-lane rural roads; indirect associations in crash data; crash prediction models for rural highways; and methodology for identifying causal factors of accident severity.

**TRIS Files:** TRIS, TRB  
**Media Type:** Print  
**Pagination:** 208p  
**Features:** Figures; References; Tables  
**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: [http://www.trb.org/news/blurp\\_detail.asp?id=9953](http://www.trb.org/news/blurp_detail.asp?id=9953)

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**ISBN:** 9780309125956  
**Publication Date:** 20080000  
**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2083  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Accident black spots; Accident exposure; Accident modification factors; Accident prone locations; Accident severity; Advanced transport telematics; Arterial highways; Arterial streets; ATT; Boulevards; Carriageways; Causal factors; Controlled access highways; Crash prediction models; Curbs; Freeways; Gridlock (Traffic); Hazardous road locations; High accident locations; Highway safety; Hit and run accidents; Hotspot; Injury severity; Intelligent transportation systems; Intelligent vehicle highway systems; ITS (Intelligent transportation systems); IVHS; Kerbs; Main roads; Motorways; Nested logit models; Performance measurement; Ramp freeway junctions; Ramps (Interchanges); Risk management; Road safety; Road transport informatics; Roadway; RTI; Rural highways; Safety data; Signalised intersections; Signalized intersections; Speed limits; Surrogate safety measures; Thorofares; Thoroughfares; Through highways; Time-spent-following; Traffic congestion; Traffic flow; Traffic lanes; Traveled way; Two lane highways; Two lane roads; Urban areas

**Subject Areas:** Highways; Safety and Human Factors; I80: Accident Studies

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**Title:** **Road Safety Culture Development for Substantial Road Trauma Reduction: Can the Experience of the State of Victoria, Australia, be Applied to Achieve Road Safety Improvement in North America?**

**Accession Number:** 01051422

**Record Type:** Component

**Language:** English

**Record URL:** <http://www.aaafoundation.org/pdf/HowardSweatman.pdf>

**Abstract:** The State of Victoria, Australia has improved its road safety performance substantially in the periods 1989 to 1992 and since 2001. The lessons learned from this experience suggest that mechanisms by which governments and communities can achieve improved road safety outcomes are not well understood and have received little research attention. A clear recognition and understanding of principles and processes which will assist change are fundamentally important if new countermeasure proposals are to achieve community acceptance over time. Proponents of change need to be well equipped if their ideas are to negotiate the difficult course of public debate and bring about greater acceptance (albeit, often incrementally) in public attitudes. This paper outlines the new road safety thinking developed in Victoria, Australia including the focus on road safety performance measurement which is a key driver of road safety management. It compares road safety outcomes with the current situation in the USA. The paper suggests that consideration be given to implementation of a tailored pilot implementation in selected states of the US. Such implementation would be based, in particular, on a more complete understanding of how the transition from concept to implementable reality can occur.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 305-327

**Authors:** Howard, Eric  
VicRoads

Sweatman, Peter  
University of Michigan Transportation Research Institute

**Features:** Figures (2) ; References; Tables (1)

**Monograph Title:** Improving Traffic Safety Culture in the United States - The Journey Forward

**Monograph Accession Number:** 01050454

**Corporate Authors:** AAA Foundation for Traffic Safety  
607 14th Street, NW, Suite 201  
Washington, DC 20005

**Availability:** AAA Foundation for Traffic Safety  
607 14th Street, NW, Suite 201  
Washington, DC 20005

**Publication Date:** 20070000

**Index Terms:** Acceptance; Attitudes; Collision injuries; Countermeasures; Crash injuries; Culture (Social sciences); Goals; Highway accidents; Highway safety; Implementation; Lessons learned; Mental attitudes; Objectives; Performance measurement; Pilot studies; Priorities; Public opinion; Road safety; Safety management; Strategic planning; Strategies; Traffic accidents; Traffic safety; United States; Victoria (Australia)

**Subject Areas:** Highways; Research; Safety and Human Factors; Society; I80: Accident Studies

---

**Title:** **Improving Traffic Safety Culture in the United States - The Journey Forward**

**Accession Number:** 01050454

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.aaafoundation.org/pdf/SafetyCultureReport.pdf>

**Abstract:** This report presents a compendium of papers about traffic safety and traffic safety culture in the United States. Topics covered include cultural paradigms, public health and medicine, measuring program effectiveness, intervention, understanding drivers, driver feedback, rural traffic safety, speed and speeding, implementation, and international comparisons.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** 386p

**Features:** Figures; References; Tables

**Corporate Authors:** AAA Foundation for Traffic Safety  
607 14th Street, NW, Suite 201  
Washington, DC 20005

**Availability:** AAA Foundation for Traffic Safety  
607 14th Street, NW, Suite 201  
Washington, DC 20005

**Publication Date:** 20070000

**Index Terms:** Countermeasures; Culture (Social sciences); Drivers; Feedback; Highway safety; Implementation; International; Medicine; Motor vehicle operators; Overspeed; Paradigm; Performance measurement; Public health; Road safety; Rural areas; Safety programs; Speed; Speeding; Traffic safety; United States; Worldwide

**Subject Areas:** Highways; Research; Safety and Human Factors; Society; I80: Accident Studies

---

**Title:** Use and Misuse of Motor-Vehicle Crash Death Rates in Assessing Highway-Safety Performance

**Accession Number:** 01042013

**Record Type:** Component

**Language:** English

**Abstract:** The objectives of the article are to assess the extent to which comparisons of motor-vehicle crash death rates can be used to determine the effectiveness of highway-safety policies over time in a country or to compare policy effectiveness across countries. Motor-vehicle crash death rates per mile traveled in the 50 U.S. states from 1980 to 2003 are used to show the influence on these rates of factors independent of highway-safety interventions. Multiple regression models relating state death rates to various measures related to urbanization and demographics are used. The analyses demonstrate strong relationships between state death rates and urbanization and demographics. Almost 60% of the variability among the state death rates can be explained by the independent variables in the multiple regression models. When the death rates for passenger vehicle

occupants (i.e., excluding motorcycle, pedestrian, and other deaths) are used in the regression models, almost 70% of the variability in the rates can be explained by urbanization and demographics. The analyses presented in the article demonstrate that motor-vehicle crash death rates are strongly influenced by factors unrelated to highway-safety countermeasures. Overall death rates should not be used as a basis for judging the effectiveness (or ineffectiveness) of specific highway-safety countermeasures or to assess overall highway-safety policies, especially across jurisdictions. There can be no substitute for the use of carefully designed scientific evaluations of highway-safety interventions that use outcome measures directly related to the intervention; e.g., motorcyclist deaths should be used to assess the effectiveness of motorcycle helmet laws. While this may seem obvious, there are numerous examples in the literature of death rates from all crashes being used to assess the effectiveness of interventions aimed at specific subsets of crashes.

- Supplemental Notes:** Abstract reprinted with permission from Taylor and Francis
- TRIS Files:** TRIS
- Media Type:** Print
- Pagination:** pp 307-318
- Authors:** O'Neill, Brian  
[brianeoneill@cox.net](mailto:brianeoneill@cox.net)  
Insurance Institute for Highway Safety
- Kyrychenko, Sergey Y  
[skyrychenko@iihs.org](mailto:skyrychenko@iihs.org)  
Insurance Institute for Highway Safety
- Features:** Figures (3) ; References; Tables (7)
- Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/oclc/49192340>
- Publication Date:** 20061200
- Serial:** Traffic Injury Prevention  
Volume: 7  
Issue Number: 4  
Publisher: Taylor & Francis  
ISSN: 1538-9588  
OCLC: 49192340  
Serial URL: <http://www.tandf.co.uk/journals/titles/15389588.html>
- Index Terms:** Accident causes; Accident factors; Accident frequency; Accident rates; Accident responsibility; Automotive vehicles; Collisions;

Countermeasures; Countries; Crashes; Death; Death rates; Demographics; Evaluation and assessment; Fatal accidents; Fatalities; Government policy; Highway safety; Literature reviews; Literature surveys; Mathematical models; Measures of effectiveness; Motor vehicles; Motorcycles; Multiple regression analysis; Occupants; Passenger vehicles; Pedestrians; Performance measurement; Policies; Policy; Prevention; Regulatory policy; Road safety; States; Time periods; Traffic fatalities; United States; Urbanization; Variables; Vehicle occupants

**Subject Areas:** Highways; Passenger Transportation; Pedestrians and Bicyclists; Policy; Safety and Human Factors; Security and Emergencies; Society; I81: Accident Statistics

---

**Title:** **Evaluating the Effectiveness of State Department of Transportation Investment Decisions: Linking Performance Measures to Resource Allocation**

**Accession Number:** 01041088

**Record Type:** Component

**Language:** English

**Abstract:** In recent years, many state departments of transportation (DOTs) have developed performance measures to monitor their transportation systems and improve transportation planning. One of the main outstanding questions with regard to using performance measures is how to best characterize the connection between resources and outcomes, particularly at a system (state) level. In this paper, the authors examine the effectiveness of state DOT investment decisions on two performance areas: Safety and congestion. The authors collected expenditure and performance data from 1984–2000 and developed state-specific linear regression models for each performance area. The statistical significance and direction of influence of each expenditure category varied between models, so the authors used 29 transportation-system characteristics to interpret model results. The findings of this study provide a better understanding of the link between resources and outcome and will help state DOTs utilize the new funding opportunities, improve the planning procedures and address government accountability concerns.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 216-229

**Authors:** Hendren, Patricia  
Niemeier, Debbie A

**Features:** Figures (2) ; References; Tables (9)

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/10760342>

**Publication Date:** 20061200

**Serial:** Journal of Infrastructure Systems  
Volume: 12  
Issue Number: 4  
Publisher: American Society of Civil Engineers  
ISSN: 1076-0342

**Index Terms:** Decision making; Effectiveness; Expenditures; Financial accountability; Financing; Funding; Gridlock (Traffic); Highway safety; Investment requirements; Investments; Linear regression; Linear regression analysis; Performance measurement; Resource allocation; Road safety; State departments of transportation; Traffic congestion; Traffic flow; Transportation planning; Transportation system management; Transportation systems management; TSM

**Subject Areas:** Finance; Highways; Planning and Forecasting; I10: Economics and Administration; I72: Traffic and Transport Planning

---

**Title:** **Quantified road safety target and road fatality reduction**

**Accession Number:** 01045793

**Record Type:** Component

**Language:** English

**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E214656

**Abstract:** This study evaluates the effectiveness of setting quantified road safety targets on road fatalities in nine countries from 1981 to 1999. Based on the systematic selection by the odds ratio qualification test, a suitable comparison group is established for each treatment country. A treatment-comparison group and the before-and-after comparison method are adopted to estimate the change in road fatalities after setting

a quantified target, and the majority of countries are shown to experience an appreciable reduction in road fatalities. Overall, a significantly favorable association is found between the implementation of a quantified road safety target and road safety performance. (a) For the covering entry of this conference, please see ITRD abstract no. 0612AR242E.

**TRIS Files:** ITRD

**Pagination:** 8P

**Authors:** Wong, S C  
[hhecwsc@hkucc.hku.hk](mailto:hhecwsc@hkucc.hku.hk)  
University of Hong Kong

Sze, N N  
[nnsze@graduate.hku.hk](mailto:nnsze@graduate.hku.hk)  
University of Hong Kong

YIP, H F  
University of Hong Kong

LOO, B P  
University of Hong Kong

Hung, W T  
Phone: 852 2766 6044  
Fax: 852 2334 6389  
[cewthung@inet.polyu.edu.hk](mailto:cewthung@inet.polyu.edu.hk)  
Hong Kong Polytechnic University

LO, H K  
Hong Kong University of Science and Technology

**Monograph Title:** Asphalt performance testing and mix design: a way forward

**Monograph Accession Number:** 01045641

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/isbn/1876592494>

**ISBN:** 1876592494

**Publication Date:** 20061100

**Serial:** ARRB CONFERENCE, 22ND, 2006, CANBERRA, ACT, AUSTRALIA  
Publisher: ARRB Group Limited

ISSN: 0572-1431

**Index Terms:** Accident frequency; Accident rate; Accident rates; Before and after studies; Before and after study; Conference; Conferences; Congresses; Death; Durability; Fatal accidents; Fatalities; Fatality; Measurement; Measurement; Measuring; Performance; Public safety; Safety; Safety; Safety measures; Symposia; Traffic fatalities

**Subject Areas:** Safety and Human Factors; I81: Accident Statistics

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**Title:** Working Group on Achieving Ambitious Road Safety Targets: Country Reports on Road Safety Performance

**Accession Number:** 01033925

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.cemt.org/JTRC/WorkingGroups/RoadSafety/Performance/TS3-report.pdf>

**Abstract:** This report was prepared by the OECD/ECMT Working Group on Achieving Ambitious Road Safety Targets. At its first meeting held on 9-10 March 2005, the Working Group discussed the importance of cross-country comparisons and targeted performance assessment in identifying the priority areas for implementation of effective measures and areas for possible improvements. It was decided to present and publish an overview of the safety evolution of individual countries, based on information collected through a survey. The survey was sent to all 50 OECD/ECMT countries to collect information on road safety trends, recent road safety measures implemented; key road safety issues, measures planned to address these issues and targets set and current results towards these targets. The responses to the survey are completed by other relevant data from other sources (e.g. IRTAD, ECMT statistics, and recent reports of the JTRC). Responses were received from 38 out of the 50 OECD/ECMT countries. In addition, the states of Victoria and Western Australia also provided responses to the Questionnaire. This report includes first a summary of road safety performance in OECD/ECMT countries. It presents an overview of road safety targets in OECD/ECMT countries, highlights the main road safety problems identified by member countries and provides some country comparisons.

**TRIS Files:** TRIS

**Media Type:** Web

**Pagination:** 439p  
**Features:** Figures; Tables  
**Corporate Authors:** Organisation for Economic Cooperation and Development  
2 rue Andre Pascal  
Paris Cedex 16 75775 France  
European Conference of Ministers of Transport  
2 rue Andre Pascal  
F-75775 Paris Cedex 16 France

**Publication Date:** 20060700

**Index Terms:** Alternatives analysis; Comparison studies; Countermeasures; Countries; Europe; Goals; Highway safety; Improvements; Objectives; Performance; Performance measurement; Priorities; Road safety; Strategic planning; Strategies; Surveys; Trade off analysis; Traffic safety; Trend (Statistics)

**Subject Areas:** Highways; Planning and Forecasting; Safety and Human Factors

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**Title:** **Halving Roadway Fatalities: A Case Study from Victoria, Australia, 1989-2004**

**Accession Number:** 01027357

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://www.international.fhwa.dot.gov/halving\\_fatalities/halving\\_fatalities.pdf](http://www.international.fhwa.dot.gov/halving_fatalities/halving_fatalities.pdf)

**Abstract:** In April 2004, the Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO), National Cooperative Highway Research Program (NCHRP), and Austroads undertook a scanning study of how agencies in Australia, Canada, Japan, and New Zealand use performance measures in transportation planning and decision making [Transportation Performance Measures in Australia, Canada, Japan, and New Zealand (FHWA-PL-05-001)]. The U.S. panel was particularly impressed with how Australia's transportation and safety agencies used performance measures to implement driver behavioral strategies geared toward reducing crashes. According to the panel's observations, the Australian model demonstrated the most advanced process of understanding the problems, benchmarking against others, setting targets, identifying strategies, monitoring effects, and integrating results into future planning efforts. Since 1980, Australia has gone from nearly 4.5 to 1.5 deaths per 10,000 registered motor vehicles. This compares to a change of 3.5 to 2.3 deaths per 10,000

registered motor vehicles in the United States over the same time period. In terms of traffic deaths as a function of population, Australia went from 22.5 deaths per 100,000 population in 1980 to fewer than 9 deaths per 100,000 population in 2003. From nearly identical rates in 1980, the Australian rate has fallen to a point where it is now a little more than half the U.S. rate. This report, which was undertaken through Austroads by Professor Ian Johnston, director of the Monash University Accident Research Centre, reviews Australia's accomplishments in highway safety. It not only discusses the performance measures established, but also goes beyond the public data. It draws from interviews with politicians, senior agency staff, and others with firsthand knowledge of how the traffic safety strategies were put together and, above all, how they were implemented, often amid public controversy but with majority community support.

**TRIS Files:** TRIS

**Report Numbers:** FHWA-PL-06-011

**Media Type:** Web

**Pagination:** 22p

**Authors:** Johnston, Ian  
Monash University

**Features:** Appendices (1) ; Figures; Photos; Tables (2)

**Corporate Authors:** Federal Highway Administration  
Office of International Programs, 1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Publication Date:** 20060400

**Index Terms:** Australia; Case studies; Death; Fatal accidents; Fatalities; Goals; Highway accidents; Highway safety; Implementation; Objectives; Performance measurement; Priorities; Road safety; Strategic planning; Strategies; Traffic accidents; Traffic fatalities; Traffic safety; Victoria (Australia)

**Subject Areas:** Highways; Planning and Forecasting; Research; Safety and Human Factors; I72: Traffic and Transport Planning; I81: Accident Statistics

---

**Title:** Road Infrastructure Safety Assessment

**Accession Number:** 01041671

**Record Type:** Component

**Language:** English

**Abstract:** The purpose of this paper is to describe the background and development methodology of Road Infrastructure Safety Assessment (RISA) information. The paper also describes the ongoing development of the assessment methodology, the uses of the process and the proposed future development of RISA. Land Transport NZ will also be able to use this tool as a performance measurement and comparison of Road Controlling Authorities (RCAs). The assessment methodology also has opportunities for adaptation for review and assessment of road safety features for other purposes. Land Transport New Zealand (Land Transport NZ) is developing a tool to enable RCAs to understand and manage their road safety infrastructure provisions in a more effective way.

**TRIS Files:** TRIS

**Media Type:** CD-ROM

**Pagination:** 9p

**Authors:** Appleton, Ian  
Land Transport New Zealand

Hannah, John  
Impact Consulting

Noone, M  
M J Noone & Partners

Wilkie, Sam  
MHW, New Zealand

**Features:** Figures (1) ; References; Tables (2)

**Monograph Title:** Research into Practice: 22nd ARRB Conference Proceedings

**Monograph Accession Number:** 01041647

**Corporate Authors:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Availability:** ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

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Order URL: <http://worldcat.org/isbn/1876592494>

**ISBN:** 1876592494

**Publication Date:** 20060000

**Conference:** Research into Practice: 22nd ARRB Conference  
Location: Canberra , Australia  
Date: 20061029 - 20061102  
Sponsors: ARRB Group Limited

**Index Terms:** Development; Evaluation and assessment; Highway safety; Infrastructure; Methodologies; Methodology; New Zealand; Performance measurement; Public safety; Road safety; Safety; Safety audits; Safety management; Safety measures

**Subject Areas:** Bridges and other structures; Highways; Planning and Forecasting; Safety and Human Factors; I21: Planning of Transport Infrastructure; I82: Accidents and Transport Infrastructure

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**Title:** **Identifying and Quantifying Operational and Safety Performance Measures for Access Management: Micro-Simulation Results**

**Accession Number:** 01019175

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://swutc.tamu.edu/publications/technicalreports/167725-1.pdf>

**Abstract:** This research report summarizes the activities of a research project intended to identify and quantify appropriate operational and safety performance measures that can be used for investigating access management treatments. Specifically, the research had three objectives: 1) assess the state-of-the-practice relative to performance measures that are applicable to access management and identify existing and/or new measures—particularly measures that can capture the safety benefits of access management treatments, 2) perform micro-simulation using the identified measures on two selected case study corridors and on three theoretical corridors to demonstrate the application of the measures, and 3) develop guidance for applying the performance measures for evaluating roadway improvements that include access management treatments (e.g., raised medians, driveway consolidation) and incorporating them into the transportation planning process. The research will be useful to practitioners as it identifies desirable input

and output characteristics for individuals searching for a micro-simulation tool to use for assessing the impacts of access management. It also identifies surrogate safety measures related to time-to-collision (TTC), and incorporates them into a micro-simulation model (VISSIM) as a demonstration of how both safety and operational impacts might be investigated in the same software package. Generally, the results appear intuitive—particularly at lower volumes and for the theoretical corridors. The research report also discusses how the safety measures can be incorporated into the traditional transportation planning process. It also cautions that corridor improvements are very case specific and illustrates how micro-simulation, when calibrated appropriately to field conditions, provides a tool to estimate the effects of combined corridor characteristics. Finally, the research report concludes with future research needs that can enhance the state-of-the-practice in this area.

**Supplemental Notes:** Project Title: Quantifying Access Management Performance Measures and Incorporating Them into the Transportation Planning Process. This research was supported by a grant from the U.S. Department of Transportation, University Transportation Centers program.

**TRIS Files:** UTC, TRIS

**Report Numbers:** SWUTC/05/167725-1  
Report 167725-1

**Contract Numbers:** 10727

**Media Type:** Web

**Pagination:** 105p

**Authors:** Eisele, William L  
[bill-eisele@tamu.edu](mailto:bill-eisele@tamu.edu)  
Toycen, Casey M  
Phone: 512-467-0946  
Fax: 512-467-8971  
[c-toycen@ttimail.tamu.edu](mailto:c-toycen@ttimail.tamu.edu)  
Texas Transportation Institute

**Features:** Figures (46) ; Maps (2) ; Photos (4) ; References (41) ; Tables (22)

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA  
Southwest Region University Transportation Center  
Texas Transportation Institute, Texas A&M University

College Station, TX 77843-3135 USA

**Federal Highway Administration**

1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20050800

**Index Terms:** Access control (Transportation); Access management (highways); Case studies; Central reserves; Driveways; Future; Highway corridors; Highway operations; Highway safety; Improvements; Median strips; Medians; Microsimulation; Needs assessment; Performance measurement; Research; Road safety; Software packages; State of the practice; Time-to-collision; Traffic corridors; Traffic operations; VISSIM (Computer model)

**Subject Areas:** Highways; Operations and Traffic Management; Research; Safety and Human Factors; I73: Traffic Control; I80: Accident Studies

---

**Title:** **Analysing Road Pavement Skid Resistance**

**Accession Number:** 01006873

**Record Type:** Component

**Language:** English

**Abstract:** In recent years, many Road Controlling Authorities have made concerted efforts to measure skid resistance in order to better understand how their asset are performing and to improve their decision making. Because of the prohibitive costs of skid testing measurements, usually only one 'network level' test are undertaken annually. This sampling period, while being reasonable for other pavement condition indicators, should be used with caution as a performance indicator of skid resistance. This paper discusses infrastructure asset management goals and the development in New Zealand (NZ) of the NZdTIMS system of predictive deterioration modeling. The paper then demonstrates that measured skid resistance varies significantly from month to month, week to week and even day to day, based on a number of external variables. The outcome being that it is very difficult to develop credible incremental deterministic prediction models for skid resistance. The paper then reports upon research that is currently being

undertaken at the University of Auckland, New Zealand into the variability of road pavement skid resistance over time. The methodology includes the measuring and analyses of skid resistance with rainfall and contaminants in the field using the GripTester, SCRIM and the Dynamic Friction Tester (DFTester) and secondly by means of controlled laboratory experiments on prepared samples. The paper discusses the results of the experiments that were developed to try and simulate infield skid resistance variability. The research demonstrates the importance of understanding the significance of a single skid measurement as a 'snapshot' in time. This result must be qualified in the context of not only the method of measurement but an understanding of the surrounding local environmental factors in which the measurement was taken.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** 16p

**Authors:** Wilson, Douglas J  
Dunn, Roger C. M.

**Features:** CD-ROM; Figures (7) ; References; Tables (2)

**Monograph Title:** ITE 2005 Annual Meeting and Exhibit Compendium of Technical Papers

**Monograph Accession Number:** 01006879

**Corporate Authors:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

ARRB Group Limited  
500 Burwood Highway  
Vermont South, Victoria 3133

**Availability:** Institute of Transportation Engineers  
1627 Eye Street, NW, Suite 600  
Washington, DC 20006 USA

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Order URL: <http://worldcat.org/isbn/1933452080>

**ISBN:** 1933452080

**Publication Date:** 20050000

**Conference:** ITE 2005 Annual Meeting and Exhibit Compendium of Technical Papers  
Location: Melbourne , Australia  
Date: 20050807 - 20050810  
Sponsors: Institute of Transportation Engineers; ARRB Group Limited

**Index Terms:** Asset management; Decision making; Environment; Highway safety; Infrastructure; Measurement; Measuring; New Zealand; Pavement design; Pavement performance; Road safety; Skid resistance; Skidding

**Subject Areas:** Design; Highways; Pavements; I22: Design of Pavements, Railways and Guideways

**TRID Search 2/27/2012 with Additions on April 06 2012  
("traffic safety" or "road\* safety" or "highway safety" ) and "design  
guideline\*" with index term "design" with date between 2000 and 2012**

**Title:** Highway Geometric Design from the Perspective of Recent Safety Developments

**Accession Number:** 01363803

**Record Type:** Component

**Language:** English

**Abstract:** In a safe-system approach to road safety, problems are dealt with by considering how several components of the road transportation system interact rather than implementing countermeasures in isolation. In this paper, the authors propose that relevant information from the fields of the safe-system approach, including user-centered design and road safety auditing, be integrated into highway geometric design guidelines. A framework is proposed for integrating safety and human factor issues into highway geometric design guidelines. Key issues to be addressed include safety training of highway design engineers, three-dimensional highway design and implementation of a safe system. The safe system approach has already been applied in several states and countries, and has the potential to be implemented in other places.

**TRIS Files:** TRIS

**Media Type:** Print

**Pagination:** pp 841-844

**Authors:** Kanellaidis, George  
National Technical University of Athens  
Vardaki, Sophia  
Phone: 30-210-77231282  
Fax: 30-210-7721327  
[sophiav@central.ntua.gr](mailto:sophiav@central.ntua.gr)  
National Technical University of Athens

**Features:** Figures; References

**Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/oclc/8674831>

**Publication Date:** 20111201

**Serial:** Journal of Transportation Engineering  
Volume: 137  
Issue Number: 12  
Publisher: American Society of Civil Engineers  
ISSN: 0733-947X  
OCLC: 8674831  
Serial URL: <http://ascelibrary.aip.org/teo>

**Index Terms:** Geometric design; Highway safety; Human factors; Road safety; Safety engineering

**Subject Areas:** Design; Highways; Safety and Human Factors; I20: Design and Planning of Transport Infrastructure; I82: Accidents and Transport Infrastructure

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**Title:** **Operations and Safety of Super 2 Corridors with Higher Volumes**

**Accession Number:** 01343277

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://ti.tamu.edu/documents/0-6135-1.pdf>

**Abstract:** As traffic volumes increase, in both urban and rural areas, the demand on the highway network also increases. Specifically, as rural traffic volumes rise in Texas, the pressure on the state's network of two-lane highways rises accordingly. Previous research in Texas demonstrated that periodic passing lanes can improve operations on two-lane highways with average daily traffic (ADT) lower than 5000; these "Super 2" highways can provide many of the benefits of a four-lane alignment at a lower cost. This project expands on that research to develop design guidelines for passing lanes on two-lane highways with higher volumes, investigating the effects of volume, terrain, and heavy vehicles on traffic flow and safety. This report discusses findings from field observations and crash analysis of existing Super 2 highway corridors in Texas and computer modeling of traffic conditions on a simulated Super 2 corridor. Results indicate that passing lanes provide added benefit at higher traffic volumes, reducing crashes, delay, and percent time spent following. Empirical Bayes analysis of crash data reveals a 35 percent reduction in expected nonintersection injury crashes. Simulation results indicate that most passing activity takes place within the first mile of the passing lane, so providing additional passing lanes can offer greater benefit than providing longer passing lanes. Whether adding new passing lanes or adding length to existing lanes, the incremental benefit diminishes as additional length is

provided and the highway more closely resembles a four-lane alignment. The simulation study also showed that the effects of ADT on operations were more substantial than the effects of terrain or truck percentage for the study corridor.

**Supplemental Notes:** Project Title: Super 2 Design for Higher Traffic Volumes. Report Date: February 2011; Published: June 2011.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-11/0-6135-1  
Report 0-6135-1

**Contract Numbers:** Project 0-6135

**Media Type:** Web

**Pagination:** 208p

**Authors:** Brewer, Marcus A  
[m-brewer@tamu.edu](mailto:m-brewer@tamu.edu)  
Texas Transportation Institute

Venglar, Steven P  
Texas Transportation Institute

Ding, Liang  
Phone: 210-979-9411  
[l-ding@tamu.edu](mailto:l-ding@tamu.edu)  
Texas Transportation Institute

Fitzpatrick, Kay  
[k-fitzpatrick@tamu.edu](mailto:k-fitzpatrick@tamu.edu)  
Texas Transportation Institute

Park, Byung-Jung  
Texas Transportation Institute

**Features:** Appendices (2) ; Figures (60) ; Maps (2) ; Photos (3) ; References (50) ; Tables (41)

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration

1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20110600

**Edition:** Technical Report

**Period Covered:** September 2008–February 2011

**Index Terms:** Accident analysis; Average daily traffic; Computer models; Empirical Bayes method; Field studies; Guidelines; Highway design; Highway operations; Highway safety; Passing lanes; Road design; Road safety; Texas; Traffic delay; Traffic flow; Traffic operations; Traffic safety; Traffic volume; Two lane highways; Two lane roads

**Subject Areas:** Design; Highways; Operations and Traffic Management; Safety and Human Factors; I21: Planning of Transport Infrastructure; I73: Traffic Control; I82: Accidents and Transport Infrastructure

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**Title:** **Development of Safety Performance Monitoring Procedures**

**Accession Number:** 01154204

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-4703-7.pdf>

**Abstract:** Highway safety is an ongoing concern to the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. The objectives of this research project are: (1) the development of safety design guidelines and evaluation tools to be used by TxDOT designers, and (2) the production of a plan for the incorporation of these guidelines and tools in the planning and design stages of the project development process. This document summarizes the research that was conducted and the products that were developed during this six-year research project. It also describes a plan to incorporate safety design guidelines and evaluation tools into the project development process. It is intended for use by engineers responsible for the planning and design of streets and highways.

**Supplemental Notes:** Project Title: Incorporating Safety into the Highway Design Process.  
Report Date: September 2009; Published: February 2010.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-10/0-4703-7  
Report 0-4703-7

**Contract Numbers:** Project 0-4703

**Media Type:** Web

**Pagination:** 48p

**Authors:** Pratt, Michael P  
Phone: (979) 845-1907  
Fax: (979) 845-6254  
[m-pratt@ttimail.tamu.edu](mailto:m-pratt@ttimail.tamu.edu)  
Texas Transportation Institute

Bonneson, James A  
Phone: 979-845-9906  
Fax: 979-845-6254  
[j-bonneson@tamu.edu](mailto:j-bonneson@tamu.edu)  
Texas Transportation Institute

**Features:** Appendices (1) ; Figures (2) ; References; Tables

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA  
  
Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20100200

**Edition:** Technical Report

**Period Covered:** September 2003 - August 2009

**Index Terms:** Guidelines; Highway design; Highway safety; Monitoring; Monitoring systems; Planning and design; Project development process; Road design; Road safety

**Subject Areas:** Design; Highways; Safety and Human Factors; I20: Design and Planning of Transport Infrastructure; I82: Accidents and Transport Infrastructure

---

**Title:** **Integrating Safety and Human Factor Issues into Road Geometric Design Guidelines**

**Accession Number:** 01338127

**Record Type:** Component

**Language:** English

**Abstract:** “Safe System” is a novel approach to road safety and represents a radical evolution in strategies for further improving road safety outcomes. "Vision Zero" and "Advancing Sustainable Safety", recently developed in Sweden and the Netherlands, are two breakthrough paradigms of such an approach, including provisions aiming at road design, shifting a major share of the safety responsibility from road users to those who design the road transport systems. “Human Factors Guidelines for Road Systems”, an ongoing publication (8) which aims to provide the best factual information and insight on the characteristics of road users to facilitate safe roadway and operations decisions, is a benchmark current development for a safe user centered roadway design. In Road Safety Audits and Road Safety Inspections, considerations of safety and human factors have already been exploited. Specific guidelines and recommendations have also been developed to accommodate older road users, a group which is of growing importance. Roadway designers, who bear a major responsibility for the safe roadway design, should have a thorough understanding of the safety implications of their design decisions. Unfortunately, this kind of knowledge is limited among roadway designers due to the lack of appropriate professional training on safety and human factor issues, as well as the pertinent inadequacies in the University curricula. Consequently, there is an urgent need to aid roadway design engineers, in order to become familiar with current safety and human factors recent developments. The authors think that a promising way in achieving this objective is the effective integration of safety and human factors issues into road geometric design guidelines. In order to identify how safety and human factor considerations have been integrated in road geometric design guidelines, a critical review of current design policies in the United States of America, Germany, Canada and

Australia was carried out and showed that these considerations have been incorporated to a varying degree into design guidelines. However, there are several areas of road geometric design that have to be enriched accordingly. On the basis of this review and the aforementioned recent developments, a framework is suggested and discussed that will contribute to integrating the existing knowledge regarding safety and human factors issues into road geometric design guidelines.

**TRIS Files:** TRIS

**Media Type:** CD-ROM

**Pagination:** 15p

**Authors:** Kanellaidis, George  
National Technical University of Athens

Vardaki, Sophia  
Phone: 30-210-77231282  
Fax: 30-210-7721327  
[sophiav@central.ntua.gr](mailto:sophiav@central.ntua.gr)  
National Technical University of Athens

**Features:** Figures (1) ; References (38)

**Monograph Title:** 4th International Symposium on Highway Geometric Design, June 2-5, 2010, Valencia, Spain

**Monograph Accession Number:** 01338092

**Corporate Authors:** Polytechnic University of Valencia  
Department of Transportation, Camino de Vera  
Valencia 46022 Spain

Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Availability:** Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Publication Date:** 20100000

**Conference:** 4th International Symposium on Highway Geometric Design  
Location: Valencia , Spain  
Date: 20100602 - 20100605  
Sponsors: Polytechnic University of Valencia; Transportation Research

Board

**Index Terms:** Geometric design; Highway design; Highway safety; Human factors; Road design; Road safety

**Subject Areas:** Design; Highways; I20: Design and Planning of Transport Infrastructure

---

**Title:** Country Report – the Netherlands

**Accession Number:** 01338100

**Record Type:** Component

**Language:** English

**Abstract:** This paper provides an overview of the most significant developments in the area of road (geometric) design practices and standards and related research in the Netherlands in recent years. The paper describes the importance of the Sustainable Road Safety policy in this context. Furthermore, it provides a summary of a number of new initiatives and developments with respect to road and intersection design with a specific focus on related (road safety) research and its role in the development and application of guidelines. Since 1998 the Netherlands has applied the principles of Sustainable Safety in road design and over the years these have been researched and in varying degrees been adopted into geometric design standards and guidelines. In recent years the strategic direction of road safety has shifted from being focussed on predominantly infrastructure to concentrating on regular traffic offenders and vulnerable road users and where technological innovation plays an important role. The newly adopted road safety strategy for 2020 is a testament of this shift. However, road authorities, standards and research organisations continue pursuing the long term vision set out by the Sustainable Safety programme by adapting the road environment and related standards and guidelines to meet the ongoing challenge of further reducing road accidents. To facilitate and support these developments, extensive research programmes have been carried out and these include driving simulator research into the (behavioural) effects of, for example narrow cross-sections, research into safe and credible speeds and research into the effects of road design and layout on road safety. The results of these research programmes are used in the development and/or amendment of road design guidelines and standards. Examples discussed in the paper include the implementation and evaluation of the essential characteristics for the recognition of road infrastructure, the further expansion of 30 and 60km/h zones and 2+1 roads. The paper further elaborates on the following significant and

related developments: – Optimising the use of available road space through innovative design and traffic management procedures (e.g. network approach; emergency lane etc.); – the planned new guidelines for national highways; – guidelines for signing and marking at road construction zones; – the guidelines for essential characteristics for the recognition of road types; – experiences related to the use and design of turbo-roundabouts (traffic circles) and subsequently adopted design guidelines; – design guidelines for 2+1 roads; – the Dutch traffic safety handbook; – the relationship between road design and (direction) signing and in-car/roadside information systems; and – Human factor guidelines (the so called Golden Rules). The focal point of Sustainable Safety is that the human and consequently human factors still play an increasingly important role in road design in the Netherlands. The Sustainable Safety programme has been around since 1997 and has had a major impact on infrastructure design and the way in which the Netherlands approaches road safety. This has resulted in 10 years of re-engineering major parts of the Dutch road network and making a significant contribution to the 300 to 400 fewer road traffic fatalities in 2007 when compared to 1997. This paper will briefly touch on these effects. The paper closes with an overview of other future developments and their possible consequence on road design practices in the Netherlands.

<b>TRIS Files:</b>	TRIS
<b>Media Type:</b>	CD-ROM
<b>Pagination:</b>	15p
<b>Authors:</b>	Schermers, Govert Institute for Road Safety Research (SWOV)
	Wegman, Fred <a href="mailto:fred.wegman@swov.nl">fred.wegman@swov.nl</a> Institute for Road Safety Research (SWOV)
	van Vliet, Pieter <a href="mailto:Pieter.vVliet@avv.rws.minvenw.nl">Pieter.vVliet@avv.rws.minvenw.nl</a> Ministry of Transport, Public Works, and Water Management
	van der Horst, Richard <a href="mailto:richard.vanderhorst@tno.nl">richard.vanderhorst@tno.nl</a> TNO Human Factors Research Institute
	Boender, John CROW
<b>Features:</b>	Figures (2) ; References

**Monograph Title:** 4th International Symposium on Highway Geometric Design, June 2-5, 2010, Valencia, Spain

**Monograph Accession Number:** 01338092

**Corporate Authors:** Polytechnic University of Valencia  
Department of Transportation, Camino de Vera  
Valencia 46022 Spain

Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Availability:** Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Publication Date:** 20100000

**Conference:** 4th International Symposium on Highway Geometric Design  
Location: Valencia , Spain  
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Sponsors: Polytechnic University of Valencia; Transportation Research Board

**Index Terms:** Cross roads; Design standards; Geometric design; Highway design; Highway safety; Human factors; Intersections; Junctions (Traffic); Netherlands; Road design; Road safety; Sustainable safety

**Subject Areas:** Design; Highways; I20: Design and Planning of Transport Infrastructure

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**Title:** **Synthesis of Information Related to Highway Problems. Topic 41-01. Geometric Design Practices for Resurfacing, Restoration, and Rehabilitation**

**Accession Number:** 01339294

**Record Type:** Project

**Language:** English

**Record URL:** <http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=2739>

**Source Agency:** National Cooperative Highway Research Program  
Washington, DC 20001

**Source Data:**

RiP Project 22388

**Abstract:**

In response to a provision in the Surface Transportation Assistance Act of 1982, the Transportation Research Board studied the safety and cost effectiveness of highway geometric design standards and recommended minimum standards for Resurfacing, Restoration and Rehabilitation (RRR) projects on existing federal-aid highways, except for freeways. In 1987, The Transportation Research Board (TRB) published Special Report 214, Designing Safer Roads: Practices for Resurfacing, Restoration, and Rehabilitation." The American Association of State Highway Transportation Officials (AASHTO) subsequently amended the Foreword of the Policy on Geometric Design for Highways and Streets to include the following sentence: "This publication is not intended as a policy for Resurfacing, Restoration, or Rehabilitation (3R) projects and refers the reader to TRB Special Report 214 for design guidance." In 2001, AASHTO published Guidelines for Geometric Design for Very-Low Volume Local Roads (ADT &#8804; 400). While this document does not specifically address RRR work, it does provide some guidance related to improving the safety and cost-effectiveness of geometric design for existing, low-volume roads. With TRB SR 214 specifically addressing RRR work on federal-aid highways and AASHTO providing limited guidance only on roads with ADT less than 400 vehicles per day, there is a lack of design guidance for RRR work on the wide range of roads that have traffic volumes in excess of 400 vehicles per day but are not eligible for federal-aid funding. A need exists to document the state of highway practice related to resurfacing, restoration, and rehabilitation (3R) design guidelines for these roadway types. State transportation agencies in Alabama, California, Florida, Kansas, North Carolina, Oregon, and Texas all have 3R design guidelines; however, all are different. It is therefore likely that the range of current practice is considerable. The main focus of this project should be to conduct a state transportation agency survey to document current practices related to 3R design. The synthesis should document the range of 3R design practices used by state transportation agencies in the United States. This product of this synthesis will be of considerable value to local transportation agencies in need of a document that highlights best practices of 3R design policies currently used in the U.S. Information will be gathered by literature review, survey of transportation agencies, and selected interviews.

**TRIS Files:**

TRB, RiP

**Contract Numbers:**

Project 20-05, Topic

**Funding:**

35000.00

**Start Date:**

20090701

**Performing Agencies:** Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001 USA

**Funding Agencies:** Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

American Association of State Highway & Transp Officials  
444 North Capitol Street, NW, Suite 225  
Washington, DC 20001

National Cooperative Highway Research Program  
Transportation Research Board  
500 Fifth Street, NW  
Washington, DC 20001

**Responsible Individuals:** Williams, Jon M  
[jwilliams@nas.edu](mailto:jwilliams@nas.edu)

**Index Terms:** Average daily traffic; Cost effectiveness; Geometric design; Highway design; Highway maintenance; Highway safety; Low volume roads; Pavement maintenance; Rehabilitation (Maintenance); Repaving; Research projects; Restoration; Resurfacing; Road design; Road maintenance; Road safety; Roadwork

**Subject Areas:** Design; Finance; Highways; Maintenance and Preservation; Pavements

---

**Title:** Roadway Safety Design Workbook

**Accession Number:** 01141674

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-4703-P2.pdf>

**Abstract:** Highway safety is an ongoing concern to the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. The objectives of this research project are: (1) the development of safety design guidelines and evaluation tools to be used by TxDOT designers, and (2) the production of a plan for the incorporation of these guidelines and tools in the planning and design stages of the project

development process. This document provides the best-available information describing the relationship between various highway geometric design components and crash frequency. It is intended to be used by engineers for the purpose of explicitly evaluating the potential safety trade-offs associated with various design alternatives. This document focuses on quantitative safety relationships for specific design components known to be correlated with crash frequency. It is intended for engineers responsible for the geometric design of streets and highways. Following an introductory chapter, the remaining chapters are devoted to freeways, rural highways, urban and suburban arterials, interchange ramps and frontage roads, rural intersections, and urban intersections.

**Supplemental Notes:** Project Title: Incorporating Safety into the Highway Design Process.  
Report Date: March 2009; Resubmitted: April 2009; Published: July 2009.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-09/0-4703-P2  
Product 0-4703-P2

**Contract Numbers:** Project 0-4703

**Media Type:** Web

**Pagination:** 220p

**Authors:** Bonneson, James A  
Phone: 979-845-9906  
Fax: 979-845-6254  
[j-bonneson@tamu.edu](mailto:j-bonneson@tamu.edu)  
Texas Transportation Institute

Pratt, Michael Paul  
Phone: (979) 845-1907  
Fax: (979) 845-6254  
[m-pratt@ttimail.tamu.edu](mailto:m-pratt@ttimail.tamu.edu)  
Texas Transportation Institute

**Features:** Appendices (2) ; Figures; Photos; References; Tables

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080

Austin, TX 78763-5080 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20090700

**Edition:** Product

**Period Covered:** September 2003-August 2009

**Index Terms:** Accident frequency; Accident rates; Arterial highways; Arterial streets; Boulevards; City streets; Controlled access highways; Cross roads; Freeways; Frontage roads; Geometric design; Guidelines; Highway design; Highway safety; Interchanges; Intersections; Junctions (Traffic); Main roads; Motorways; Ramp freeway junctions; Ramps (Interchanges); Road design; Road safety; Rural areas; Rural highways; Streets; Suburbs; Texas; Thorofares; Thoroughfares; Through highways; Urban areas

**Subject Areas:** Design; Highways; Safety and Human Factors; I20: Design and Planning of Transport Infrastructure; I82: Accidents and Transport Infrastructure

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**Title:** **Calibration Factors Handbook: Safety Prediction Models Calibrated with Texas Highway System Data**

**Accession Number:** 01115344

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-4703-5.pdf>

**Abstract:** Highway safety is an ongoing concern to the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. The objectives of this research project are: (1) the development of safety design guidelines and evaluation tools to be used by TxDOT designers, and (2) the production of a plan for the incorporation of these

guidelines and tools in the planning and design stages of the project development process. This document summarizes the research conducted and the conclusions reached during the development of safety prediction models for intersections and highway segments in Texas. Models were developed for urban and suburban arterial intersections, urban and suburban arterial street segments, rural multilane highway segments, and urban and rural freeway segments. They were subsequently calibrated using Texas highway system data. Selected accident modification factors were also developed and calibrated. These factors address several geometric design elements, including turn bay presence, median width, barrier presence, and weaving section length.

**Supplemental Notes:** Report Date: June 2008; Published: October 2008. Project Title: Incorporating Safety into the Highway Design Process.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-08/0-4703-5  
Report 0-4703-5

**Contract Numbers:** Project 0-4703

**Media Type:** Web

**Pagination:** 160p

**Authors:** Bonneson, James A  
Phone: 979-845-9906  
Fax: 979-845-6254  
[j-bonneson@tamu.edu](mailto:j-bonneson@tamu.edu)  
Texas Transportation Institute

Pratt, Michael Paul  
Phone: 979-845-1907  
[M-Pratt@TTIMAIL.TAMU.EDU](mailto:M-Pratt@TTIMAIL.TAMU.EDU)  
Texas Transportation Institute

**Features:** Figures; References; Tables

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration

1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20081000

**Edition:** Technical Report

**Period Covered:** September 2003-June 2008

**Index Terms:** Accident modification factors; Arterial highways; Arterial streets; Boulevards; Calibrating; Calibration; Controlled access highways; Cross roads; Freeways; Guidebooks; Guidelines; Handbooks; Highway design; Highway safety; Intersections; Junctions (Traffic); Main roads; Mathematical models; Mathematical prediction; Motorways; Multilane highways; Road design; Road safety; Texas; Texas Department of Transportation; Thorofares; Thoroughfares; Through highways

**Subject Areas:** Data and Information Technology; Design; Highways; Planning and Forecasting; Safety and Human Factors; I21: Planning of Transport Infrastructure; I82: Accidents and Transport Infrastructure

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**Title:** **Optimizing Design of Highway Horizontal Alignments: New Substantive Safety Approach**

**Accession Number:** 01111413

**Record Type:** Component

**Language:** English

**Abstract:** Highway agencies are continually facing safety problems on highways, especially on horizontal alignments. Traditionally, the geometric design implicitly considers safety through satisfying minimum design requirements for different geometric elements. This paper presents a new substantive-safety approach for design of horizontal alignments based not only on minimum design guidelines, but also on actual collision experience. The curve radii, spiral lengths, lane width, shoulder width, and tangent lengths are determined to optimize mean collision frequency along the highway. The model allows the parameters of the horizontal alignment to vary within specified ranges. The model also considers any specified physical obstructions in selecting the optimal alignment. Collision experience is addressed using existing collision prediction models for horizontal alignments and cross

sections. The model is applicable to 2-lane rural highways for which collision prediction models exist. Application of the model is presented using numerical examples. The proposed substantive-safety approach takes horizontal alignment design one step further beyond the minimum-guideline concept, and therefore should be of interest to highway designers.

- TRIS Files:** TRIS
- Media Type:** Print
- Pagination:** pp 560-573
- Authors:** Easa, Said M  
Phone: 416-979-5000 x 7868  
Fax: 416-979-5122  
[seasa@ryerson.ca](mailto:seasa@ryerson.ca)  
Ryerson University
- Mehmood, Atif  
Ryerson University
- Features:** Appendices (1) ; Figures (7) ; References; Tables (6)
- Availability:** Find a library where document is available  
Order URL: <http://worldcat.org/issn/10939687>
- Publication Date:** 20080000
- Serial:** Computer-Aided Civil and Infrastructure Engineering  
Volume: 23  
Issue Number: 7  
Publisher: Blackwell Publishing  
ISSN: 1093-9687
- Index Terms:** Accident causes; Accident factors; Accident responsibility; Alignment; Alinement; Collisions; Crashes; Highway accidents; Highway design; Highway safety; Horizontal alignment; Road design; Road safety; Rural highways; Traffic accidents
- Subject Areas:** Highways; Safety and Human Factors; I82: Accidents and Transport Infrastructure
- 

**Title:** Development of Tools for Evaluating the Safety Implications of Highway Design Decisions

**Accession Number:** 01045892

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-4703-4.pdf>

**Abstract:** Highway safety is an ongoing concern to the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. The objectives of this research project are: (1) the development of safety design guidelines and evaluation tools to be used by TxDOT designers, and (2) the production of a plan for the incorporation of these guidelines and tools in the planning and design stages of the project development process. This document summarizes the research conducted and the findings for the initial three years of the project. This research included a review of the TxDOT design and safety evaluation process, identification of the safety information sources and needs, identification of the data needed to use selected safety evaluation tools, assessment of the applicability of accident modification factors for design evaluation, and calibration of selected safety evaluation tools for Texas application.

**Supplemental Notes:** Project Title: Incorporating Safety into the Highway Design Process.  
Report Date: September 2006; Published: February 2007.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-07/0-4703-4  
Report 0-4703-4

**Contract Numbers:** Project 0-4703

**Media Type:** Print

**Pagination:** 144p

**Authors:** Bonneson, James A  
[j-bonneson@tamu.edu](mailto:j-bonneson@tamu.edu)  
Texas Transportation Institute

Lord, Dominique  
Phone: 979-458-3949  
Fax: 979-845-6481  
[d-lord@tamu.edu](mailto:d-lord@tamu.edu)  
Texas Transportation Institute

Zimmerman, Karl H  
Phone: 979-458-2853  
Fax: 979-845-6254

[k-zimmerman@ttimail.tamu.edu](mailto:k-zimmerman@ttimail.tamu.edu)

Texas Transportation Institute

Fitzpatrick, Kay

Phone: 979-845-7321

Fax: 979-845-6481

[k-fitzpatrick@tamu.edu](mailto:k-fitzpatrick@tamu.edu)

Texas Transportation Institute

Pratt, Michael P

Phone: (979) 845-1907

Fax: (979) 845-6254

[m-pratt@ttimail.tamu.edu](mailto:m-pratt@ttimail.tamu.edu)

Texas Transportation Institute

**Features:** Figures; References (12) ; Tables

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20070200

**Edition:** Technical Report

**Period Covered:** September 2003-August 2006

**Index Terms:** Decision making; Geometric design; Guidelines; Highway design; Highway planning; Highway safety; Road design; Road safety; Safety management

**Subject Areas:** Design; Highways; Safety and Human Factors; I20: Design and Planning of Transport Infrastructure; I82: Accidents and Transport Infrastructure

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**Title:** **Crash Warning System Interfaces: Human Factors Insights and Lessons Learned**

**Accession Number:** 01095914

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www-nrd.nhtsa.dot.gov/departmen...%20Insights%20Task%205%20Final%20Rpt.pdf>

**Abstract:** The goal of this project has been to develop human factors insights and lessons learned for crash warning devices that emphasize driver performance and safety. The project reflects an important review of the human factors literature associated with the effective implementation of crash warning system interfaces; the lessons learned from this literature were characterized in terms of guidelines for interface design and driver performance. This document is intended to highlight issues to be addressed and provide guidance in the development of Collision Warning Systems (CWSs); the guidelines presented here reflect the best-available human factors information, and are neither requirements nor mandates. Information is presented on a variety of topics relevant to the driver-vehicle interface (DVI) of CWS devices. Chapters 2 through 11 contain the design guidelines produced through this effort. Chapter 2 provides general guidelines for CWS design, and focuses on issues associated with levels of warning and the prioritization of warnings, as well as recommendations for preventing false and nuisance alarms. Chapter 3 provides guidelines for presenting auditory warnings and focuses on the selection and design of various options for auditory warnings, including simple tones, earcons, auditory icons, and speech messages. Chapter 4 provides guidelines for visual warnings, focusing on recommendations for using visual displays and on determining the most appropriate visual display. Chapter 5 provides guidelines for haptic warnings, focusing on recommendations for using haptic displays and on determining the most appropriate haptic warnings. Chapter 6 provides a set of guidelines for selecting and designing user controls for CWS devices. Chapters 7, 8, and 9 provide—respectively—guidelines for forward collision (headway warning), lane change (blind spot warning) and road departure warnings; each of these chapters provides guidance on developing both cautionary and imminent warnings, as well as device-specific guidance for visual, auditory, and haptic warnings. Chapter 10 provides a series of guidelines specific to heavy truck and bus applications.

**TRIS Files:** HSL, TRIS

**Report Numbers:** HS-810 697

**Contract** DTNH22-02-D-02104

**Numbers:**

**Media Type:** Web

**Pagination:** 184p

**Authors:** Campbell, John L  
Phone: (206) 528-3254  
Fax: (206) 528-3555  
[campjohn@battelle.org](mailto:campjohn@battelle.org)  
Battelle

Richard, Christian M  
Battelle

Brown, James L  
Battelle

McCallum, Marvin  
Battelle

**Features:** Appendices (1) ; Figures; References; Tables

**Corporate Authors:** Battelle  
1100 Dexter Avenue North  
Seattle, WA 98109-3598 USA

National Highway Traffic Safety Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20070100

**Edition:** Final Report

**Index Terms:** Auditory warnings; Collision avoidance systems; Collision warning systems; Design; Driver vehicle interfaces; Guidelines; Human factors; Lessons learned; Literature reviews; Literature surveys; Tactile warning devices; Visual warnings

**Subject Areas:** Design; Highways; Safety and Human Factors; Vehicles and Equipment; I83: Accidents and the Human Factor; I91: Vehicle Design and Safety

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**Title:** **Roadway Safety Design Synthesis**

**Accession Number:** 01022815

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-4703-P1.pdf>

**Abstract:** Highway safety is an ongoing concern to the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. The objectives of this research project are: (1) the development of safety design guidelines and evaluation tools to be used by TxDOT designers, and (2) the production of a plan for the incorporation of these guidelines and tools in the planning and design stages of the project development process. This document describes the effect of key design components on street and highway safety. The information presented herein represents the findings from a critical review of the literature and an evaluation of the reported safety trends and relationships. The purpose of this document is to promote the explicit and objective consideration of safety in the design process. It is envisioned to be a reference document that will be useful to engineers and researchers who desire detailed safety information on various highway geometric design elements. The information in this document was used to develop the guidelines presented in the Interim Roadway Safety Design Workbook.

**Supplemental Notes:** Project Title: Incorporating Safety into the Highway Design Process.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-05/0-4703-P1  
Product 0-4703-P1

**Contract Numbers:** Project 0-4703

**Media Type:** Print

**Pagination:** 204p

**Authors:** Bonneson, J  
Zimmerman, K  
Fitzpatrick, K

**Features:** Figures (68) ; References; Tables (110)

**Corporate Authors:** Texas Transportation Institute

Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

**Texas Department of Transportation**

Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

**Federal Highway Administration**

1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20051100

**Edition:** Product

**Index Terms:** City streets; Development; Evaluation; Geometric design; Goals; Guidelines; Highway design; Highway engineers; Highway safety; Literature reviews; Literature surveys; Objectives; Planning and design; Priorities; Project management; Researchers; Road design; Road safety; Strategic planning; Strategies; Streets; Syntheses; Texas; Trend (Statistics)

**Subject Areas:** Administration and Management; Design; Highways; Planning and Forecasting; Safety and Human Factors; I21: Planning of Transport Infrastructure; I72: Traffic and Transport Planning; I82: Accidents and Transport Infrastructure

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**Title:** **Role and Application of Accident Modification Factors in the Highway Design Process**

**Accession Number:** 01003794

**Record Type:** Monograph

**Language:** English

**Abstract:** Highway safety is an ongoing concern to the Texas Department of Transportation (TxDOT). As part of its proactive commitment to improving highway safety, TxDOT is moving toward including quantitative safety analyses earlier in the project development process. The objectives of this research project are: (1) the development of safety design guidelines and evaluation tools to be used by TxDOT designers, and (2) the production of a plan for the incorporation of these

guidelines and tools in the planning and design stages of the project development process. This report describes the role and application of accident modification factors (AMFs) in the highway geometric design process. The potential applications of AMFs are identified and procedures for using AMFs are outlined. AMFs that can be used in design applications are also identified. Those AMFs that are needed to evaluate key highway design elements are identified. Recommendations are made regarding future research needed to enhance the use of AMFs in the design process.

**Supplemental Notes:** Project Title: Incorporating Safety Into the Highway Design Process.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-05/0-4703-2  
Technical Report 0-4703-2

**Contract Numbers:** Project 0-4703

**Media Type:** Print

**Pagination:** 42p

**Authors:** Bonneson, J  
Lord, D

**Features:** Figures (1) ; References (18) ; Tables (5)

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA  
Order Number: PB2005-109960/ABS

**Publication Date:** 20050500

**Period Covered:** September 2003-May 2005

**Index Terms:** Accident modification factors; Geometric design; Guidelines; Highway

design; Highway safety; Planning and design; Project development process; Recommendations; Research; Road design; Road safety; Safety design

**Subject Areas:** Design; Highways; Planning and Forecasting; Research; Safety and Human Factors; I21: Planning of Transport Infrastructure

---

**Title:** **Driver Perception of Roadway, Traffic and Environment: A Basic Human Factor to be Considered in Road Design Standards**

**Accession Number:** 01084247

**Record Type:** Component

**Language:** English

**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E135558

**Abstract:** More than 40 thousand people are killed and more than 3 million injured each year in road traffic accidents in both the United States and the European Union. In Europe 99 percent of fatal transportation accidents are road traffic related. More than 50 percent of all road crashes are attributed at least partly to late or missed perception of relevant information to avoid the accident. Safe driving requires adequate and efficient information gathering and processing from relevant sources within the road environment. A continuous input, in particular visual input, is essential for the orientation on the road. Orientation starts with the development of an internal representation of the road and ends with safe guidance and control of the vehicle. Perception is thereby the most important single basis for the drivers' decision making. Without knowledge about the actual traffic situation, organisation of appropriate and safe driving behaviour is not possible. Therefore, perception is a key issue in maintaining a high level of road safety. The design of a road should be in accordance to the perceptual capabilities of the driver. Changes in the design must be recognizable by the driver and transitions must be long enough to react appropriately. An extensive worldwide review of road design guidelines revealed that in most guidelines perception is underrepresented. The question of relevant information for driving tasks, optical guidance, perceptual illusions, reaction to combined signals as well as perception at night and under poor vision conditions are not adequately considered in the reviewed guidelines. Moreover,

perceived road features may mislead drivers into making wrong decisions. Is it possible to construct roads in such a way that they are self-explaining in the sense that design features guide drivers to safe behaviour without further signs and signalling? This paper proposes recommendations with respect to perception for the consideration of human factors in the design of roads. Design recommendations were developed from the analysis of these factors which will be explained using an example. A methodology for integrating human factors into actual road design standards will be provided. For the covering abstract see ITRD E135448.

**TRIS Files:** ITRD

**Pagination:** 6p

**Authors:** HEGER, R  
Dresden Univ Technol, Germany

SCHLAG, B  
Dresden Univ Technol, Germany

**Publication Date:** 20040000

**Serial:** PROCEEDINGS OF THE 22ND PIARC WORLD ROAD CONGRESS, 19-25 OCTOBER 2003, DURBAN, SOUTH AFRICA - INDIVIDUAL PAPERS STRATEGIC THEME 3

**Index Terms:** Accident; Accidents; Behavior; Behaviour; Behaviour; Conference; Conferences; Congresses; Design; Design (overall design); Driver communications; Driver information; Driver information systems; Guidance; Guidance; Highway communications; Highway transportation; Human behavior; In vehicle advisory; In vehicle communications; Perception; Perception; Permanent International Association of Road Congresses; Piarc; Public safety; Road transport; Road transportation; Safety; Safety; Safety measures; Symposia; Traffic information systems

**Subject Areas:** Design; Planning and Forecasting; Safety and Human Factors; I21: Planning of Transport Infrastructure; I82: Accidents and Transport Infrastructure; I83: Accidents and the Human Factor

---

**Title:** **Integrating Human Factor Evaluation in the Design Process of Roads - A Way to Improve Safety Standards for Rural Roads**

**Accession Number:** 01084134

**Record Type:** Component

**Language:** English

**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E135565

**Abstract:** Each year between 40 and 50 thousand people are killed and more than 3 million are injured due to road traffic accidents in both the United States and the European Union. In Europe 99 percent of fatal transportation accidents are road traffic related and about 95 percent of all factors contributing to road crashes are attributed to human factors. However, research with respect to accident causes clarifies, that it is not always one single factor that causes the accident, but a considerable amount of them are originated from a combination of human errors, and the road itself. Furthermore, it is known that, in principle, road design is a powerful instrument to influence road user behavior. Thus, this study will primarily focus on the interaction between road environment and road user behavior to develop appropriate design alternatives for improving road safety. A brief worldwide review of geometric highway design guidelines revealed that most standards include human factor issues only implicitly. This paper describes a methodology, developed on the basis of an International research project financed by the University of Catania and by the Italian University Ministry. The aim of the research project is to improve highway design standards for road safety with respect to human factors needs. An evaluation system to quantify driver mental workload is provided. A variety of research methods and research instruments were applied. The field data were collected by using an instrumented car traveling under real traffic conditions on two-lane rural roads. The car was equipped with a GPS receiver, vehicle speed- and acceleration sensors, a video camera for recording the driver's view and a system to record psycho-physiological responses (i.e. Electrocardiogram ECG, Electroculogram EOG, Electrodermal Activity EDA, Electromiography EMG). A survey was conducted on roadway sections to provide a representative sample of Italian two-lane rural roads. Based on this experience a procedure was developed to distinguish between good and poor driving conditions. For the covering abstract see ITRD E135448.

**TRIS Files:** ITRD

**Pagination:** 9p

**Authors:** CAFISO, S  
Catania Univ, Italy

HEGER, R

Dresden Univ, Germany

LAMM, R

Karlsruhe Univ, Germany

**Publication Date:** 20040000

**Serial:** PROCEEDINGS OF THE 22ND PIARC WORLD ROAD CONGRESS,19-25 OCTOBER 2003, DURBAN, SOUTH AFRICA - INDIVIDUAL PAPERS STRATEGIC THEME 3

**Index Terms:** Apparatus (measuring); Behavior; Behaviour; Behaviour; Conference; Conferences; Congresses; Design; Design (overall design); Gages; Gauges; Guidance; Guidance; Human behavior; Human factor; Improvement; Improvements; Instruments; Measuring devices; Measuring equipment; Measuring instruments; Meters; Metres; Networks; Permanent International Association of Road Congresses; Piarc; Public safety; Road network; Road networks; Roads; Rural highways; Rural road; Safety; Safety; Safety measures; Symposia; Vehicle; Vehicles

**Subject Areas:** Design; Highways; Safety and Human Factors; Vehicles and Equipment; I82: Accidents and Transport Infrastructure; I83: Accidents and the Human Factor

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**Title:** **A NEW PROCEDURE FOR EVALUATING TRAFFIC SAFETY ON TWO-LANE RURAL ROADS**

**Accession Number:** 00986227

**Record Type:** Component

**Language:** English

**Abstract:** This paper is based on research of the authors emphasizing traffic safety and highway geometric design, which has led to the development of three quantitative safety criteria for distinguishing sound and poor design practices on both planned and existing two-lane roadway sections. The safety criteria are directed toward the achievement of (1) design consistency (Safety Criterion I), (2) operating speed consistency (Safety Criterion II), and (3) driving dynamic consistency (Safety Criterion III) in highway design. All three criteria are evaluated in terms of three ranges, described as "Good", "Fair" and "Poor". Cut-off values between the three ranges are developed. Furthermore, it is dealt with the issues: design speed, operating speed, and sound friction factors. A comparative analysis of the actual accident situation with the results of the Safety Criteria reveals a convincing agreement. It is

known, that signs and markings can improve the safety record of a road section. However, the improvement is seldom substantial and certainly not to the level of transforming a "poor" design to a "good" design. The developed safety evaluation process is meeting with acceptance in the professional highway engineering community. It has been adopted or referenced in their geometric design guidelines by several Roads Agencies internationally including those in Canada, Greece, Hungary, Italy, Japan, South Africa, and partially in the United States. It is thus reasonable to suggest that the methodology has gained international acceptance. Thirty case studies were analyzed. The results confirm that the classification system agrees well with the outcome of large accident databases.

**Supplemental Notes:** Full conference proceedings available on CD-ROM.

**TRIS Files:** TRIS

**Pagination:** 10p

**Authors:** Lamm, R  
University of Karlsruhe

Beck, A  
University of Karlsruhe

Cafiso, S  
La Cava, G

**Features:** Figures (2) ; References (8) ; Tables (4)

**Corporate Authors:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

**Availability:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

**Publication Date:** 20030000

**Conference:** The XXIIInd PIARC World Road Congress  
Location: Durban, South Africa  
Date: 20031019 - 20031025  
Sponsors: World Road Association - PIARC

**Index Terms:** Accident frequency; Accident rates; Alignment; Alinement; Camber; Curvature; Design; Design speed; Methodologies; Methodology; Operating speed; Procedures; Public safety; Rural highways; Safety; Safety measures; Traffic safety; Two lane highways; Two lane roads

**Subject Areas:** Administration and Management; Design; Highways; Safety and Human Factors; I80: Accident Studies

---

**Title:** **INTEGRATING HUMAN FACTOR EVALUATION IN THE DESIGN PROCESS OF ROADS - A WAY TO IMPROVE SAFETY STANDARDS FOR RURAL ROADS**

**Accession Number:** 00986244

**Record Type:** Component

**Language:** English

**Abstract:** Each year between 40 and 50 thousand people are killed and more than 3 million are injured due to road traffic accidents in both the United States and the European Union. In Europe 99 percent of fatal transportation accidents are road traffic related and about 95 percent of all factors contributing to road crashes are attributed to human factors. However, research with respect to accident causes clarifies, that it is not always one single factor that causes the accident, but a considerable amount of them are originated from a combination of human errors, and the road itself. Furthermore, it is known that, in principle, road design is a powerful instrument to influence road user behavior. Thus, this study will primarily focus on the interaction between road environment and road user behavior to develop appropriate design alternatives for improving road safety. A brief worldwide review of geometric highway design guidelines revealed that most standards include human factor issues only implicitly. This paper describes a methodology, developed on the basis of an International research project financed by the University of Catania and by the Italian University Ministry. The aim of the research project is to improve highway design standards for road safety with respect to human factors needs. An evaluation system to quantify driver mental workload is provided. A variety of research methods and research instruments were applied. The field data were collected by using an instrumented car traveling under real traffic conditions on two-lane rural roads. The car was equipped with a GPS receiver, vehicle speed- and acceleration sensors, a video camera for recording the driver's view and a system to record psycho-physiological responses (i.e. Electrocardiogram ECG, Electroculogram EOG, Electrodermal Activity EDA, Electromyography EMG). A survey was conducted on roadway sections to provide a representative sample of Italian two-lane rural roads. Based on this experience a procedure was developed to distinguish between good and poor driving conditions.

**Supplemental Notes:** Full conference proceedings available on CD-ROM.

**TRIS Files:** TRIS

**Pagination:** 9p

**Authors:** Cafiso, S  
La Cava, G  
Heger, R  
Lamm, R  
University of Karlsruhe

**Features:** Figures (3) ; References (7) ; Tables (1)

**Corporate Authors:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

**Availability:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

**Publication Date:** 20030000

**Conference:** The XXIIInd PIARC World Road Congress  
Location: Durban, South Africa  
Date: 20031019 - 20031025  
Sponsors: World Road Association - PIARC

**Index Terms:** Adverse conditions; Behavior; Behaviour; Death; Design; Driver experience; Driving; Electrocardiography; Fatal accidents; Fatalities; Geometric design; Global Positioning System; GPS; Highway design; Human behavior; Human error; Human factors; Motor vehicle handling; Road design; Rural highways; Speed; Traffic fatalities; Traffic safety; Two lane highways; Two lane roads; Vehicle handling; Vehicle navigation; Weather conditions

**Subject Areas:** Design; Highways; Safety and Human Factors; I82: Accidents and Transport Infrastructure

---

**Title:** DESIGN GUIDELINES FOR SAFETY OF IN-VEHICLE INFORMATION SYSTEMS

**Accession Number:** 00941938

**Record Type:** Component

**Language:** English  
**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** IRRD E117105

**Abstract:** These design guidelines are based on current understanding of ergonomic good practice and cover many issues that need to be considered when designing and evaluating in-vehicle information systems (IVIS). Safety and usability are paramount design concerns. The objective of these guidelines is to provide designers and manufacturers (and others in the supply chain) with a summary review of the factors that need to be considered in the design process of IVIS in an easy to use format. The guidelines deal primarily with systems that provide the private car driver with information specific to his/her journey such as congestion, incident warnings or route guidance information. Advanced driver assistance systems are not covered. The guidelines are divided into sections on: the different stages of the design process and the possible need for conducting assessments at these stages; documentation and user instructions; how the IVIS should be fitted within the vehicle; ergonomic issues; interface design; safety related aspects including timeliness of information; legal issues; references; and a bibliography.

**TRIS Files:** ITRD

**Pagination:** 55 p.

**Authors:** STEVENS, A  
QUIMBY, A  
Board, A  
KERSLOOT, T  
BURNS, P

**Features:** References (54)

**Corporate Authors:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Publication Date:** 20021100

**Serial:** TRL STAFF PAPER PA 3721/01  
Publisher: TRL

**Index Terms:** Advanced transport telematics; ATT; Automobiles; Car; Design; Design (overall design); Driver communications; Driver information; Driver information systems;

Education; Education; Ergonomics; Ergonomics; Highway communications; In vehicle advisory; In vehicle communications; Installation; Installation; Installing; Intelligent transport system; Intelligent transportation systems; Intelligent vehicle highway systems; Interface; Interfaces; ITS (Intelligent transportation systems); IVHS; Legislation; Legislation; Legislative support; Public safety; Road transport informatics; RTI; Safety; Safety; Safety measures; Textbook; Textbooks; Traffic information systems; United kingdom; United Kingdom; Vehicle; Vehicles

**Subject Areas:** Design; Law; Maintenance and Preservation; Operations and Traffic Management; Safety and Human Factors; Vehicles and Equipment

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**Title:** DEVELOPMENT OF GUIDELINES FOR IN-ROADWAY WARNING LIGHTS

**Accession Number:** 00987625

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://www.virginiadot.org/vtrc/main/online\\_reports/pdf/05-r10.pdf](http://www.virginiadot.org/vtrc/main/online_reports/pdf/05-r10.pdf)

**Abstract:** An illuminated crosswalk is a relatively new traffic control device that is being used throughout the nation to alert approaching motorists to the presence of pedestrians in or about to enter the crosswalk. It consists of a series of lighting units encased in durable housings and embedded in the pavement parallel with the marked crosswalk. The lights are activated by a pedestrian, either by pushbutton or passive detection, and are aimed to flash toward approaching traffic. These light systems are known by many names. In deference to the terminology used in the "Manual on Uniform Traffic Control Devices for Streets and Highways," this study refers to them as in-roadway warning lights (IRWLs). The purpose of this research was to develop guidelines for IRWLs that the Virginia Department of Transportation (VDOT) could use statewide to ensure uniformity. The guidelines include both "planning" and "design" guidelines. Planning guidelines focus on when and where IRWLs are needed or justified. Design guidelines focus on design features of IRWLs and their components. The scope of the research was limited to a review of existing guidelines and of experiences with existing IRWLs. Specific tasks undertaken for this research included a literature review, discussions on key issues involving IRWLs with practicing transportation engineering professionals via the Institute of Transportation Engineers' traffic engineering Internet discussion group, and a review of the experiences

with several IRWLs in Virginia. A task group of VDOT planners and traffic engineers from the central office and district offices provided oversight, guidance, and, as appropriate, approval of the developed draft guidelines. Based on the findings and conclusions from these three tasks, draft guidelines for IRWLs were compiled and synthesized and then presented to the task group for review and discussion. Revised guidelines were then developed and recommended for pilot implementation.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/VTRC 05-R10,  
Final Report

**Contract Numbers:** 71848

**Pagination:** 36 p.

**Authors:** Arnold Jr, E D

**Features:** Appendices (3) ; References (16) ; Tables (2)

**Corporate Authors:** Virginia Transportation Research Council

530 Edgemont Road  
Charlottesville, VA 22903 USA  
Virginia Department of Transportation  
1401 East Broad Street  
Richmond, VA 23219 USA  
Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Publication Date:** 20041200

**Index Terms:** Crosswalks; Design; Field studies; Guidelines; Literature reviews; Literature surveys; Pedestrian crossings; Pedestrian safety; Planning; Traffic engineers; Virginia Department of Transportation; Warning devices

**Subject Areas:** Design; Highways; Operations and Traffic Management; Planning and Forecasting; I73: Traffic Control

---

**Title:** **Advance Warning Flashers: Guidelines for Application and Installation**

**Accession Number:** 01043571

**Record Type:** Monograph

**Language:** English

**Record URL:** <https://mediant.magma.ca/tacatc/bookst...ucts.cfm?catid=12&subcatid=21&prodid=173>

**Source Agency:** Transportation Association of Canada  
2323 St Laurent Boulevard  
Ottawa, Ontario K1G 4J8 Canada

**Abstract:** Until this new guide was released, no set practice or uniform guide for the application and implementation of Advanced Warning Flashers (AWFs) existed in Canada. As a result, there was a wide range of practice in the use of AWFs across the country. TAC was interested in consolidating the best available knowledge and developing a national guideline for the application and installation of AWFs. TAC's new publication, Advance Warning Flashers: Guidelines for Application and Installation, presents the results of the process to develop these new guidelines. Users should note, however, that the report focuses on dynamic systems interconnected to traffic signal operations and does not include continuously flashing signs or beacons.

**TRIS Files:** TAC

**Media Type:** Print

**Pagination:** 34p.

**Authors:** ZEIN, SR  
CHOW, K  
Gibbs, M  
Junnor, G

**Corporate Authors:** Transportation Association of Canada  
2323 St Laurent Boulevard  
Ottawa, Ontario K1G 4J8 Canada

**Publication Date:** 20050000

**Index Terms:** Canada; Efficiency; Highway traffic signals; Installation; Installing; Specifications; Traffic control signals; Traffic lights; Traffic signals; Warning systems

**Subject Areas:** Maintenance and Preservation; Operations and Traffic Management; Safety and Human Factors; I73: Traffic Control; I85: Safety Devices used in Transport Infrastructure

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## Pavement Friction Guidelines

**Title:** Guide for Pavement Friction

**Accession Number:** 01131300

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_w108.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w108.pdf)

**Abstract:** This report documents the research performed under NCHRP Project 1-43. It describes the work activities undertaken in the study and presents the results of those activities toward the development of the Guide for Pavement Friction. The information provided in this report serves as the basis for many of the guidelines and recommendations contained in the Guide. The information will be of interest to highway materials, construction, pavement management, safety, design, and research engineers, as well as others concerned with the friction and related surface characteristics of highway pavements. Using information collected through detailed literature reviews and surveys/interviews with state highway agencies, this report discusses a variety of aspects regarding pavement friction. It describes and illustrates the importance of friction in highway safety, as well as the principles of friction, as defined by micro-texture and macro-texture. It identifies the factors affecting friction and examines the ways that friction can be measured (equipment and procedures) and expressed (reporting indices). Most importantly, it presents valuable information on (a) the management of friction on existing highway pavements and (b) the design of new highway surfaces with adequate friction. This information focuses on techniques for monitoring friction and crashes and determining the need for remedial action, as well as identifying combinations of aggregate (micro-texture) and mix types/surface texturing methods (macro-texture) that satisfy friction design requirements. The report includes various conclusions and recommendations based on the results of the study, and it features five appendixes containing supplemental information on friction.

**TRIS Files:** TRIS

**Report Numbers:** NCHRP Project 01-43

**Media Type:** Web

**Pagination:** 257p

**Authors:** Hall Jr, Jim W  
[jhall@ara.com](mailto:jhall@ara.com)  
Applied Research Associates, Incorporated

Smith, Kelly L

[klsmith@ara.com](mailto:klsmith@ara.com)

Applied Research Associates, Incorporated

Titus-Glover, Leslie

Phone: 217-356-4500

Fax: 217-356-3088

[ltitusglover@ara.com](mailto:ltitusglover@ara.com)

Applied Research Associates, Incorporated

Wambold, James C

CDRM Incorporated

Yager, Thomas J

NASA Langley Research Center

Rado, Zoltan

[zxr100@psu.edu](mailto:zxr100@psu.edu)

Pennsylvania State University, University Park

**Features:** Appendices (5) ; Bibliography; Figures; References; Tables

**Publication Date:** 20090200

**Edition:** Contractor Final Report

**Serial:** NCHRP Web Document  
Issue Number: 108  
Publisher: Transportation Research Board

**Index Terms:** Aggregates; Friction; Gages; Gauges; Guidelines; Highway safety; Instruments; Interviewing; Literature reviews; Literature surveys; Macrotexture; Measurement; Measuring; Measuring devices; Measuring equipment; Measuring instruments; Meters; Metres; Microtexture; Monitoring; Monitoring systems; Pavement design; Pavement maintenance; Recommendations; Road safety; Surface properties; Surface texture; Surveys; Texture

**Subject Areas:** Design; Highways; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces

---

**Title:** **Guide for Pavement Friction**

**Accession Number:** 01121721

**Record Type:** Monograph

**Language:** English

**Abstract:** This report contains guidelines and recommendations for managing and designing for friction on highway pavements. The contents of this report will be of interest to highway materials, construction, pavement management, safety, design, and research engineers, as well as others concerned with the friction and related surface characteristics of highway pavements. Information is presented that emphasizes the importance of providing adequate levels of friction for the safety of highway users. The factors that influence friction and the concepts of how friction is determined (based on measurements of surface micro-texture and macro-texture) are discussed. Methods for monitoring the friction of in-service pavements and determining appropriate actions in the case of friction deficiencies (friction management) are described. Also, aggregate tests and criteria that help attain adequate micro-texture are presented, followed by a discussion of how paving mixtures and surface texturing techniques can be selected so as to impart the macro-texture required to achieve the design friction level.

**TRIS Files:** TRIS

**Report Numbers:** Pubcode: GPVF-1

**Media Type:** Print

**Pagination:** 83p

**Features:** Appendices (3) ; Figures; References; Tables

**Corporate Authors:** American Association of State Highway and Transportation Officials  
444 North Capitol Street, NW  
Washington, DC 20001 USA

**Availability:** American Association of State Highway and Transportation Officials  
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Washington, DC 20001 USA  
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Order URL: <http://worldcat.org/isbn/9781560514282>

**ISBN:** 9781560514282

**Publication Date:** 20080000

**Index Terms:** Aggregate tests; Blanket course; Friction; Macrottexture; Microtexture; Mixtures; Pavement construction; Pavement design; Pavement management; Pavement management systems; Paving; Road surfaces; Surface course (Pavements); Surface properties; Surface texture; Texture

**Subject Areas:** Highways; Pavements; I22: Design of Pavements, Railways and Guideways; I23: Properties of Road Surfaces

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**Title:** EVALUATION OF PAVEMENT FRICTION CHARACTERISTICS

**Accession Number:** 00806417

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_syn\\_291.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_291.pdf)

**Abstract:** This synthesis report will be of interest to pavement design, construction, management, and research engineers, highway safety officials, and others concerned with pavement friction characteristics. It describes the current state of the practice for evaluating pavement friction characteristics. Information for the synthesis was collected by surveying U.S., Canadian, and international transportation agencies, and by conducting a literature search to gather additional information. This report of the Transportation Research Board provides information on wet pavement friction characteristics of new and restored pavements. It includes information on the methods for measuring and reporting friction and texture, causes for friction changes over time, and on the related aspects of aggregate and mix design to provide adequate friction. A limited amount of information on the impact of economic and legal considerations is also included. In addition, considerations of noise and ride quality are discussed when compromise may be required. The International Friction Index (IFI) is included with information on the measuring and reporting of friction and texture.

**TRIS Files:** TRIS, TRB

**Report Numbers:** Project 20-5 FY 1998,  
Topic 30-11

**Pagination:** 72 p.

**Authors:** Henry, John J

**Features:** Appendices (2) ; Figures (10) ; Photos (15) ; References (63) ; Tables (22)

**Corporate Authors:** Transportation Research Board  
500 Fifth Street, NW

Washington, DC 20001 USA

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Find a library where document is available  
Order URL: <http://worldcat.org/isbn/0309068746>

**ISBN:** 0309068746

**Publication  
Date:** 20000000

**Serial:** NCHRP Synthesis of Highway Practice  
Issue Number: 291  
Publisher: Transportation Research Board  
ISSN: 0547-5570

**Index  
Terms:** Aggregates; Economics; Evaluation; Friction; International  
Friction Index; Legal aspects; Legal factors; Literature  
reviews; Literature surveys; Mix design; Noise; Noise  
pollution; Pavements; Ride quality; State of the practice;  
Surface properties; Surface texture; Surveys; Texture;  
Transport economics; Transportation economics

**Subject  
Areas:** Design; Economics; Environment; Geotechnology;  
Highways; Law; Pavements; I22: Design of Pavements,  
Railways and Guideways; I23: Properties of Road Surfaces

---

**TRID search 2/27/2102 with additions on April 6 2012  
"implementation" with index term "warning" with date between 2000 and  
2012**

**Title:** Cost Benefit Evaluation of Advanced Primary Safety Systems:  
Final Report

**Accession Number:** 01359137

**Record Type:** Monograph

**Language:** English

**Record URL:** [http://www.trl.co.uk/online\\_store/repo...rimary\\_safety\\_systems -  
\\_final\\_report.htm](http://www.trl.co.uk/online_store/repo...rimary_safety_systems_-_final_report.htm)

**Abstract:** This report presents a project entitled The Evaluation of Safety System Technologies, which took a "bottom-up" approach to evaluating advanced safety technology by analysing a small number of specific systems claiming to have significant safety benefits for intelligent vehicles. The target population of casualties and cost benefit information for these systems was estimated using primarily in-depth accident data and then scaling the results up to national level, while adjusting for under-reporting. As part of this study, potential casualty benefits have been evaluated and compared to the likely system fitment costs for four separate advanced primary safety technologies, as follows: 1) Advanced Emergency Brake Systems (AEBS) for passenger cars - AEBS1 - with potential to mitigate/avoid all moving target rear shunts, but those with stationary targets only if closing speed is 40 mph or less; AEBS2 - with potential to mitigate/avoid all rear shunt impacts regardless of whether shunted target vehicle is stationary or not; 2) Pedestrian capable AEBS for passenger cars - 0.6s/1s/2s systems which applies full braking 0.6s/1s/2s before a detected, imminent impact with a pedestrian; 3) Lane Departure Warning Systems for passenger cars; and 4) Youth/Family key.

**TRIS Files:** TRIS

**Report Numbers:** PPR 586

**Media Type:** Digital/other

**Pagination:** 71p

**Authors:** Robinson, B  
Hulshof, W  
Cookson, R

TRL

Cuerden, R

TRL

Hutchins, R

Delmonte, E

**Corporate Authors:**

TRL

Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Availability:**

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Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom  
Order Number: PPR 586

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**ISBN:**

9781846089879

**Publication Date:**

20111100

**Index Terms:**

Accident data; Active safety systems; Advanced brake warning systems; Advanced technology; Audible warning devices in vehicles; Automated vehicles; Benefit cost analysis; Braking; Casualties; Cost benefit analysis; Highway safety; Intelligent vehicles; Lane changing; Pedestrian vehicle interface; Road safety; Smart cars; Technological innovations; Vehicle safety

**Subject Areas:**

Highways; Safety and Human Factors; Vehicles and Equipment; I91: Vehicle Design and Safety

---

**Title:** **Crash Warning Interface Metrics Task 3: Report Appendices**

**Accession Number:** 01357962

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.nhtsa.gov/DOT/NHTSA/NVS/Cra...echnical%20Publications/2011/811470c.pdf>

**Abstract:** These are the appendices for the report that documents the methods and findings of Task 3 under the project “Crash Warning Interface Metrics (CWIM).” The CWIM project has the objective of examining the potential advantages and concerns of Advanced Crash Warning Systems (ACWS), with a particular focus on the driver-vehicle interface (DVI). Task 3 involved new empirical research to address issues of DVI variability for ACWS systems across vehicles. Two experiments were performed. Experiment 1 addressed whether driver response to a forward collision warning (FCW) acoustic alert suffered when the participant switched from a vehicle with one acoustic alert to a different vehicle with a different acoustic alert. After the alert was switched, participants displayed substantially delayed brake reaction times, particularly in one direction of shift. This comparison provides some evidence of a potential negative transfer effect. Experiment 2 investigated whether people who are unfamiliar with ACWS features were able to identify and comprehend status displays for a variety of existing ACWS. Overall, individuals were not particularly accurate in assessing whether an advanced crash warning system was present (more than 40% of these responses were incorrect), but participants were nonetheless confident in their responses. A degree of familiarity with an ACWS (from reading owner’s manual materials) improved comprehension slightly, but there was no finding of a systematic trend toward either positive or negative transfer. The final section of the report discusses methodological assessments and implications for each experiment. The appendices include data on negative transfers, and status display comprehension.

**TRIS Files:** HSL, TRIS

**Report Numbers:** HS-811 470c

**Media Type:** Web

**Pagination:** 126p

**Features:** Appendices; Figures; Photos; Tables

**Corporate Authors:** National Highway Traffic Safety Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Publication Date:** 20110800

**Edition:** Appendices

**Index Terms:** Audible warning devices in vehicles; Collision avoidance systems; Comprehension; Countermeasures; Driver vehicle interfaces; Forward collision warning; Highway safety; Road safety; Warning systems

**Subject Areas:** Highways; Safety and Human Factors; Vehicles and Equipment; I83: Accidents and the Human Factor; I91: Vehicle Design and Safety

---

**Title:** Crash Warning Interface Metrics Task 3 Report: Empirical Studies of Effects of DVI Variability

**Accession Number:** 01357943

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://www.nhtsa.gov/DOT/NHTSA/NVS/Cra...echnical%20Publications/2011/811470b.pdf>

**Abstract:** This report documents the methods and findings of Task 3 under the project “Crash Warning Interface Metrics (CWIM).” The CWIM project has the objective of examining the potential advantages and concerns of Advanced Crash Warning Systems (ACWS), with a particular focus on the driver-vehicle interface (DVI). Task 3 involved new empirical research to address issues of DVI variability for ACWS systems across vehicles. Two experiments were performed. Experiment 1 addressed whether driver response to a forward collision warning (FCW) acoustic alert suffered when the participant switched from a vehicle with one acoustic alert to a different vehicle with a different acoustic alert. After the alert was switched, participants displayed substantially delayed brake reaction times, particularly in one direction of shift. This comparison provides some evidence of a potential negative transfer effect. Experiment 2 investigated whether people who are unfamiliar with ACWS features were able to identify and comprehend status displays for a variety of existing ACWS. Overall, individuals were not particularly accurate in assessing whether an advanced crash warning system was present (more than 40% of these responses were incorrect), but participants were nonetheless confident in their responses. A degree of familiarity with an ACWS (from reading owner’s manual materials) improved comprehension slightly, but there was no finding of a systematic trend toward either positive or negative transfer. The final section of the report discusses methodological assessments and implications for each experiment.

**TRIS Files:** HSL, TRIS

**Report Numbers:** HS-811 470b

**Media Type:** Web

**Pagination:** 72p

**Authors:** Robinson, Emanuel  
Westat  
Lerner, Neil  
[LERNER1@westat.com](mailto:LERNER1@westat.com)

Westat

Jenness, James

Singer, Jeremiah

[jeremiahsinger@westat.com](mailto:jeremiahsinger@westat.com)

Westat, Incorporated

Huey, Richard

Westat, Incorporated

Baldwin, Carryl

Kidd, David

Roberts, Daniel

Monk, Chris

**Features:** Figures (25) ; References; Tables (11)

**Corporate** Westat

**Authors:** 1650 Research Boulevard  
Rockville, MD 20850 USA

National Highway Traffic Safety Administration

1200 New Jersey Avenue, SE

Washington, DC 20590 USA

**Availability:** National Technical Information Service

5301 Shawnee Road

Alexandria, VA 22312 USA

**Publication**  
**Date:** 20110800

**Edition:** Final Report

**Index**  
**Terms:** Audible warning devices in vehicles; Collision avoidance systems; Countermeasures;  
Display systems; Driver vehicle interfaces; Forward collision warning; Highway safety;  
Information display systems; Road safety; Warning systems

**Subject**  
**Areas:** Highways; Safety and Human Factors; Vehicles and Equipment; I83: Accidents and the  
Human Factor; I91: Vehicle Design and Safety

---

**Title:** Safety Effectiveness of Actuated Advance Warning Systems

**Accession Number:** 01333478

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/2250-03>

**Abstract:** Driver behavior within the dilemma zone can be a major safety concern at high-speed signalized intersections. The Nebraska Department of Roads (DOR) has developed and implemented an actuated advance warning dilemma zone protection system. This paper investigates the impact that system has had on safety at high-speed signalized intersections. The operating algorithm has been designed such that the system continually monitors an upstream detector, as well as traffic at the intersection, to predict the onset of the yellow signal indication. Flashing beacons are used to warn drivers of the impending end of the green indication. Although these systems have received positive reviews from the public—and commercial vehicle operators in particular—there has been no comprehensive analysis of their effect on safety. The focus of this research was to address this evaluative need and provide answers about the effectiveness of the Nebraska DOR system in improving safety. Crash records from before and after the implementation of the system at 26 intersections were compared. In addition, 29 control intersections were used to compare crash rates over time, and a fully Bayesian technique was employed to ensure that no exogenous variables affected the study. Results of the analysis were promising (an overall crash reduction rate of 8%) and suggested that the use of the system should be encouraged as an effective safety treatment for the dilemma zone problem at high-speed signalized intersections.

**TRIS Files:** TRIS, TRB

**Report Numbers:** 11-2561

**Media Type:** Print

**Pagination:** pp 19-24

**Authors:** Appiah, Justice  
[jappiah@unl.edu](mailto:jappiah@unl.edu)  
University of Nebraska, Lincoln

Naik, Bhaven  
[bnaik1@bigred.uni.edu](mailto:bnaik1@bigred.uni.edu)  
University of Nebraska, Lincoln

Wojtal, Remigiusz  
[rwojtal2@unl.edu](mailto:rwojtal2@unl.edu)  
University of Nebraska, Lincoln

Rilett, Laurence R

**Features:** Figures (1) ; References (28) ; Tables (3)

**Monograph Title:** Traffic Control Devices, Visibility, and Highway–Rail Grade Crossings 2011

**Monograph Accession Number:** 01360546

**Availability:** Transportation Research Board Business Office  
500 Fifth Street, NW  
Washington, DC 20001 USA  
Order URL: <http://www.trb.org/Main/Blurbs/166471.aspx>

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**ISBN:** 9780309167703

**Publication Date:** 20110000

**Serial:** Transportation Research Record: Journal of the Transportation Research Board  
Issue Number: 2250  
Publisher: Transportation Research Board  
ISSN: 0361-1981

**Index Terms:** Accident frequency; Accident rates; Advanced traffic management systems; Amber phase; ATMS; Bayesian approach; Before and after studies; Dilemma zone; High speed intersections; Nebraska; Signalised intersections; Signalized intersections; Traffic flow; Traffic safety; Warning systems; Yellow interval (Traffic signal cycle)

**Subject Areas:** Highways; Operations and Traffic Management; Safety and Human Factors; I73: Traffic Control; I83: Accidents and the Human Factor

---

**Title:** **An Examination of the Rural Intersection Collision Avoidance System**

**Accession Number:** 01148232

**Record Type:** Component

**Language:** English

**Abstract:** To address the challenges of rural safety, the U.S. Department of Transportation established the Rural Safety Initiative in February 2008. One component of the Rural Safety Initiative is the Rural Safety Innovation Program (RSIP). Through the RSIP, Wisconsin Department of Transportation is implementing, demonstrating, and validating a new Rural Intersection Collision Avoidance System (RICAS). RICAS uses

emerging sensing, computation, and display technologies to provide real-time warnings to drivers before the conditions which lead to a life changing crash can develop. This paper examines RICAS in terms of project goals and objectives, anticipated safety benefits, design, implementation and evaluation approach.

**TRIS Files:** TRIS

**Media Type:** CD-ROM

**Pagination:** 10p

**Authors:** Smith, Theodore A  
[tsmithj@gmu.edu](mailto:tsmithj@gmu.edu), [theodore.smith@mitretek.org](mailto:theodore.smith@mitretek.org)

Szymkowski, Rebecca  
Phone: 608-266-9381  
[rebecca.yao@dot.wi.gov](mailto:rebecca.yao@dot.wi.gov)  
Wisconsin Department of Transportation

Dodge, Linda D  
Phone: 202-366-8034  
[linda.dodge@dot.gov](mailto:linda.dodge@dot.gov)  
Research and Innovative Technology Administration

Berg, John H  
Phone: 608-829-7515  
[john.berg@fhwa.dot.gov](mailto:john.berg@fhwa.dot.gov)  
Federal Highway Administration

**Features:** Figures; Photos; References (8)

**Monograph Title:** ITS in Daily Life

**Monograph Accession Number:** 01149593

**Corporate Authors:** ITS America  
1100 17th Street NW, 12th Floor  
Washington 20036 USA

**Availability:** ITS America  
1100 17th Street NW, 12th Floor  
Washington 20036 USA

**Publication Date:** 20090000

**Conference:** 16th ITS World Congress and Exhibition on Intelligent Transport Systems and Services

Location: Stockholm , Sweden  
Date: 20090921 - 20090925  
Sponsors: ITS America; ERTICO; ITS Japan

**Index Terms:** Advanced technology; Collision avoidance systems; Cross roads; Intersections; Junctions (Traffic); Low volume roads; Real time information; Rural highways; Technological innovations; Traffic safety; Warning systems

**Subject Areas:** Highways; Safety and Human Factors; I85: Safety Devices used in Transport Infrastructure

---

**Title:** **Implementation of Advance Warning of End of Green System (AWEGS): Implementation Report**

**Accession Number:** 01140587

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/5-5113-01-1.pdf>

**Record URL:** <http://ntl.bts.gov/lib/31000/31100/31132/5-5113-01-1.pdf>

**Abstract:** The objective of this implementation project was to implement four Advance Warning of End of Green Systems (AWEGS) across Texas at intersections appropriate for the installation of AWEGS. After a survey across Texas, four sites were chosen in the Atlanta District, Pharr District, Odessa District, and San Antonio District. The AWEGS design plans were prepared for these four sites and submitted to the districts. These plans were prepared for an intersection with high-speed approaches having the required dilemma zone detection design. The Atlanta District implementation was typical of the earlier implementation and used the TS 2 TS 1 conversion panel. However, the remaining implementations were configured for using enhanced bus interface units (BIUs). AWEGS software was also modified to account for rail preemption as the site in Odessa District was being preempted by between 15 to 25 trains per day. Finally, the implementation in San Antonio District was redesigned to use radar detection for both dilemma zone and advance detection. AWEGS at the Atlanta, Pharr, and Odessa Districts have been implemented and an evaluation of the system showed that AWEGS was performing satisfactorily at all sites. TTI researchers are awaiting the San Antonio District to install the radar detectors to implement the system there.

**Supplemental Notes:** Project Title: Implementation of Advance Warning of End of Green

Systems (AWEGS).

**TRIS Files:**

NTL, TRIS

**Report Numbers:**

FHWA/TX-08/5-5113-01-1  
Report 5-5113-01-1

**Contract Numbers:**

Project 5-5113-01

**Media Type:**

Web

**Pagination:**

26p

**Authors:**

Sunkari, Srinivasa R  
Phone: 979-845-7472  
Fax: 979-845-9873  
[s-sunkari@tamu.edu](mailto:s-sunkari@tamu.edu)  
Texas Transportation Institute

Charara, Hassan A  
Phone: 979-845-1908  
Fax: 979-845-9873  
[h-charara@tamu.edu](mailto:h-charara@tamu.edu)  
Texas Transportation Institute

Johnson, Jeremy D  
Phone: 979-862-7253  
Fax: 979-845-9873  
[j-johnson@ttimail.tamu.edu](mailto:j-johnson@ttimail.tamu.edu)  
Texas Transportation Institute

**Features:**

Figures (5) ; Photos (3) ; References (2) ; Tables (4)

**Corporate Authors:**

Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:**

National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20081000  
**Edition:** Technical Report  
**Period Covered:** March 2007-August 2008  
**Index Terms:** Advance detection; Advance traffic warning devices; Advance warning flashers; Advance Warning of End of Green System; Dilemma zone; High speed intersections; Implementation; Preemption (Traffic signals); Radar vehicle detectors; Texas; Traffic signal preemption; Traffic signal priority systems  
**Subject Areas:** Highways; Operations and Traffic Management; I73: Traffic Control

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**Title:** **Enhanced Field Observation of Traffic Patterns for Intersection Collision Warning Systems**

**Accession Number:** 01141981

**Record Type:** Component

**Language:** English

**Abstract:** This paper describes an ongoing research project on safety countermeasures for preventing left-turn crossing-path collisions at signalized intersections. The author reports an update on the research activities especially on field data collection, where a combination of sensing technologies are deployed to detect and measure traffic conflict scenarios that are possible situations for offering warnings to the drivers. This is an ongoing study from earlier investigations when a methodology was developed to extract scenario-specific parameters of interests. An enhanced set of sensing devices are combined and used to acquire more accurate and informative data for the developments of warning algorithms. The author hopes that data from this study will provide valuable inputs for the implementation of intersection safety countermeasures.

**TRIS Files:** TRIS

**Media Type:** CD-ROM

**Pagination:** 12p

**Authors:** Chan, Ching-Yao  
Phone: 510-665-3621  
Fax: 510-665-3757  
[cychan@path.berkeley.edu](mailto:cychan@path.berkeley.edu)  
University of California, Berkeley

**Features:** Figures (6) ; Photos (8) ; References (14) ; Tables (1)

**Monograph Title:** ITS Connections: Saving Time. Saving Lives

**Monograph Accession Number:** 01130159

**Corporate Authors:** ITS America  
1100 17th Street NW, 12th Floor  
Washington 20036 USA

**Availability:** ITS America  
1100 17th Street NW, 12th Floor  
Washington 20036 USA

**Publication Date:** 20080000

**Conference:** 15th World Congress on Intelligent Transport Systems and ITS  
America's 2008 Annual Meeting  
Location: New York NY  
Date: 20081116 - 20081120  
Sponsors: ITS America; ERTICO; ITS Japan; Transcore

**Index Terms:** Active grade crossing warning systems; Advanced Driver Assistance Systems; Advanced technology; Advanced transport telematics; Algorithms; ATT; Audible warning devices in vehicles; Automotive sensors; Collision avoidance systems; Data acquisition; Data collection; Driver assistance systems (In vehicle); Driver support systems; Electronic co-pilots; Grade crossing protection systems; Grade crossing signals; Highway accidents; Highway safety; In vehicle sensors; Intelligent transportation systems; Intelligent vehicle highway systems; ITS (Intelligent transportation systems); IVHS; Left turns; Road safety; Road transport informatics; RTI; Signalised intersections; Signalized intersections; Technological innovations; Traffic accidents

**Subject Areas:** Data and Information Technology; Highways; Operations and Traffic Management; Safety and Human Factors; I73: Traffic Control; I82: Accidents and Transport Infrastructure

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**Title:** Study on Lane Departure Warning and Lane Change Assistant Systems

**Accession Number:** 01216096

**Record Type:** Project

**Language:** English

**Source Agency:** TRIP, Research Projects from the ITRD Database

**Source Data:** RiP Project 20138

**Abstract:** Lane Departure Warning (LDW) Systems assist drivers in keeping their lanes by warning drivers when their vehicle is in danger of leaving the lane unintentionally (mainly due to lack of attention). Current systems use either an audible beep or a rumble strip noise, which mimics the sound made when the tire runs over a lane divider. A supplement to the LDW system is the Lane Change Assistant (LCA) system. This assists drivers intending to change lanes. The lane change assistant monitors the adjacent lanes and warns the driver if another vehicle is likely to come within colliding distance during the lane change. This occurs for example, if the other vehicle is located in the LCA equipped vehicle's blind spot. Presently the system would warn the driver of such a problem with e.g. a red flashing side mirror. Later on, a system with feedback in the steering wheel could be introduced. The LCA requires predictive sensors to scan the surrounding vehicles. A recent study for the Commission (DG TREN) indicated that combined LDW and LCA systems could reduce the risk and severity of head-on and side collisions and accidents where the vehicle departs from the roadway altogether. The study estimated that EU implementation could save 3,941 lives in 2010 and 5,491 lives in 2020, when all vehicles in had been installed with the required equipment. In addition, two sub-projects under the Commission's PREVENT project (SAFELANE and LATERALSAFE) have been examining LDW and LCA concepts. It is understood that current LCA systems are designed only to sense other vehicles. However, the benefits of such systems could be significantly enhanced if pedestrians and cyclists could also be detected. All current heavy goods vehicles are required to be fitted with a range of mirrors giving various fields of view around the vehicle. Cameras are also allowed as alternatives in certain areas. However, these systems have their limitations and the information presented to the driver can be confusing (images are often distorted due to the convexity of the mirrors, and it may be difficult for the driver to process simultaneously information from mirrors and cameras positioned or focused upon various parts of the vehicle). The use of an advanced LCA system could offer the driver integrated information on the positional relationship between his vehicle and other road users. It is also possible that the replacement of conventional mirrors could yield savings in fuel consumption and hence CO<sub>2</sub> emissions.

**TRIS Files:** RiP

**Funding:** 0.00

**Start Date:** 20071217

**Actual Completion Date:** 20081217

**Performing Agencies:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Funding Agencies:** Ec DG Industry and Enterprise  
London United Kingdom

**Index Terms:** Accidents; Advanced transport telematics; ATT; Carbon dioxide; Carriageways; Drivers; Driving; Emissions; Fuel consumption; Intelligent transportation systems; Intelligent vehicle highway systems; ITS (Intelligent transportation systems); IVHS; Motor vehicle handling; Motor vehicle operators; Pollutants; Research projects; Road transport informatics; Roadway; RTI; Technology; Traffic; Traffic lanes; Traveled way; Vehicle handling; Vehicle navigation; Warning systems

**Subject Areas:** Highways; Operations and Traffic Management; Safety and Human Factors

---

**Title:** **Forecasting and Evaluation of Traffic Safety Impacts: Driving Assistance Systems Against Road Infrastructure Measures**

**Accession Number:** 01083215

**Record Type:** Component

**Language:** English

**Abstract:** This article reports on a study of the forecasting and evaluation of traffic safety projects in the Netherlands, focusing on driving assistance systems and road infrastructure measures. The authors examine the use of a one-variable first-order grey model (GM(1,1)), to model and forecast the trend of the level of cumulative traffic accident severity for strategic scenarios. The scenarios include implementation of driving assistance systems, physical infrastructure redesign, and combinations of the two categories of measures. The accident severity levels (in terms of fatalities and hospitalizations) of five scenarios for the period 2003-2007 are analyzed and modeled. The five scenarios are implementation of infrastructure redesign program; driving assistance systems by market-pull; driving assistance systems by policy-push and market-pull; combination of partial DVA (Duurzaam Veilige Infrastructuur, which means Sustainably Safe Infrastructure) and driving systems by market pull; and a combination of partial DVI and driving systems by policy-push and market-pull. In addition, the trend

of fatalities and hospitalizations for each scenario for the years 2008 until 2010 is forecasted. For further policy evaluation, the costs of each scenario (for the years 2003-2010) are estimated. Driving assistance systems can include speed assistance, navigation, and lane departure warning. The authors conclude that although further implementation of DVI programs may improve traffic safety, they are not cost-effective due to the large investment needed. The scenarios based on application of driving assistance systems are very appealing for enhancing road traffic safety and are much more cost-effective than the combination scenarios. None of the scenarios would achieve the ambitious Dutch policy targets of reduction of fatality and hospitalization levels for 2010.

<b>TRIS Files:</b>	TRIS
<b>Media Type:</b>	Print
<b>Pagination:</b>	pp 117-123
<b>Authors:</b>	Lu, Meng <a href="mailto:meng.lu@tft.lth.se">meng.lu@tft.lth.se</a> Lund University
	Wevers, K NAVTEQ
<b>Features:</b>	References (37) ; Tables (5)
<b>Publication Date:</b>	20070000
<b>Serial:</b>	IET Intelligent Transport Systems Volume: 1 Issue Number: 2 Publisher: Institution of Engineering and Technology
<b>Index Terms:</b>	Accident severity; Advanced Driver Assistance Systems; Audible warning devices in vehicles; Cost effectiveness; Death; Driver assistance systems (In vehicle); Driver support systems; Electronic co-pilots; Fatal accidents; Fatalities; Forecasting; Global Positioning System; GPS; Highway safety; Hospitalization; Infrastructure; Lane changing; Marketing; Navigation; Projections; Road safety; Scenarios; Speed control; Speed indicators; Traffic fatalities; Traffic safety; Warning signals
<b>Subject Areas:</b>	Highways; Safety and Human Factors; Vehicles and Equipment; I83: Accidents and the Human Factor; I85: Safety Devices used in Transport Infrastructure; I91: Vehicle Design and Safety

---

**Title:** **Accident Reduction Potential of Advanced Adverse Weather Warning Systems**

**Accession Number:** 01080941

**Record Type:** Component

**Language:** English

**Abstract:** This paper presents the main results of a research project that was conducted at Madrid Polytechnic University to assess the potential of effectively reducing accident rates in adverse conditions by deploying Intelligent Transportation Systems (ITS). Traffic accidents that had occurred in the Spanish National System in adverse weather conditions during a 5-year period were studied to identify road sections with an accident record that justified the implementation of specific countermeasures. American and European experience in applying Road Weather Information Systems (RWIS) and Advanced Adverse Weather Motorist Warning Systems (AAWWS) were analyzed prior to the development of three pilot tests for the deployment of AAWWS at three Spanish network sites. These tests were complemented with an in-depth study of a sample of 259 adverse conditions injury crashes. The results were used to provide an estimation of the crash reduction attainable by the deployment of these systems in Spain. The research showed that the annual savings in social costs of traffic crashes would exceed the total investment needed to deploy the systems.

**TRIS Files:** TRIS

**Media Type:** CD-ROM

**Pagination:** 14p

**Authors:** Mayoral, Juan M

**Features:** Figures; Photos; References (7) ; Tables (3)

**Monograph Title:** The Choice for Sustainable Development. Pre-Proceedings of the 23rd PIARC World Road Congress

**Monograph Accession Number:** 01081328

**Corporate Authors:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

**Availability:** World Road Association - PIARC  
La Grande Arche, Paroi Nord, Niveau 8  
F-92055 La Defense Cedex France

**Publication Date:** 20070000

**Conference:** Choice for Sustainable Development. Pre-Proceedings of the 23rd PIARRC World Road Congress  
Location: Paris , France  
Date: 20070917 - 20070921  
Sponsors: World Road Association - PIARC

**Index Terms:** Accident frequency; Accident rates; Adverse conditions; Adverse weather; Collision injuries; Crash injuries; Highway accidents; Madrid (Spain); Road weather information systems; RWIS; Traffic accidents; Traffic safety; Warning systems; Weather conditions

**Subject Areas:** Highways; Safety and Human Factors; I80: Accident Studies

---

**Title:** **Enhancements to the Advance Warning of End of Green System (AWEGS)**

**Accession Number:** 01043618

**Record Type:** Monograph

**Language:** English

**Record URL:** <http://tti.tamu.edu/documents/0-5113-1.pdf>

**Abstract:** The objective of this project was to make improvements to the Advance Warning of End of Green System (AWEGS). These improvements have enhanced the operation of AWEGS as well as have made the implementation of AWEGS much simpler. The enhancements include reducing false actuations, accounting for detector failures, detecting and treating queues, improving the visibility of the AWEGS sign, and making numerous modifications to the AWEGS interface. The improvements to AWEGS have made a significant improvement in the implementation of AWEGS at new locations. These improvements were implemented at existing AWEGS sites and at a new location in College Station, Texas. However, the advance warning at the College Station location is higher than expected at times. This basically means that sometimes the controller is not gapping out after AWEGS predicted that it would. Analysis of the data has shown that this is primarily due to the high volumes on the arterial approaches at the College Station site. These results have illustrated that the volumes have an impact on the operation of AWEGS and should be considered in the selection of future AWEGS sites. From the data collected from all AWEGS locations, it appears that AWEGS would function very well when the average daily traffic (ADT) at the intersection is below 15,000 vehicles. Above those volumes, the advance warning times can

be higher than expected. A higher advance warning is not harmful. However, if it happens frequently, it can give rise to some confusion in the motorists.

**Supplemental Notes:** Project Title: Improving Intersection Safety and Operations Using Advance Warning of End of Green System (AWEGS). Report Date: October 2006; Published: December 2006.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-07/0-5113-1  
Report 0-5113-1

**Contract Numbers:** Project 0-5113

**Media Type:** Web

**Pagination:** 144p

**Authors:** Sunkari, Srinivasa R  
Texas Transportation Institute

Charara, Hassan A  
[h-charara@tamu.edu](mailto:h-charara@tamu.edu)  
Texas Transportation Institute

Parker, Ricky T  
Texas Transportation Institute

Palekar, Trishul A  
Texas Transportation Institute

**Features:** Appendices (1) ; Figures; Photos; References; Tables

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA  
  
Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road  
Alexandria, VA 22312 USA

**Publication Date:** 20061200  
**Edition:** Technical Report  
**Period Covered:** September 2004-August 2006  
**Index Terms:** Advance traffic control signs; Advance traffic warning devices; Advance warning flashers; Advance Warning of End of Green System; Average daily traffic; College Station (Texas); Implementation; Improvements; Traffic volume  
**Subject Areas:** Highways; Operations and Traffic Management; Research; I73: Traffic Control

---

**Title:** **Improved risk management of potential roadside slip sites: development and implementation of a roadside slope hazard warning system**

**Accession Number:** 01045619

**Record Type:** Component

**Language:** English

**Source Agency:** TRL  
Crowthorne House, Nine Mile Ride  
Wokingham, Berkshire RG40 3GA United Kingdom

**Source Data:** ITRD E214346

**Abstract:** This report documents the findings of R & D Project 953, to evaluate the potential of an automated warning system for improving risk management of potential roadside slip sites. The aim of the project was to assess usefulness and suitability of simple electronic warning systems for this purpose in the VicRoads environment. A rockfall warning system was set up at a coastal location in south western Victoria as a trial system and has been functioning satisfactorily. The long term usefulness of this system will be assessed after operation over a seasonal cycle. The system design is sufficiently flexible that it can be readily adapted to suit other similar applications. (a)

**TRIS Files:** ITRD

**Pagination:** 16P + APPENDICES

**Authors:** WAITE, B  
VicRoads, Australia

**Corporate Authors:** VicRoads, Australia  
**Publication Date:** 20060526  
**Serial:** Research and Development Report  
Issue Number: GE025-19  
Publisher: VicRoads  
**Index Terms:** Administration; Continuous; Continuous structures; Danger; Hazards; Highway; Management; Risk; Roads; Rock; Rock; Rocks; Side; Side; Slope stability; Slope stability; Soil mechanics; Soil mechanics; Surveillance; Surveillance; Warning; Warning systems  
**Subject Areas:** Administration and Management; Geotechnology; Highways; I42: Soil Mechanics; I43: Rock Mechanics

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**Title:** **Improved Grade Crossing Safety with In-Pavement Warning Lights**  
**Accession Number:** 01041797  
**Record Type:** Monograph  
**Language:** English  
**Record URL:** <http://www.path.berkeley.edu/PATH/Publications/PDF/PRR/2005/PRR-2005-10.pdf>  
**Source Agency:** UC Berkeley Transportation Library  
**Source Data:** Caltrans 957  
**Abstract:** Rail crossing collisions, while experiencing a reduction in the past decade, still continue to occur in California. This project examined different methods of improving commercial off-the-shelf (COTS) in-pavement warning signals and their suitability for use at grade crossings. This project focused on the modification of a commercially available in-pavement warning signal that was originally designed to indicate the presence of pedestrians in a crosswalk. The project proposed using a similar device to provide warning to vehicles approaching a railroad grade crossing. A variety of illumination patterns were tested in order to provide an optimal implementation of such a warning device. Laboratory tests demonstrated an improvement in visual response, as evidenced by a lowered reaction time, to a pattern incorporating alternating groups of spatially-separated flashed LEDs in order to stimulate perception of movement. Researchers also completed preparations, including installation, for a future field test to study vehicle behavior in the presence of embedded warning lights incorporating this modified firing pattern.

**TRIS Files:** CALTRANS, TRIS

**Report Numbers:** UCB-ITS-PRR-2005-10  
F/CA/IR-2004/07

**Contract Numbers:** 65A0071

**Media Type:** Print

**Pagination:** 55p

**OCLC:** 58458290

**Authors:** Cohn, Theodore E  
[tecohn@berkeley.edu](mailto:tecohn@berkeley.edu)  
University of California, Berkeley

**Features:** Figures; Tables

**Corporate Authors:** University of California, Berkeley  
California PATH Program, Institute of Transportation Studies  
Richmond Field Station, 1357 South 46th Street  
Richmond, CA 94804-4648 USA

University of California, Berkeley  
Berkeley, CA 94720-1720 USA

California Department of Transportation  
Division of Research and Innovation, 1227 O Street, P.O. Box 942873  
Sacramento, CA 94273-0001 USA

**Availability:** Available from UC Berkeley Transportation Library through interlibrary loan or document delivery  
Order URL: <http://library.its.berkeley.edu>

University of California, Berkeley  
California PATH Program, Institute of Transportation Studies  
Richmond Field Station, 1357 South 46th Street  
Richmond, CA 94804-4648 USA

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**Publication Date:** 20050300

**Serial:** PATH Research Report  
Publisher: University of California, Berkeley  
ISSN: 1055-1425

**Index Terms:** Active grade crossing warning systems; Crosswalk warning lights; Flashing traffic signals; Grade crossing protection systems; Grade crossing signals; Grade crossings; Highway rail intersections; Highway railroad grade crossings; Illumination; Level crossings; Lighting; Railroad grade crossings; Vision; Warning systems

**Subject Areas:** Highways; Railroads; Safety and Human Factors; I85: Safety Devices used in Transport Infrastructure

---

**Title:** **Advance Warning of Stopped Traffic on Freeways: Field Studies of Congestion Warning Signs**

**Accession Number:** 01000938

**Record Type:** Monograph

**Language:** English

**Abstract:** Stopped traffic on freeways poses safety and operational concerns to drivers, transportation agencies, construction and maintenance contractors, and enforcement and emergency service personnel. Safety issues relate to driver ability to make gradual transitions from freeway speeds to stopped conditions without erratic maneuvers or crashes. Operational concerns relate to the reliability and predictability of the freeway network. The primary type of multi-vehicle crash on a freeway facility is the rear-end collision, comprising over 50% of freeway crashes by some research findings, caused generally due to normal speed traffic encountering stopped traffic on the main lanes or ramps. Drivers frequently have minimal or no warning about downstream queuing, and information given on static signs is difficult to keep current with rapidly fluctuating queues in congested areas. Stopped traffic on the freeway may be due to a multitude of causes. This research project evaluated issues relating to stopped or very slow traffic due to three major causes: recurrent traffic congestion due to over-capacity conditions during peak periods, congestion due to construction and maintenance work zones, and congestion due to incidents such as crashes. In the first phase of this project, the research team conducted a literature review to determine current practices for advance warning for stopped traffic, observed field locations with traffic stopped due to various conditions, and determined advance warning techniques applicable to Texas. Report 4413-1 presents this information. In the second phase of this project, researchers tested two advance warning techniques using static warning signs on Dallas area freeways. The research team synthesized the field test results and developed recommendations for further research and ways to improve the signing. This information is presented in this report. Many factors remain to be

addressed in future research; however, observations conducted in this project can provide guidance to those testing and implementing operating systems for advance warning of slow/stopped traffic on freeways.

**Supplemental Notes:** Project Title: Advance Warning of Stopped Traffic.

**TRIS Files:** TRIS

**Report Numbers:** FHWA/TX-05/0-4413-2  
Technical Report 0-4413-2

**Contract Numbers:** Project No. 0-4413

**Media Type:** Print

**Pagination:** 64p

**Authors:** Wiles, Poonam B  
Phone: (817) 462-0524  
Fax: (817) 461-1239  
[p-wiles@tamu.edu](mailto:p-wiles@tamu.edu)  
Texas Transportation Institute

Cooner, Scott A  
Phone: 817-277-5503  
Fax: 817-461-1239  
[s-cooner@tamu.edu](mailto:s-cooner@tamu.edu)  
Texas Transportation Institute

Rathod, Yatin  
Wallace, Diana G

**Features:** Appendices (1) ; Figures; Photos; Tables

**Corporate Authors:** Texas Transportation Institute  
Texas A&M University System, 3135 TAMU  
College Station, TX 77843-3135 USA

Texas Department of Transportation  
Research and Technology Implementation Office, P.O. Box 5080  
Austin, TX 78763-5080 USA

Federal Highway Administration  
1200 New Jersey Avenue, SE  
Washington, DC 20590 USA

**Availability:** National Technical Information Service  
5301 Shawnee Road

Alexandria, VA 22312 USA

**Publication Date:** 20050300  
**Period Covered:** September 2001-August 2004  
**Index Terms:** Advance warning; Car truck accidents; Controlled access highways; Dallas (Texas); Field studies; Freeways; Future; Gridlock (Traffic); Highway accidents; Motorways; Multiple car accidents; Multiple vehicle accidents; Peak hour traffic; Rear end collisions; Recommendations; Research; Rush hour; Stopped traffic; Traffic accidents; Traffic congestion; Traffic incidents; Traffic queuing; Warning signs; Work zones  
**Subject Areas:** Highways; Operations and Traffic Management; Research; Safety and Human Factors; I73: Traffic Control; I80: Accident Studies

---

**Title:** ACTIVE WARNING SYSTEMS: SYNTHESIS

**Accession Number:** 00987490

**Record Type:** Component

**Language:** English

**Abstract:** Active warning systems are traffic control devices consisting of variable signs or flashing beacons with conventional warning signs, which are activated by sensors detecting real-time roadway, environmental, and operational hazards. Currently most active warning systems detect and warn drivers of variable weather or pavement conditions, high-risk vehicle operating speeds, or the presence of intermittent hazards such as other vehicles, pedestrians, or wild animals. Within the Intelligent Transportation Systems framework, active warning systems applications detect these and other variable hazards and communicate these warnings directly to the vehicle or operator. Because most active warning systems are relatively recent, limited long-term system performance data are available. Testing and evaluation of active warning signs should continue to more firmly establish their benefits to highway safety and traffic operations. This paper provides an overview of available active warning systems and discusses their implementation requirements and potential benefits based on results and recommendations from evaluation studies.

**TRIS Files:** TRIS

**Pagination:** p. 205-210

**Authors:** Sisiopiku, V P

Elliott, J R

**Features:** References (30)

**Corporate Authors:** American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, VA 20191-4400 USA

**Availability:** American Society of Civil Engineers  
1801 Alexander Bell Drive  
Reston, VA 20191-4400 USA

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**Publication Date:** 20050300

**Serial:** Journal of Transportation Engineering  
Volume: 131  
Issue Number: 3  
Publisher: American Society of Civil Engineers  
ISSN: 0733-947X  
OCLC: 8674831  
Serial URL: <http://ascelibrary.aip.org/teo>

**Index Terms:** Active warning systems; Advanced transport telematics; Adverse conditions; ATT; Highway signs; Highway signs, signals and markings; Intelligent transportation systems; Intelligent vehicle highway systems; ITS (Intelligent transportation systems); IVHS; Real time control; Real time information; Road transport informatics; Roadside hazards; RTI; Traffic control devices; Traffic safety; Traffic signs; Traffic signs and signals; Traffic signs, signals and markings; Warning signals; Weather conditions

**Subject Areas:** Highways; Operations and Traffic Management; I73: Traffic Control

---

**Title:** Advance Warning Flashers: Guidelines for Application and Installation

**Accession Number:** 01043571

**Record Type:** Monograph

**Language:** English

**Record** <https://mediant.magma.ca/tacatc/bookst...ucts.cfm?catid=12&subcatid=21&prodid=173>

**URL:**

**Source Agency:** Transportation Association of Canada  
2323 St Laurent Boulevard  
Ottawa, Ontario K1G 4J8 Canada

**Abstract:** Until this new guide was released, no set practice or uniform guide for the application and implementation of Advanced Warning Flashers (AWFs) existed in Canada. As a result, there was a wide range of practice in the use of AWFs across the country. TAC was interested in consolidating the best available knowledge and developing a national guideline for the application and installation of AWFs. TAC's new publication, *Advance Warning Flashers: Guidelines for Application and Installation*, presents the results of the process to develop these new guidelines. Users should note, however, that the report focuses on dynamic systems interconnected to traffic signal operations and does not include continuously flashing signs or beacons.

**TRIS Files:** TAC

**Media Type:** Print

**Pagination:** 34p.

**Authors:** ZEIN, SR  
CHOW, K  
Gibbs, M  
Junnor, G

**Corporate Authors:** Transportation Association of Canada  
2323 St Laurent Boulevard  
Ottawa, Ontario K1G 4J8 Canada

**Publication Date:** 20050000

**Index Terms:** Canada; Efficiency; Highway traffic signals; Installation; Installing; Specifications; Traffic control signals; Traffic lights; Traffic signals; Warning systems

**Subject Areas:** Maintenance and Preservation; Operations and Traffic Management; Safety and Human Factors; I73: Traffic Control; I85: Safety Devices used in Transport Infrastructure

---

**Title:** **Methods and Metrics for Evaluation of an Automated Real-Time Driver Warning System**

**Accession Number:** 01023716

**Record Type:** Component

**Language:** English

**Record URL:** <http://dx.doi.org/10.3141/1937-13>

**Abstract:** There is significant interest among traffic management personnel in the use of automated warning systems to provide drivers with real-time information on hazardous conditions related to traffic, limited visibility, or roadway obstructions. However, the effectiveness of such systems in achieving desired traffic safety improvements has not yet been well quantified. Relative influences on traffic safety can be assessed in many ways, and overall conclusions must be based on an appropriate set of metrics and methodologies for a particular implementation. This work, supported by the California Office of Traffic Safety and the California Department of Transportation (Caltrans), builds on prior research to develop, deploy, and test various metrics and methods to evaluate a large-scale real-time driver warning system, the Caltrans automated warning system, installed on Interstate 5 and State Route 120 near Stockton, California. Methods include the analysis of historical accident data over an 11-year period, a direct assessment of the operational behavior of the system correlated with accident data, and a study of the direct effects of real-time warning messages on driver behavior. Instrumentation deployed to facilitate these detailed analyses is described. The resultant body of data supports the correlation of measurable traffic flow parameters with relative traffic safety.

**TRIS Files:** TRIS, TRB

**Media Type:** Print

**Pagination:** pp 87-95

**Authors:** MacCarley, C Arthur  
California Polytechnic State University, San Luis Obispo

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**Subject Areas:** Highways; Operations and Traffic Management; Safety and Human Factors; I73: Traffic Control; I83: Accidents and the Human Factor

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**Appendix C: Presentations from IFSTTAR in a CalFrance Meeting in March 2012.**

Two presentations on Fog Detection Monitoring and Roadway Generation 5 are attached.

The related publications can be downloaded from the weblink below.

<http://perso.lcpc.fr/hautiere.nicolas/publications.html>

# Fog Monitoring by Highway Cameras

N. Hautière, E. Dumont, D. Aubert

# Historical Perspective

- 2001-now: fog detection by in-vehicle camera
- 2006-now: fog detection by highway cameras
  - 2006-2010: fog detection for road safety (SAFESPOT Project)
  - 2008-now: fog monitoring for transportation safety and efficiency
- CalFrance 2009: submission of a joint PATH (J. Misener, T. Kuhn, J. Sullivan) - LCPC (N. Hautière, E. Dumont, D. Aubert) proposal “Reliable Fog Monitoring With Conventional Roadside Cameras” rejected due to misunderstanding of the technology
- To try solving this issue, we published our work at TRB 2011 with the help of J. Misener

# “Visibility Monitoring Using Conventional Roadside Cameras: Shedding Light On and Solving a Multi-National Road Safety Problem“

A project supported by:



Raouf Babari, Ifsttar

Nicolas Hautière, Ifsttar

Eric Dumont, Ifsttar

Nicolas Paparoditis, IGN

James A. Misener, California PATH



# I-1 - Background

- In the presence of fog or mist, visibility is reduced. It is a source of paralysis for transport. Accidents are more numerous and more serious, e.g. **Tule fog in California**,
- Multinational problem : 700 annual fog-related fatalities in the USA and 100 in France,
- Airports are equipped with expensive and rare instruments to measure visibility (10.000 \$),
- IFSTTAR seeks to exploit the thousands of CCTV low cost cameras (500 \$) already installed along highway networks to estimate the visibility and inform road users on speed limitation,
- National weather agencies, like METEO-FRANCE, seek to integrate these information in their forecast models to predict accurately fog episodes.



Dense fog

Haze and mist

Pollution

Transportation  
safety

Weather observations

Air quality  
Health

# Outline

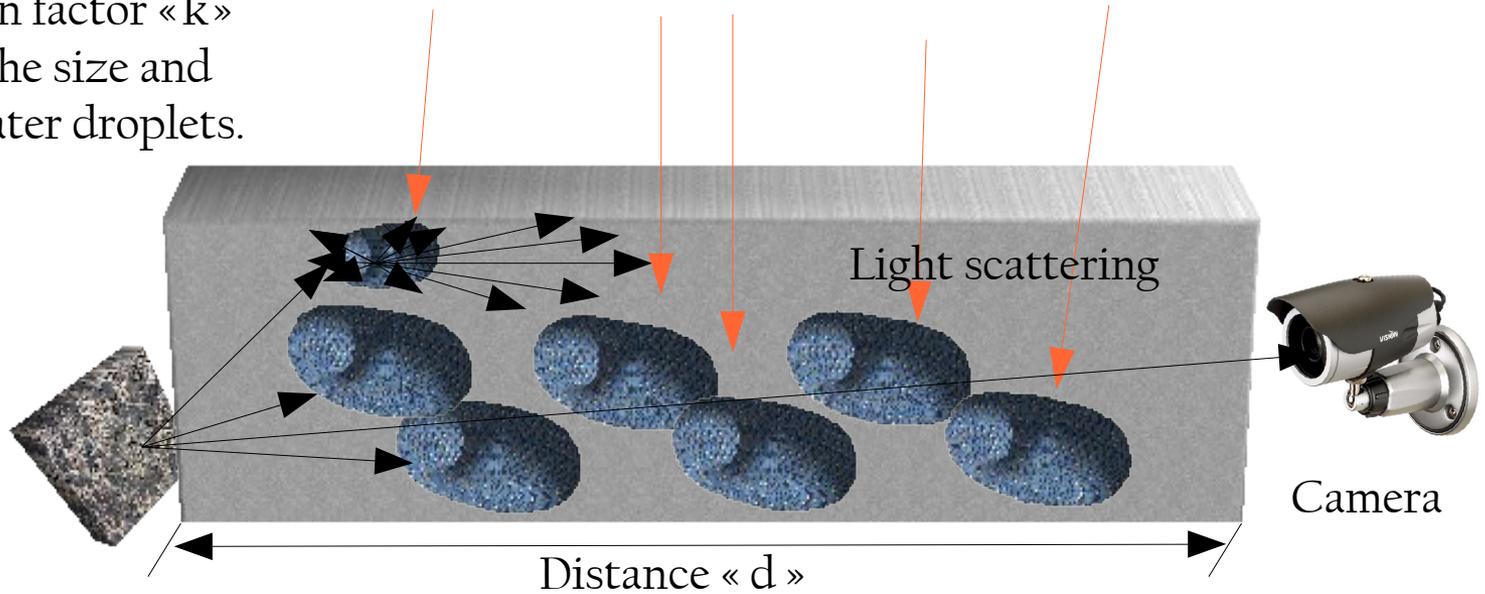
- Background
  - Physics of visibility
  - Related works
- Proposed method
  - Test site instrumentation
  - A robust visibility descriptor
  - A method to select diffuse surfaces in a scene
  - A novel visibility estimator
- Results
  - Qualitative results
  - Quantitative results
- Conclusion and Perspectives

# II -1- Physics of visibility:

## Vision through the atmosphere



- the extinction factor «k» depends on the size and density of water droplets.



- Luminance of an objet

$$L = L_0 e^{-kd} + L_f (1 - e^{-kd})$$

- Atmospheric extinction

- Atmosphéric Airlight

[Koschmieder, 1924]

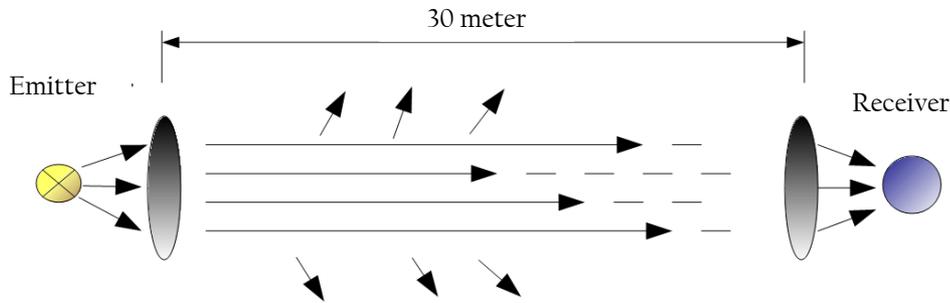
# Physics of visibility: Meteorological visibility

- Duntley [Middleton, 1958] gives a law of contrast attenuation in the scene:

$$C = \frac{L_1 - L_f}{L_f} = C_0 \cdot e^{-k \cdot d}$$

- $V_{Met}$  corresponds to the distance at which a black object  $L_1 = 0$  on the horizon sky of suitable size can be seen with a contrast of 5%.
- $V_{Met}$  can be estimated by:
  - An optical device
  - A camera

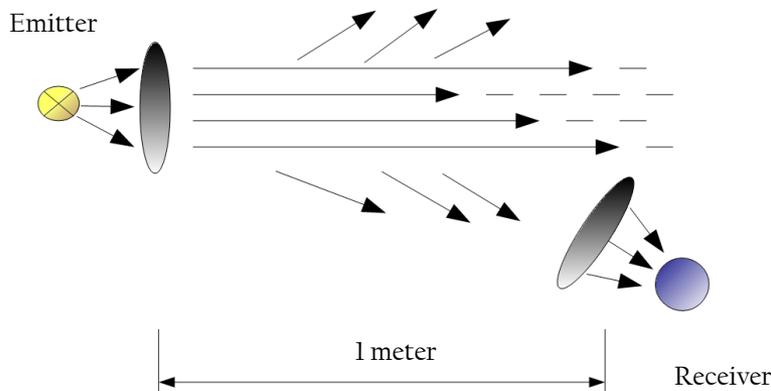
# Optical measurement of the visibility



*Fig: diagram operating principle of a transmissometer*

- The transmissometer estimates the extinction of a light beam during its path,

- The scatterometer estimates the amount of light intensity scattered by the atmosphere at a specific angle,



*Fig: diagram operating principle of a scatterometer*

- High cost (higher than 10,000 \$)

- 10% measurement error over a range of 0 - 50km

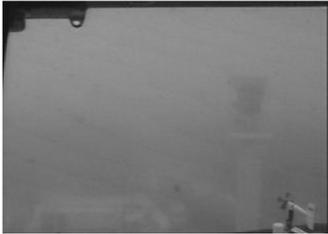
# 4- Camera-based methods for visibility measurement

● Visibility over several miles :  
Correlation between features in the image and  $V_{Met}$  .

● Highway visibility : 0-400 m  
Accuracy of the method <10 %.

USA : Clarus project (FHWA-MIT)  
[Hallowell, 2007]

- Estimators from all image features
- Decision using fuzzy logique
- Four classes of visibility (1km - 5km - 10km)



-EUROPE: Integrated Project SafeSpot  
[Hautière et al., 2008]

- Detection of contrasts higher than 5%
- Computes inflection point of Koschmieder's law



JAPAN : frequency features (WIPS)  
[Hagiwara et al., 2006]

- Assumes a flat road
- Accurate camera calibration needed

Poor visibility identification

Correlation with real data: 0.86

an accurate  
on over several miles

# III -1- Test site instrumentation



Fig: Images with different lighting conditions, presence of shadows and cloudy conditions,

## Test site of Meteo-France

- Scatterometer Degreane DF320 (0 to 35km)
- Luminancemeter LU320 (0 to 10,000 cd.m<sup>-2</sup>)
- Installing a camera  
640 x 480  
8 bits / pixel
- Matching weather data with the images



Fig: Camera



Fig: Luminancemeter

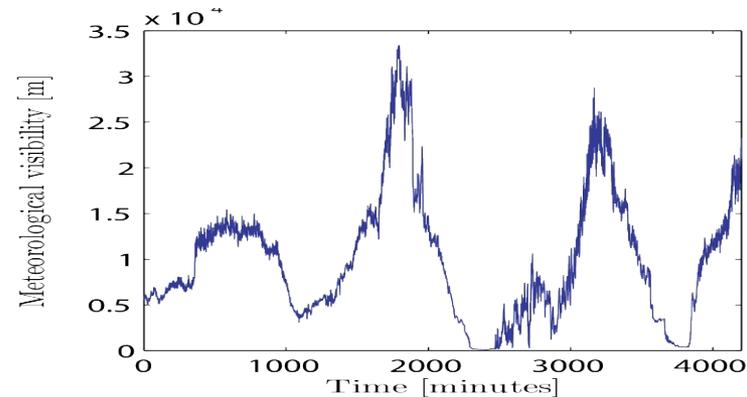
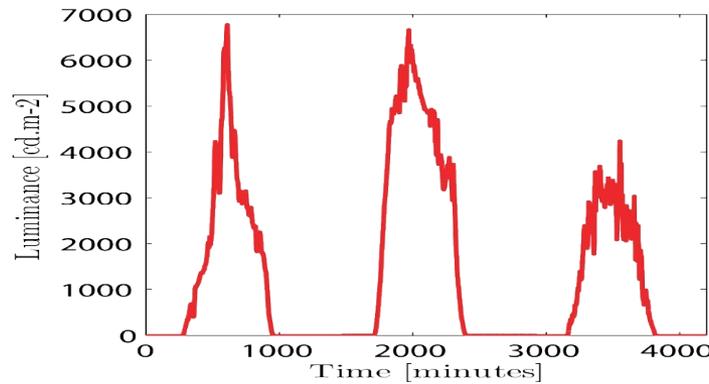


Fig: Variations in the luminance and visibility for 3 days of observation.

## III -2- State of the Art:

### Correlation between the gradient and the visibility



Fig : Original image:  
good visibility



Fig : Gradient in the  
image : good visibility



Fig : Original image:  
visibility is reduced  
by fog

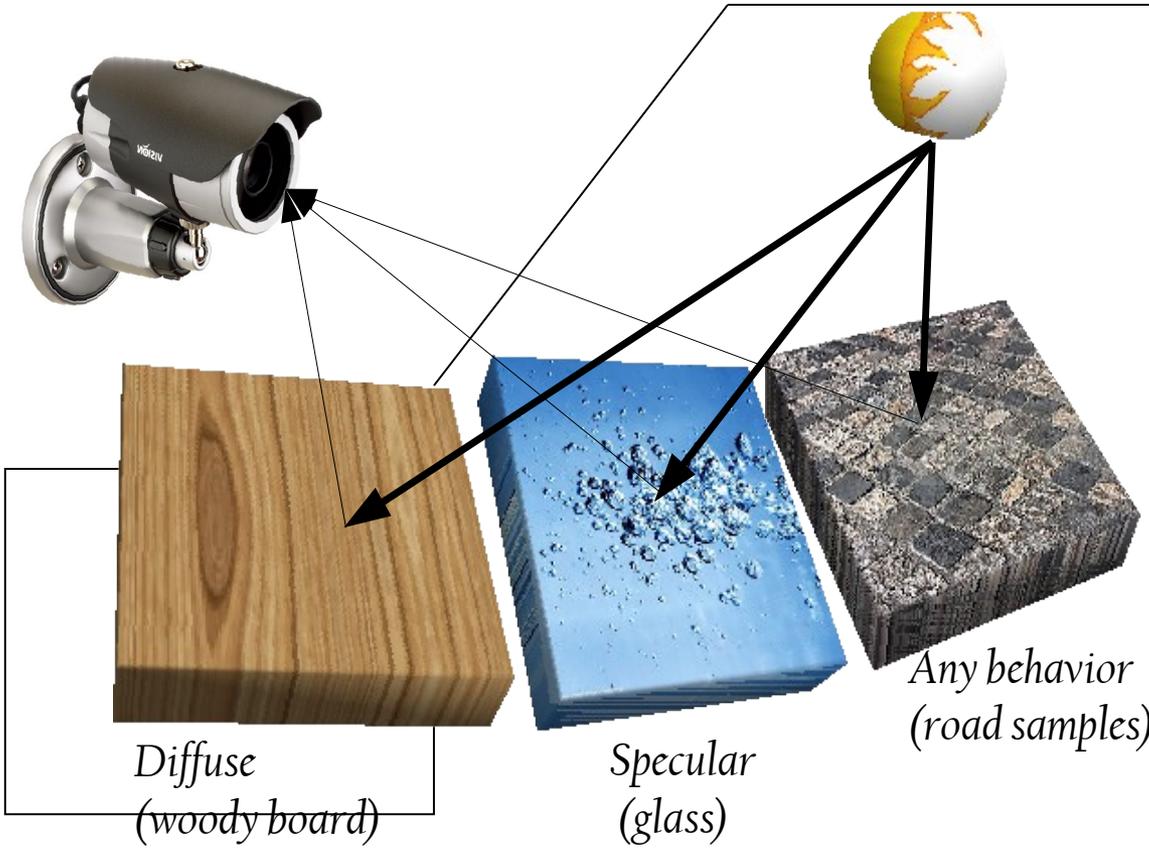


Fig : Gradient in the  
image : visibility is  
reduced by fog

- The gradient of intensity is computed for each pixel: it is the variation from black to white
- The image gradient comes from :
  - Depth discontinuities:
  - Discontinuities in surfaces orientation,
  - Changes in material properties,
  - Illumination variations.

# III -3- First proposal: A robust visibility descriptor

In diffuse surfaces of the scene:



- The contrast is **invariant with illumination variations**,  $L_{us} = \rho_1 \cdot \frac{E}{\pi}$
- It is thus expressed only as a function of meteorological visibility,  $L_{uf} = \frac{E}{\pi}$

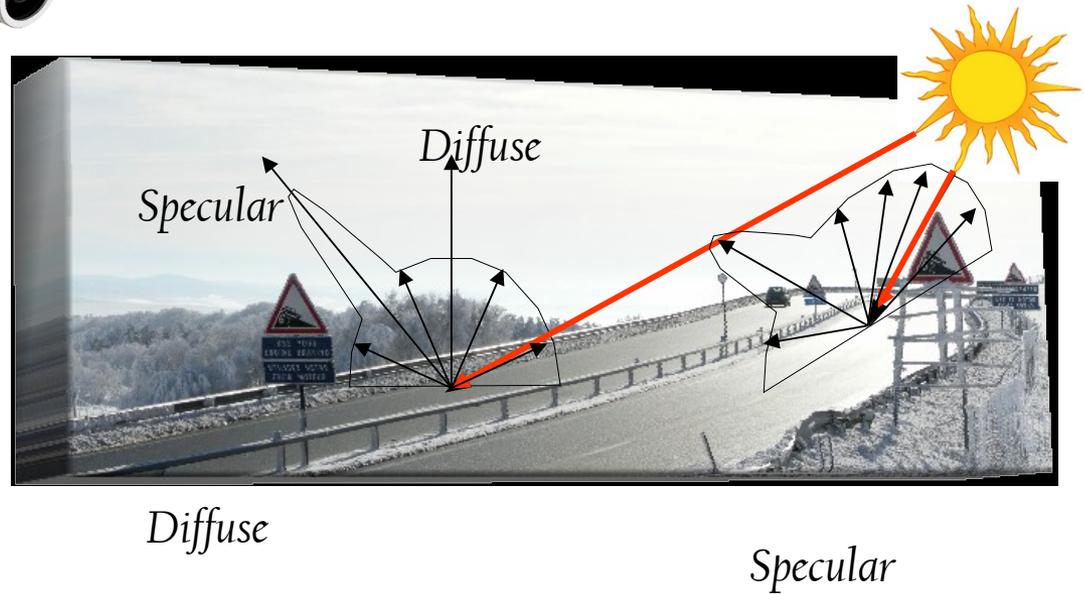
● At distance «d» and for a visibility «V» :

$$C_L = \frac{L_2 - L_1}{L_f} \approx (\rho_2 - \rho_1) \cdot e^{-k \cdot d}$$

# III-4-Second proposal: Selecting diffuse surfaces in the scene



- The temporal correlation is computed between :
  - The global illumination given by the luminance-meter and
  - The intensity of a pixel.
- It is the confidence that this pixel belongs to a diffuse surface of the scene.



$$P_{i,j}^L = \text{corr}(L_{i,j}, L_{\text{scene}})$$

- We do not assume that all surfaces have a diffuse behavior, but we select them in the image.

# IV -1- Third Proposal: A new Visibility Estimator

$$E^L = \sum_{i=0}^W \sum_{j=0}^H \frac{G_{i,j}}{A_{\infty}} \cdot P_{i,j}^L$$

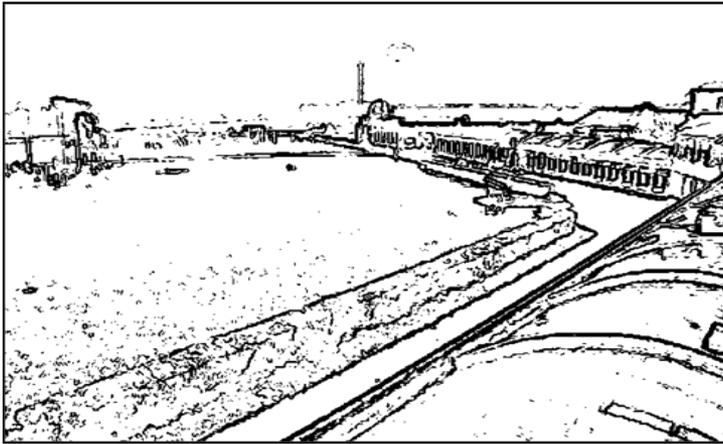


Fig : Gradient of the image

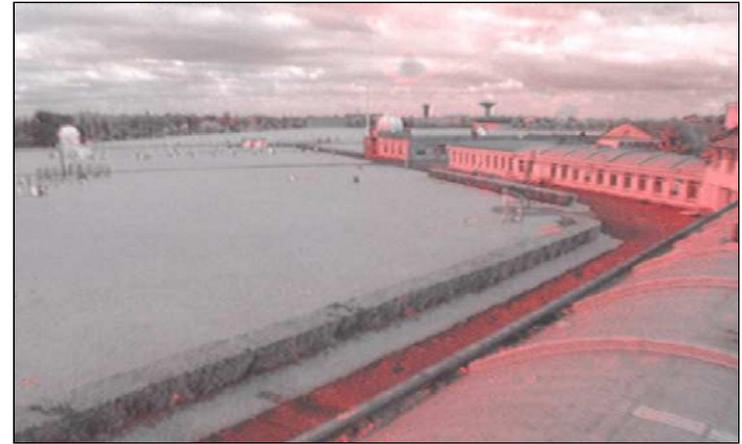


Fig : Confidence map

- The proposed visibility estimator is the weighted sum of normalized gradients  $G/A_{\infty}$
- The weight is the confidence  $P_{i,j}^L$  of each pixel to behave as a Lambertian surface

# IV -2- Experimental validation

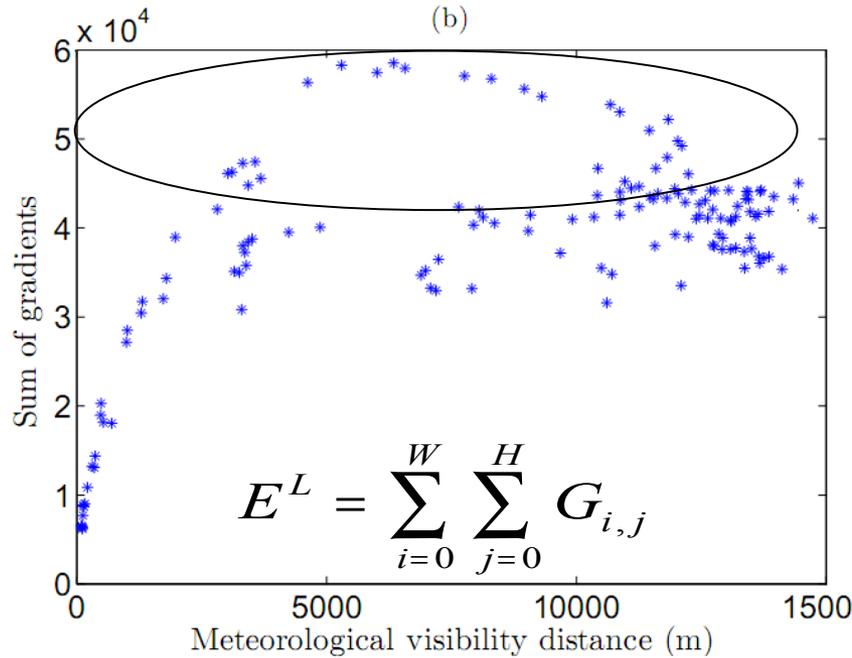


Fig : State of the art

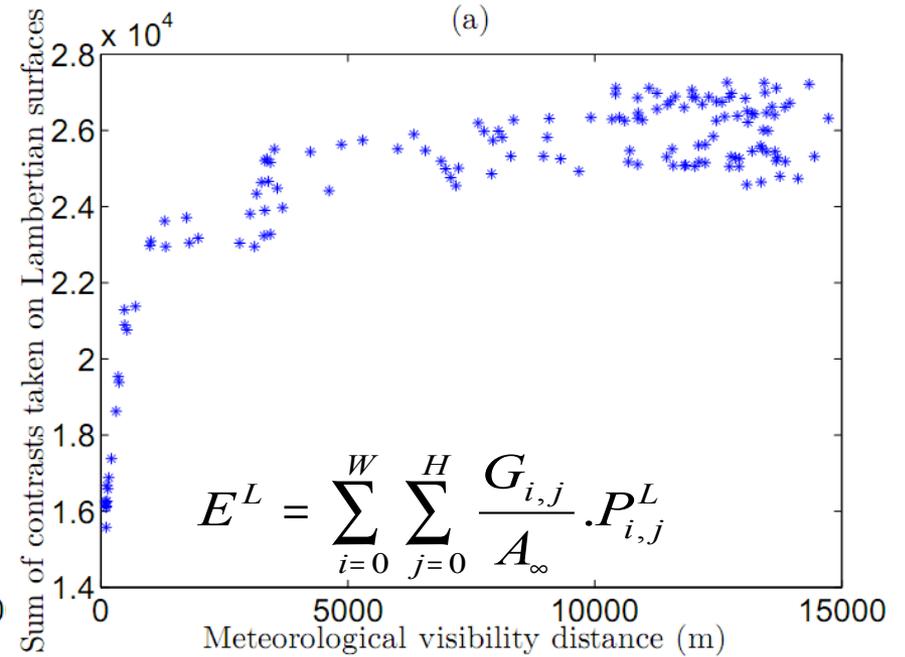
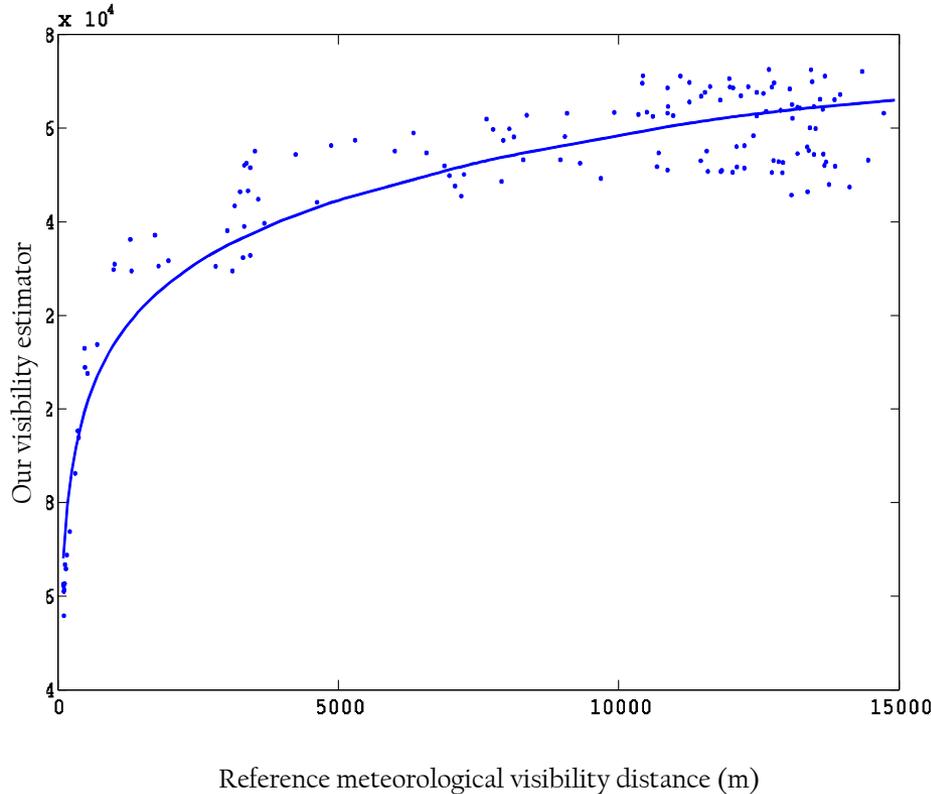


Fig : Proposed visibility estimator

- Our estimator has a more accurate response with respect to illumination variations and is a more reproducible measurement of visibility.

# V - Results

- Data are fitted with a logarithmic empirical model



$$\tilde{E}^L = A + B \cdot \log(V)$$

- The model is inverted and relative errors are computed

Application	fog	haze	Air quality	Correlation
Range of visibility	0-1 km	1-5 km	5-15 km	R <sup>2</sup>
Mean relative error	25 %	26 %	33 %	0.95

# V -Conclusion

- We propose a method which links the meteorological visibility to the sum of gradients taken on the Lambertian surfaces.
- We show that this estimator is robust to illumination variations on experimental data,
- This work has given both a fundamental and practical basis to consider deployment of our potentially life-saving real-time roadside visibilitymeter.
- Our method is easily deployable using the camera network already installed alongside highways throughout the world and therefore of high impact to traffic safety at marginal cost.
- Once deployed, our concept should increase the quality and the spatial accuracy of the visibility information :
  - can feed into weather forecasting systems.
  - can inform drivers with speed limits under low visibility conditions.

# What did we do since TRB 2011?

## 1. We proposed a model-driven approach instead of a data-driven one:

Babari, R., Hautière, N., Dumont, E., Brémond, R. and Paparoditis, N. *A Model-Driven approach to estimate atmospheric visibility with ordinary cameras*. In **Atmospheric Environment**, 45 (30): 5316-5324, 2011.

## 2. We developed further the potential applications:

Babari, R., Hautière, N., Dumont, E., Paparoditis, N. and Misener, J. *Visibility Monitoring using Conventional Roadside Cameras - Emerging Applications*. In **Transportation Research Part C**, 22: 17-28, 2012.

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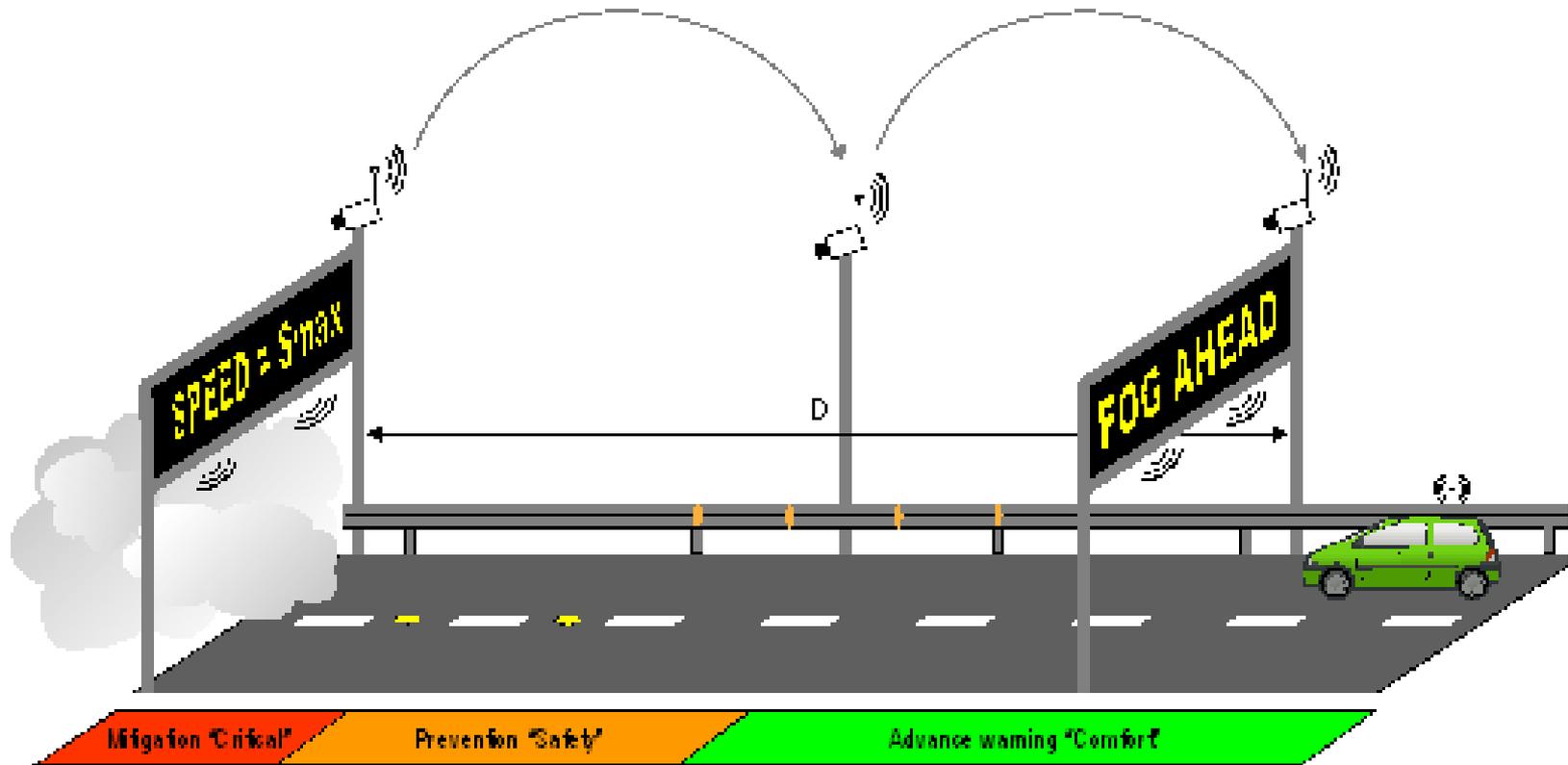
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# The Decentralized Fog-Pilot



$$S_{\max} = -T_r \gamma + \sqrt{T_r^2 \gamma^2 + 2\gamma V_{Met}}$$

$$D = \frac{1}{2} \left[ \frac{S_{\max}^2 - S_0^2}{\gamma} \right] + S_0 T_{latency}$$

# Our idea for further cooperation

- Develop a test bed in a California Valley subject to fog:
  - To collect data (image, visibility, traffic)
  - Validate the camera-based enabling technology
  - Develop a low cost “decentralized fog pilot”



# INTERNATIONAL ROAD CONGRESS

Innovation in Road Infrastructure



INTERNATIONAL ROAD FEDERATION  
FÉDÉRATION ROUTIÈRE INTERNATIONALE

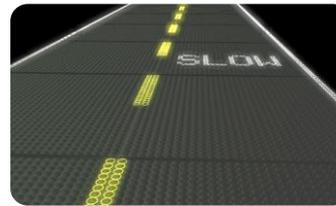
## Innovating in Road Infrastructures with R5G – The 5<sup>th</sup> Generation Road Nicolas Hautière – IFSTTAR, France Chantal De La Roche – IFSTTAR, France

MOSCOW, RUSSIA

22–24 NOVEMBER 2011

# Need for R5G in France

- The current image of road transport
  - Bad image
  - Environmental cost too high
  - Excluded from greening politics
- Innovation in road transport
  - Numerous innovations are available in labs



- Lack of risk taking by public authorities (at least notional ones)
- Technological transfer and industrialization
  - Need for full scale test beds
  - Identification of implementation tools
  - Renewal of research thematics

# Benefits of R5G

- Maintain the RAMS of road networks
  - Modal shift to guided transport
  - However, the road network must remain the same
- Reinforce industrial leaderships
  - Reduce social dumping
  - Design of new business models
- Reaching societal objectives
  - Reduction of carbon footprint of roads
  - Creation of new jobs
  - Renewal of education programs





# FOREVER OPEN ROAD

Redefining Highway Transport for the 21st Century



- Gather existing ideas and provide a solution which fulfills our future needs:
  - The adaptable road
  - The automated road
  - The climate change resilient road
- A concept which will...
  - Be adapted to future transport demand
  - Provide a low cost automated transport
  - Produce substantial benefits
- **Be Forever Open**



Winner of the 2011 Road Design and Construction prize – World Road Congress



# The Adaptable Road

Porous, low noise surfacing, light reflecting for night time driving.

Adaptable to freight transport communications, location and monitoring requirements.

Flexible, durable surface, self repairing/self-cleaning and instant crack repair.

In-built sensors for traffic monitoring/control and condition monitoring.

In-built lane control/vehicle guidance.

In-built power system for electric vehicles.

Removable/self-cleaning drainage reservoirs feeding carbon capture planting.

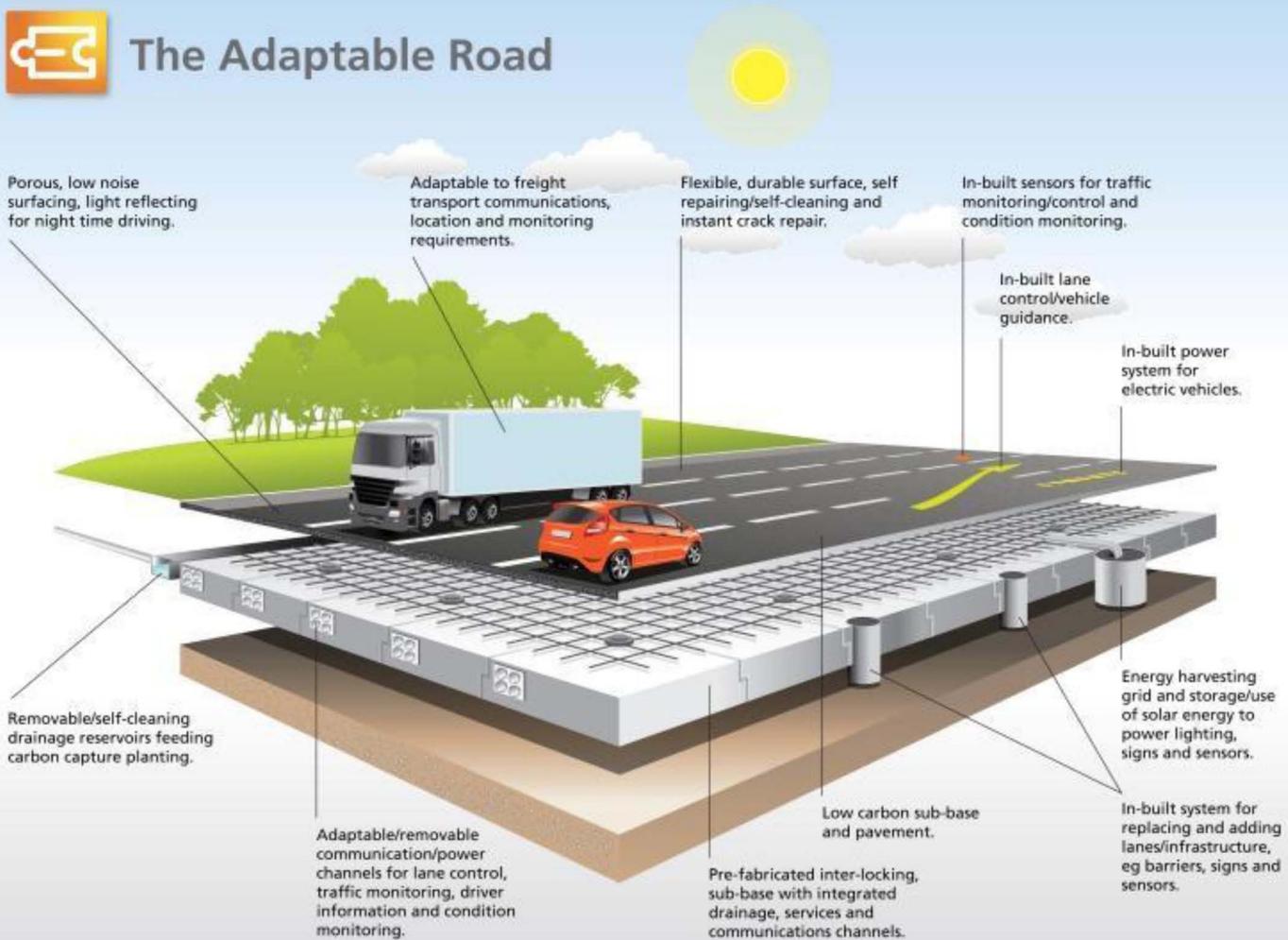
Adaptable/removable communication/power channels for lane control, traffic monitoring, driver information and condition monitoring.

Pre-fabricated inter-locking, sub-base with integrated drainage, services and communications channels.

Low carbon sub-base and pavement.

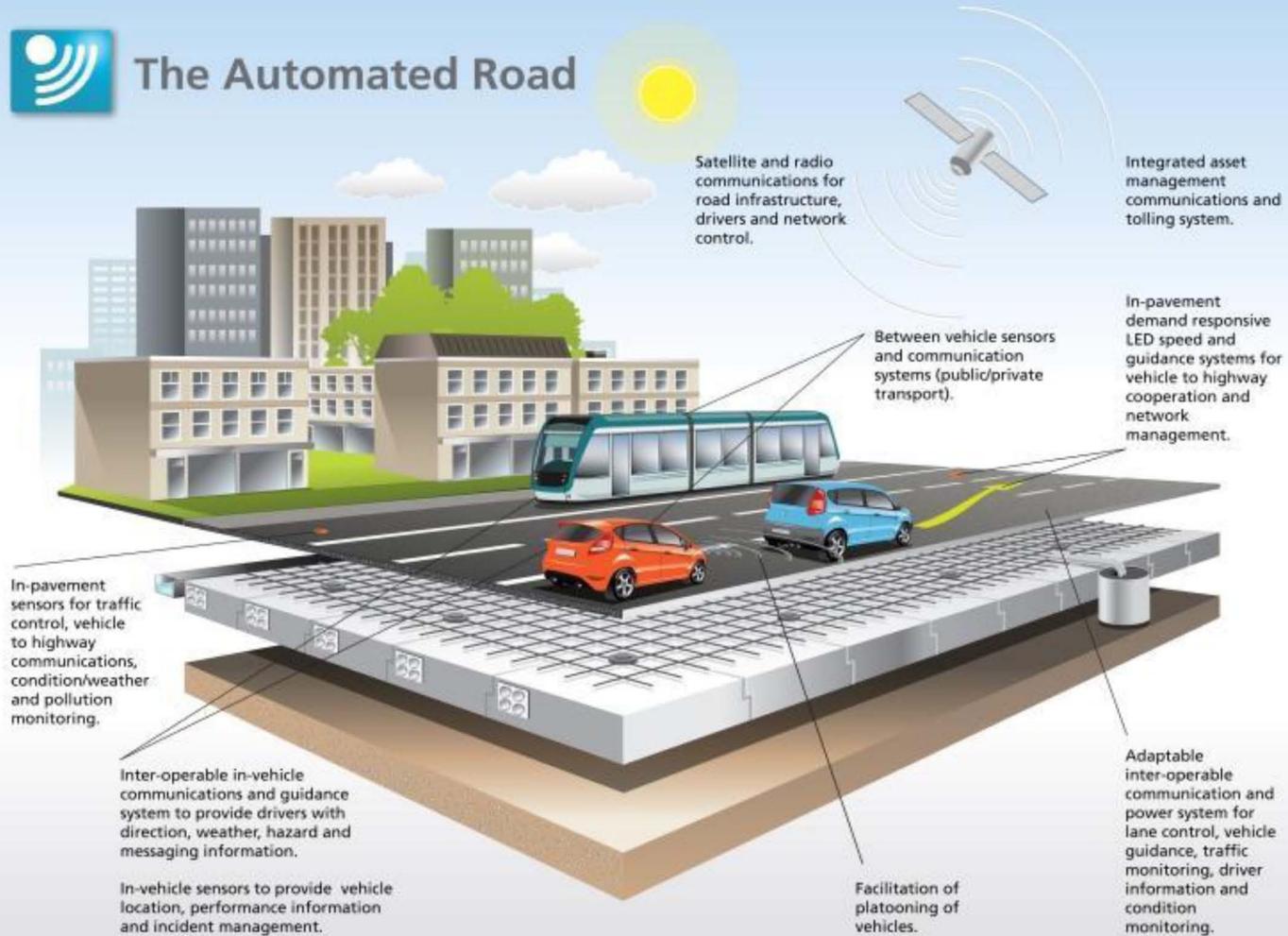
Energy harvesting grid and storage/use of solar energy to power lighting, signs and sensors.

In-built system for replacing and adding lanes/infrastructure, eg barriers, signs and sensors.





# The Automated Road





# The Resilient Road



NEW FP7-FP8  
PROJECTS

# R5G embedded in a strong European alliance through FOR

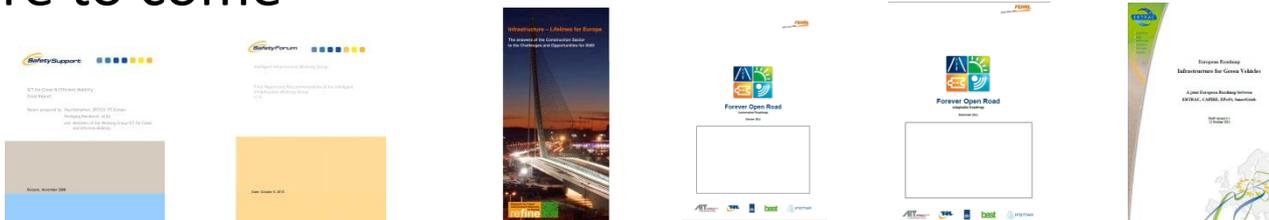
- Already included in research programs and agendas



- Already integrated in European roadmaps



- More to come



# R5G - Design, construction and operation of full scale research demonstrators

- The French project R5G combines the three elements of the Forever Open Road following a systemic approach, in order to build full scale demonstrators so as to demonstrate the synergy among them and provide acceptable solutions.

## → The 4 elements of R5G

- The adaptable road
- The automated road
- The resilient road
- **The acceptable road**



## • R5G is already successful

- Industry claims for a R5G label
- SETRA claims for a common message between R5G program, innovations at early stages, and « Routes et rues » program, mature innovations for public procurement



# An Example: Components for an Energy-Efficient Road Transport

Construction

Recycling of Materials  
Cold mixes



Low rolling resistance pavements



MIRIAM

Modular urban pavement



Energy

Mechanical energy



INNOWATTECH  
ENERGY HARVESTING SYSTEMS

Geothermal energy



bast

Solar road



Mobility

Inductive charging



Eco-traffic management



eCoMove

Autonomous shuttles





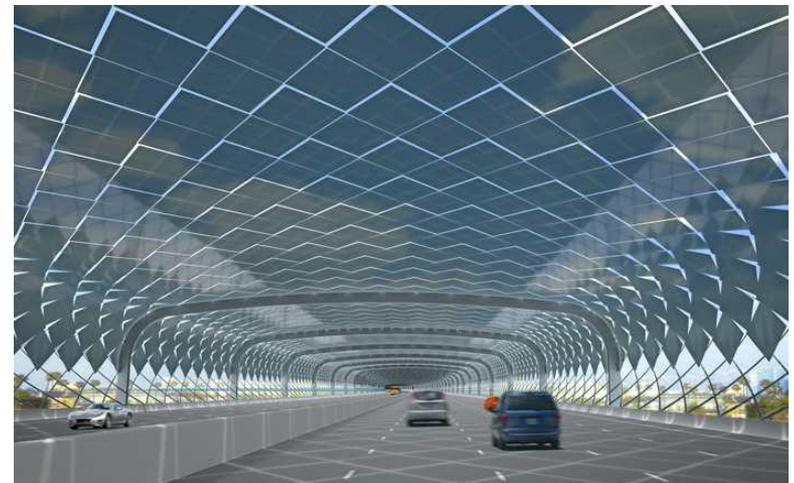
# Priorities of R5G demonstrators

	Urban networks	Periurban networks	TEN-T networks	Local networks	
Low carbon design and construction	High	High	High	High	 Adaptable road
Safe and smart operations	High	High	High	High	 Automated road
Resilience and energetic efficiency	High	High	High	High	 Resilient road
Juridical, social, individual, environmental acceptability	High	High	High	High	 Acceptable road



# Innovation Themes

- Human-centered design
- ITS Cooperative Systems
- Active traffic management
- Co-modality and intermodality
- New materials – economy of natural resources
- Business models
- Accidentology – road safety
- Road as energy provider
- Natural risks
- Environment
- Maintenance
- Modular pavements



*The solar road by Mans Tham*

# Systemic approach

Needs of road operators  
User expectations  
Societal objectives



Resilient road



Automated road

Needs of road operators  
User expectations  
Societal objectives



Adaptable road

Needs of road operators  
User expectation  
Societal objectives

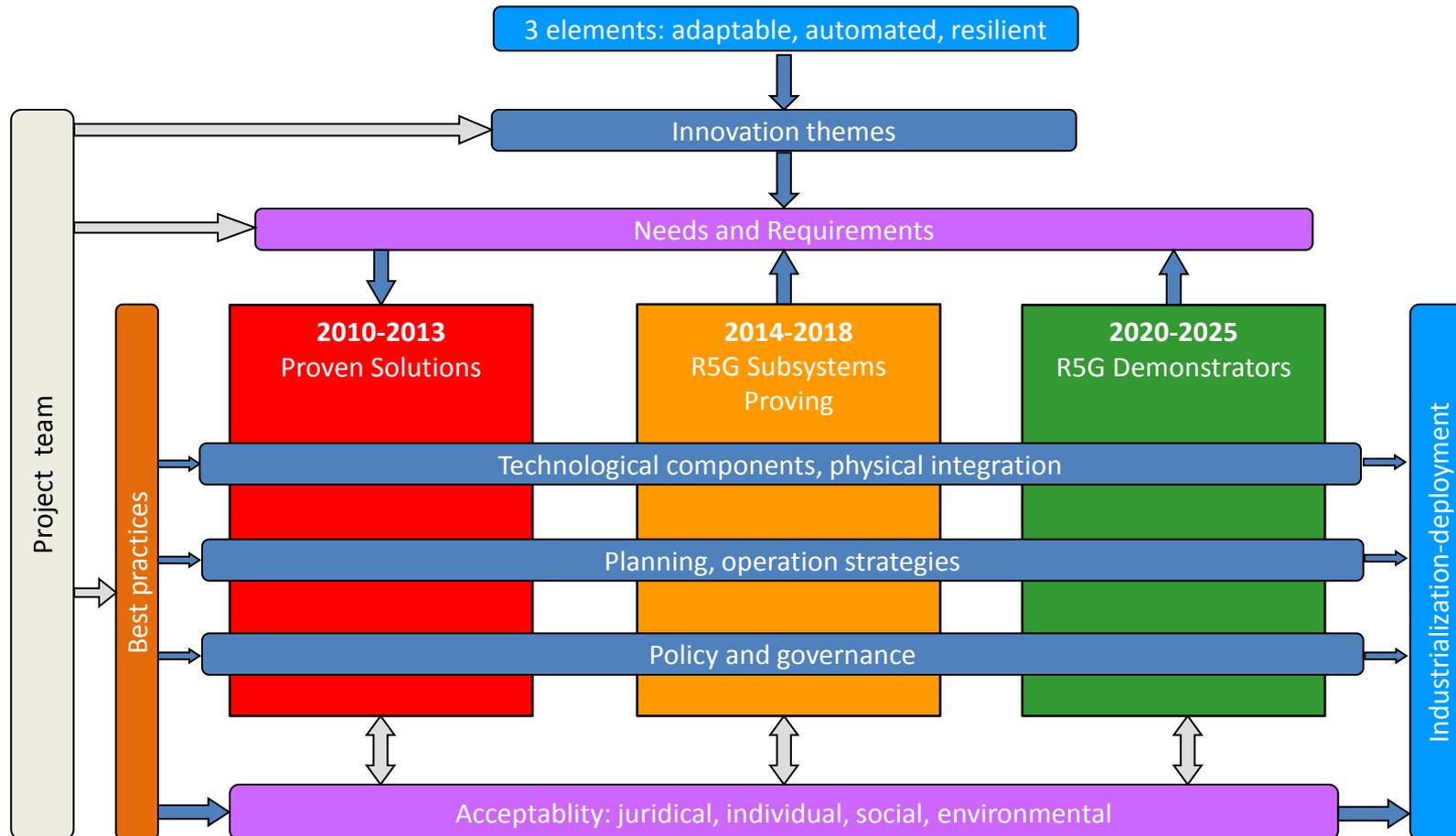




# R5G Demonstrators under Development

- Energy harvesting by the road (solar, wind, geothermal, mechanical, chemical, etc.) **together with our colleagues from BASt (Germany)**
  - Urban eco-mobility solution to be deployed in eco-neighborhoods or redesigned city hearts
  - High speed automation of motorways on dedicated lanes
  - Self-explaining and efficient secondary interurban local networks
- + 1 dedicated taskforce related to the acceptable road**

# Implementation





# Conclusion and Perspectives

- **The R5G project is building a fully integrated approach of road transport**
- **It is currently developing four full scale demonstrators which aim at proving the feasibility and the synergy among lots of innovations in terms of:**
  - Design and construction,
  - Management and operation including vehicle operations,
  - Resilience to climate change,
  - Acceptability.
- **R5G is embedded into a strong European alliance, especially the Forever Open Road program, which is the flagship program of FEHRL.**



# Questions

- R5G program managers

[nicolas.hautiere@ifsttar.fr](mailto:nicolas.hautiere@ifsttar.fr)

- European affairs: FOR project, iMobility Forum, ERTRAC
- Coordination of the different demonstrators
- Industrial contacts related to road operation

[chantal.de-la-roche@ifsttar.fr](mailto:chantal.de-la-roche@ifsttar.fr)

- Pilot of the GERI
- Industrial contacts related to road construction
- Contact with ADEME
- Pilot of the demonstrator related to road and energy

- Reference

N. Hautière, C. De La Roche. “Innovating in Road Infrastructures with R5G – The 5<sup>th</sup> Generation Road”. *IRF International Congress: Innovation in Road Infrastructure*, Moscow, Russia, November 2011